IFLA 2025
Guiding landscapes
Nantes France

BOOK OF SHORT PAPERS

IFLA World Congress
Nantes, France

WELCOME TO IFLA 2025



Dr Bruno Marques
President, International Federation of Landscape Architects

The 61st IFLA World Congress, held in the vibrant and pioneering city of Nantes under the theme "Guiding Landscapes," marks a pivotal moment for our profession. As President of the International Federation of Landscape Architects, it fills me with immense pride to witness the culmination of years of dedicated work by the French Federation of Landscape Architects (FFP) in bringing together this global gathering.

With its forward-looking theme, this IFLA World Congress underscores the critical and proactive role our profession must play in navigating the unprecedented environmental challenges facing our planet. The impressive global response, reflected in the vast number of high-quality submissions, speaks volumes about the commitment within our community to lead the way toward a more sustainable and resilient future.

The theme "Guiding Landscapes" has resonated throughout the diverse programme, which encompasses several key thematic tracks exploring our profession's leadership. These include professional practice, examining new roles and standards for landscape architects; territorial and scale challenges, focusing on steering regional futures through integrated design; and the future of education, reimagining curricula for emerging challenges. Together with high-level representation from numerous UN agencies, the World Bank, our allied built environment organisations and local stakeholders, these and many more themes provide a vital platform for in-depth discussions and the sharing of innovative solutions.

I extend my sincere gratitude to the French Federation of Landscape Architects, especially President Henri Bava and the entire Organising Committee, for their exceptional leadership and dedication in hosting this landmark event. The tireless efforts of the various committees, sponsors, and volunteers have ensured a seamless and enriching experience for all participants.

The success of this Congress lies not only in the quality of the academic discourse but also in the spirit of collaboration that defines our global community. The connections forged and the ideas exchanged in Nantes will undoubtedly inspire and empower landscape architects worldwide to continue pushing the boundaries of our profession in service of a healthier planet. As we move forward, let us carry the momentum and insights gained from this Congress to amplify our collective impact. The challenges ahead require clear guidance, and landscape architects are uniquely positioned to provide the vision and expertise needed to shape a more sustainable and equitable future for all.

WELCOME TO IFLA 2025



Henri Bava
Congress and FFP President

The IFLA WORLD 2025 congress in Nantes will take place in the context of global climate change, where adapting and building resilience in cities and territories requires profound and systemic transformations.
The profession of landscape architects plays a central role in these efforts, promoting urban approaches that prioritize living soils, biodiversity, and sustainable water management. It operates across all scales of metropolitan, agro-forestral, industrial or/and natural territories. It helps to anticipate environmental changes through participatory project approaches that make transformative dynamics accessible to inhabitants.

To support the transformation of territories, landscape architects develop nature-based solutions: to this end, they leverage all available sources of socio-environmental information, data systems and others digital tools. Combined with artificial intelligence, these tools now complement the survey and representation methods already at their disposal for their projects. The IFLA WORLD 2025 Congress is an opportunity to share best practices and insights from practitioners and researchers around the world, aiming to make the actions of landscape architects and associated professionals even more virtuous and effective.

WELCOME TO IFLA 2025



Frédéric Dellinger,
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The question raised by the IFLA 2025 congress in Nantes, 'Guidind Landscape' first integrates two postulates: we now live in a fluctuating world of socio-environmental crises for which human activities are largely responsible; faced with this uncertainty, developing our adaptability and robustness is probably one of the most promising ways to respond to it. To what extent then, do our training and the exercise of our profession as landscape architects at the service of cities and territories offer us tools to respond to these crises?

On one hand, each of our projects is part of a geographical and agronomic reality; the conditions of the site are our guide, our compass. On the other hand, working with the living (and for the living) teaches us humility and acceptance that total mastery of the project is almost impossible. Our profession would thus have all the cards in hand to accompany, "guide" the territories in their necessary transformations to respond to the upheavals at work. 'Guiding Landscape', therefore questions both the conditions and dynamics of the site as 'guide' of the project, but also about the landscape architects as 'guides' of the actors of the territory.

This question is divided into ten themes; the first half focuses more particularly on the scale of the city, and the second on the scale of the territory. These themes address both environmental and societal conditions of the project. To these themes are superimposed the questions of nature-based solutions, but also the new tools carried by artificial intelligence and an increasingly massive data collection. But our projects are not just a synthesis of ecological solutions to meet societal needs. The aesthetic dimension and spatial quality of the projects we develop remain at the heart of our DNA.

Over 800 stakeholders from 58 countries responded to the call for papers with proposals of a very high standard. The lengthy and difficult selection process resulted in half of these proposals being accepted, either for oral presentations during sessions or for a poster. The abstracts of these proposals are compiled in the conference proceedings (Abstract Book). Speakers selected for an oral presentation were invited to submit a short article based on their talk. Over 150 articles were submitted, which you will find gathered in this publication, classified according to the themes chosen by their author. In the introduction to these articles, you will find a brief summary, for each of the ten themes, of the diversity of research and/or projects presented in Nantes between September 10 and 12, 2025. I would like to finish this introduction by wishing you a good reading, the pleasure of exploring these texts in all their diversity and which I hope will be filled with many beautiful discoveries and new knowledge.

Acknowledgments

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Congress topics

Topic 1: Guiding cities

Through what is alive (ecosystems, rainwater, soil, rivers)

1.1 Cities as ecosystems

On the eve of the sixth mass extinction of species, and in the face of accelerating environmental change, we need to move from observation to action and reconsider urban ecosystems: the built and the unbuilt, the organic and the inorganic, the living, whether it be human or non-human. This objective encourages the cross-fertilisation of skills between different fields: architecture, ecology, engineering, landscape, urban planning, etc. In this context, what impact can the prioritisation of living organisms pre-existing to the project have on our urban landscapes? How can we better integrate ecological processes at different scales and their constraints into our urban areas? More specifically, biodiversity issues require us to think in terms of time, seasons, growth and senescence processes, as well as ecological dynamics and acceptance of the spontaneous. How do we choose between local and 'exotic' plant species? But also, how does the ongoing progress of 3D software offer the landscape project new ways of representing the living world and its dynamics? Can AI help us increase the value of new, mass-collected environmental data?

1.2 Soil management

Understanding the soil and its condition is a fundamental step in understanding the potential of a site to host ecological and sustainable projects. Soil not only supports plant and animal life; it is also one of the main reservoirs of biodiversity on earth. It is a major carbon sink and an essential receptacle for rainfall thanks to its retention capacity (soil also acts like a 'sponge'). Together with the flora and fauna that thrive in them, soils are our main source of food and the best climate regulators. Yet for more than a century, humanity has never neglected and polluted them to such an extent. In major cities, fertile soil has become so scarce and precious that new players such as "technical soil manufacturers" are now emerging. How can landscape architects address these issues? When is the right time to incorporate these considerations into the project? How do frugal soil strategies affect landscape design? What potential can emerge to poor or to polluted soils?

Topic 1: Guiding cities

Through what is alive (ecosystems, rainwater, soil, rivers)

1.3 Rainwater and water landscapes

The successive revolutions in town planning and architecture from the nineteenth to the twentieth century, first under the influence of hygienic thinking, then with modernity, and more recently with the concept of ”smart cities”, have gradually distanced city dwellers from their geographical environment. Rainwater and waterways have been channelled and buried, while nature has more often than not been reduced to a mere decorative element. These actions, based on the efficiency and rationality of engineering, have considerably reduced the resilience of our cities to the risks of flooding and heatwaves. It is now time to adopt the porous city and ’sponge’ city models, where water is slowed down, distributed, infiltrated and purified, thanks to and with the soil and vegetation, according to the principles of regenerative hydrology. Having tried to manage our rivers, we now need to relearn how to live with them. All over the world, cities are changing their relationship with the rivers that flow through them and the wetlands that surround them. What tools and strategies can we implement to meet the challenge of water, both as a resource and as a factor of risk? How does this (re)valorisation of river routes open the way to new aesthetic exploration around the re-appropriation of landscapes? And how can new technologies such as drone scanning and point clouds enrich project approaches?

With society (art, design, consultation, uses)

1.4 Use, memory, artistic creation

The landscaping project also involves designing living and convivial spaces, promoting diversity, intergenerational exchanges and social cohesion. Today, when it is unthinkable to develop a project without incorporating contributions from local residents and stakeholders, as well as an educational dimension aimed at the general public, what role does the landscape architect's expertise play in the creation of shared spaces? And for what social justice? What place should we leave for uses or events, what place for art, for artistic creation, for what "landscape (infra)structure"? How can we reveal to residents and/or tourists what is "already there" or the memories of this area? Aren't these memories also great resources for project design? The landscape is our everyday living environment, but to what extent does it not also provide a setting for the best of our societies? If landscape architecture and art already have a rich history, how can we participate in the new synergies between art, memory and ecology?

1.5 Participatory approaches and governance strategies

The demand for residents to participate in projects relating to their living environment requires us to change our practices and apply appropriate methodologies and teaching methods, whether through information, consultation, co-design and co-construction. This is illustrated by the need for a 'bottom-up' approach in which the knowledge and opinions of local people and their perceptions of their environment are taken into account. This corresponds with the definition of the concept of landscape in the European Convention, which " means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors " (article 1. a.) and which leads to the definition of a "landscape quality objective"´designating " the formulation by the competent public authorities of the aspirations of the public with regard to the landscape features of their surroundings " (article 1. c.). Faced with these challenges, what changes can be observed in the role of landscape architects (mediators, advisors, etc.) within multidisciplinary teams? What role should elected representatives and the technical departments under their responsibility play in these debates? What role should civil society (associations, public institutions, economic players) play? What participatory approaches should be adopted to achieve what results with the greatest possible representativeness (inclusion)? To what extent can landscape architects contribute to social equity, inclusivity, and accessibility as well as to a peaceful living together and to the health of all? What timescales should be envisaged and how should this work be remunerated?

Topic 2: Guiding territories

By changing the design of regional projects (energy landscapes, agroforestry, risks)

2.1 Tools for intervention at different scales, for multifunctional landscapes

In the context of accelerated climate change (and the risks and discomforts that go with it), in relation with the massive artificialisation of agricultural and natural areas, what role do landscape architects occupy, or should they occupy, in the planning and management of anthropized territories? How can they adopt the new technologies for data collection and AI-enabled data enhancement? Are landscape architects making a comeback in the debate on cities and contemporary urban planning issues? What skills can landscape architects bring to multi-disciplinary teams, whether to help cities expand within their own regions or to support them in their reinvention and reconstruction? We need to look at the conditions under which the profession can operate at these scales, and at the positioning of 'urban' projects as a lever for landscape projects.
The development of hydraulic, solar and wind energy is also having an ever-increasing impact on our environments. Are we at the dawn of new "technological" landscapes and a renewal of aesthetic references? How should we interpret the resistance of local populations to these changes, and what role can landscape architects play in these debates?
With regard to territorial transformations, the rise of renewable energies and the greening of territories questions the confrontation, within non-urbanised territories, between natural territories and productive territories. The search for optimisation leads to multifunctional territories. Does this greening of the countryside put the landscape architect back at the heart of the challenges facing our agricultural, fish farming and forestry landscapes? How can these landscapes be more respectful of living organisms, soils and health, and how can we participate in their emergence and deployment?

2.2 **Tools for reinventing territories in situations of risk and environmental change**

In certain areas, the need to take account of the impact of natural hazards (cyclones, heatwaves, fires, floods, etc.) and their environmental consequences (retreating coastlines, soil deterioration, desertification, etc.) has led to the development of tools and methodological approaches that combine different scales of consideration. How can these tools also benefit from AI in the analysis of the exploding quantities of data provided by new reading technologies? The aim is no longer simply to protect against or control these risks, but rather to support local populations in accepting them, with the timeframes and modifications they entail. The aim is to propose resilient layouts and arrangements. These transformations are also accompanied by a necessary change in people's perception of the notion of risk, inviting projects to play an educational role in understanding the dynamics of living things, which, it should be remembered, often develop over several generations. They also encourage a better articulation between built and unbuilt areas, between landscapes and territorial infrastructures. The layouts and construction need to be designed in an integrated way rather than separately. This is leading to changes in the professions and in the make-up of project management teams. Given these changes, what role could landscape architects play? Environmental change is accelerating the pace of geographical and ecological upheaval. In addition to the potential loss of emblematic landscapes, inhabited areas are being directly threatened, for example by retreating coastlines. These changes could trigger massive population movements. How can our tools and methodological approaches as landscape architects accompany these upheavals, and perhaps limit their most significant impacts?

With legislative and social advances in planning (planning law, nature and society, heritage landscapes)

2.3 Organisation of large territories

Over the centuries, regulatory texts relating to the planning and management of territories have evolved to accompany and modify their transformations. The frameworks, scales and objectives have varied, keeping pace with socio-economic developments as well as with evolving democratic aspirations and new knowledge about the complexity of the world. The approaches and situations vary widely from country to country and the different environmental geographies. What recent advances have been made and what new challenges do these documents face in terms of managing urban sprawl, integrating the expectations of multifunctional territories and integrating and/or mitigating environmental change? What differences can be observed between countries and their contexts in terms
of the development of these documents, and what impact do they have on these societies? How can landscape architects participate in these societal reflections and play a part in resolving these issues? More specifically, how can we reconcile, for example, food sovereignty, heritage 'food' landscapes, the environment and the European Landscape Convention?

2.4 Towards a right for nature

Nature and landscape are already subject to the law and will be increasingly so in the future. In France, the Loire River is the focus of a major campaign by associations and scientists to gain recognition as a legal entity and, ultimately, to create a 'parliament' to defend the rights of this natural entity. Landscape and biodiversity issues are trying to find their place in urban planning documents and in the creation of the "right to build". But how can we reconcile the complexity of concepts such as "landscape integration" or "cohabitation with living organisms" with a land law that aspires to be clear and pragmatic? How does the presence or absence of a nature/culture dualism in a society influence the way this notion is considered in legislation? More specifically, how do differences in understanding of the notions of 'nature' and 'landscape' interact with the law and planning expectations? If the concept of 'nature alongside man' is an approach to living things that is common in Western societies, what about the concept of landscape?

2.5 **Evolution of heritage landscapes**

The rapid pace of global warming is already having a visible impact on all landscapes, including those deemed worthy of protection because of their natural or cultural heritage value. In addition to the changes already observed (changes in farming practices, conflicts, natural disasters, etc.), the acceleration of climate change raises new questions about what defines the value of a landscape and its ability to endure beyond the transformations it has undergone. It is becoming imperative to accompany these changes by working on the collective imagination associated with these landscapes. The concept of the "cultural landscape", adopted in 1992 by UNESCO's World Heritage Committee, has also made it possible to consider the heritage value of the "organically evolved landscape". These landscapes need to evolve to retain their heritage value, while at the same time incorporating the changes taking place in their socio-economic context and because of climate change. But what do we do if some of these landscapes are no longer able to adapt to their "new" environment*?* Wouldn't the challenge be to imagine other forms of conservation, between restoring them to their original state and replacing them in a way that preserves the spirit of these landscapes? Can virtual technologies help us to understand and communicate about historical landscapes? This also invites reflection on the protection of intangible heritage linked to know-how and the relationship between man and nature...? How can regulatory documents evolve to help regulate these issues, and what role should landscape architects play in this?

Summary of submitted papers

The summary of the scientific papers presented in Nantes was prepared by Frédéric Dellinger, with the invaluable assistance of Denis Delbaere, Antoine Jacobsohn, Myriam Laidet, and Yann Nussaume.

Topic 1: Guiding cities

1.1 Through what is alive (ecosystems, rainwater, soil, rivers): Cities as ecosystems

This theme around biodiversity has generated a wide variety of responses, ranging from work on plant pallets (in Europe, Australia, or China, for example), to toolkits used in the landscape project to, or from local vegetation and/or work on the renaturation of wastelands. Other communications also address issues related to the impacts of climate change on coasts
(China), rivers (India), historic centers (China), trees or the development of biodiversity in cities. AI is the subject of a few communications, such as for example at the Simulation Service for Results on the Renaturation of Wastelands (United Kingdom), biodiversity development modeling, or mapping assistance (pollution data for example, or aerial photo analysis, both in China).

1.2 Through what is alive: Soil management

The proposed papers on soils present several multidisciplinary scientific studies studying: the creation of urban «technosols» from waste (France), limiting desertification in the Madrid forest through work on water circulation and tillage, the development of soil analysis tools for designers and mine renaturation (Turkey). Others develop an educational project (students from different backgrounds develop a project on a vast mineralized surface in Milan) or address the place of soil in their approach to landscape architect projects. Finally, coming from Korea, the creation of red clay pathways in parks, to practice barefoot, at the service of one's health.

1.3 Through what is alive: Rainwater and water landscapes

This theme is addressed both on the American continent (north and south), as well as in Europe and Asia. A majority of communications address the issue of rivers, at the crossroads of renaturation issues (renaturation of a channeled river in Belgium, buried in

Seoul, concreted in southern Spain), to limit the risk of flooding (up to the subsidence of a city in the Philippines), from memory (industrial memory in the United States, traditional approach to the garden and geography in China or cultural memory of indigenous populations in Brazil) or to develop social ties or health (AI analysis of the impact of the blue stream, a river in Beijing, on the health of residents). Others wonder about stormwater management, using nature-based solutions, sometimes by developing new territorial approaches, such as the city of Oslo in Norway, where the scale of the catchment area serves as a reference for rethinking urbanization around the issue of water. Note the opening of reflection on sublime river landscapes (in the Netherlands) or the creation of an observatory of the landscape of the Rhône valley as a tool for mediation with the population.

1.4 Guiding cities with society: use, memory, artistic creation

The research presented in this group demonstrates how the artistic creation that is the landscape project serves to anchor or revive the memory of places. This idea may seem obvious, given how often landscape is associated with the concept of heritage. But here, researchers from Turkey and the U.S., China and Denmark, the Philippines and Brazil, South Korea and Ireland — not to mention France — are focusing on ordinary places: streets crowded with street vendors, hikers on trails, city dwellers walking through subway stations, and users of "junk playgrounds." In these situations, the memory evoked by artistic creation is deeply connected to everyday life and the lives of the most disadvantaged. Heritage intersects with social justice through the landscape.

1.5 Guiding cities with society: participatory approaches and governance strategies

Consultation is a widely used project tool around the world, from China to the United States, passing through Japan, the Middle East and Europe. It provides assistance both on issues of landscape or natural heritage management, as well as the co-design of proximity spaces for residents of historic centers and suburbs. Several communications also address the impact of migrants on the landscapes where they come to settle and what could be learned; while others demonstrate how consultation can help rebuild communities and families separated by their daily activities. The tools of consultation remain varied (interviews, workshops, etc.), but ultimately AI is still not widely used in these discussions presented at Nantes.

Topic 2: Guiding territories

2.1 Guiding territories by changing the design of regional projects: tools for intervention at different scales, for multifunctional landscapes

Nowadays, the development of tools (instruments, resources, methods) helps to refine our understanding of and interventions in the landscape at both micro and macro scales. The rise of digital technologies, statistical analysis, geographic information systems (GIS), modelling, and innovations such as the development of drones is helping to address contemporary challenges and transforming landscape architects into multifunctional professionals. The integration of these technologies is helping to expand environmental, social, economic and climatic knowledge across a wide variety of territories. These tools enhance the accuracy of assessments, project processes and the development of forward-looking scenarios. Depending on the cultural context, they promote greater diversification in the ways in which residents participate. They contribute to the accuracy of baseline assessments, the drafting of charters and the implementation of management plans in urban planning and landscape architecture. They support the emergence of proposals where the natural and the man-made interplay, helping to conceive of a holistic landscape where a reinterpretation of natural mechanisms is prioritised: storm water management, green corridors, etc. They help to rethink built environments: managing heat islands, flood risks and decontamination. In the future, these tools will continue to advance rapidly thanks to developments in artificial intelligence, BIM models, interactive mapping and environmental simulations. However, whilst these tools facilitate the generation of information and aid the creative process, they must not reduce the work of landscape architects to that of mere technicians; sensitive and creative intelligence must remain engaged and continue to foster the 'transformation' of the places around us.

2.2 Guiding territories by changing the design of regional projects: Tools for reinventing territories in situations of risk and environmental change

Risk is everywhere and increasingly unpredictable. In Nantes, stakeholders from Europe, Asia, and Africa came to talk to us about the risks associated with floods, fires, heatwaves, and more generally with the degradation of remarkable environments, such as estuaries (in Spain), agricultural heritage landscapes (in the Mediterranean) or those of tropical Africa (Ghana), transformed by the invasion of used clothing sent by the inhabitants of developed countries. Several communications also offer tools to address them, comparative maps, toolkits or new indicators, most of them to transform risk into a project opportunity. Others wonder about the effects of abandoning land and/or, in a number of cases, returning to vernacular approaches, which may be less efficient on the short term, but more effective and resilient in the medium term.

2.3 Guiding territories with legislative and social advances in planning: Organisation of large territories

The landscape as a guide to large-scale regional development: how relevant is this today? The fascinating presentations of studies and projects focused on metropolitan networks and their park areas, with the aim of managing peri-urban food production areas. Yilan County (Taiwan) has developed an intensive urban-rural land-use mix based on wet agriculture and disruptive mobility, a potential 'Desakota-city'. Everyone agrees on the key role of local authorities. In this regard, the German federal fund supporting local authorities is particularly explicit. Artificial intelligence is proving to be an effective resource for implementing this concept of complexity so dear to Edgar Morin (conservation of rice-growing cultural landscapes in Fujian Province, regulation of Chinese national parks, planning the transition of urban forests in Latin American cities).Nevertheless, the gap between official and normative documents and the actual use of Nature-Based Solutions is highlighted in Curitiba, the Brazilian capital of the state of Paraná, as well as in the major French cities of Lyon and Reims. The latest generation of French landscape plans designed to support the transition offers practical solutions (Institut Agro Angers, France). Indeed, should we not view landscape planning as a tool for holistic thinking to be shared with all disciplines involved in territorial development, rather than treating it as merely one aspect of the transition? There cognition of the status of landscape architect – championed since 1949 by the IFLA network (CIVA, Brussels) — clearly supports this position. 'History-based solutions' seem increasingly relevant.

2.4 Guiding territories by changing the design of regional projects: Towards a right for nature

Five quality papers propose a reflection on the theme of Nature as a source of law, in Australia, France, Turkey and Canada (Quebec). In the Canadian and Australian territories, the reflection is based on the relations to nature and site (river and natural place) of the indigenous population managers; it bases as well the questions of planning (and designing) as of management of these territories. In France (the Loire) and in Turkey, the authors rather focus their reflections on cultural landscapes and biodiversity, which leads to a shift from the anthropocentric territorial approach to abio-centric approach. In any case, the change of perspective on these spaces or natural «entities» leads societies to develop the law. In the case of the Bodrum peninsula in Turkey, the particular emphasis given to environmental issues (human impact on biodiversity and climate justice) leads the research to propose the ARAS method to manage the very large amount of scientific data to be processed. For the case of the article on the Magpie-Mutehekau Shipu River in the territory of the Innu in Quebec, you can consult it in the spring 2026 edition of Landscape / Landscape architecturein Canada (see on line:https://www.landscapes-digital.com/cslq/library/item/0126_spring_2026/4334307/).

2.5 Guiding territories by changing the design of regional projects: Evolution of heritage landscape

All landscapes are “heritage”, but those that are identified as “heritage landscapes” conjure entire cultures and represent a condensed form of identity. Perhaps that is why both those who presented and those who came to listen were especially cross cultural, transdisciplinary: they were old and young, academics and practitioners, specialists and generalists, united by the question of what is it of the past that we want to pass on to the future and what is it that we are willing to make disappear. From France to Costa Rica, from one continent to another, by specialists speaking of places near their homes or across the world, the studies were diverse. Contemporary methodologies, both computer assisted design and digital humanities, including data mining of social media posts, were applied to heritage landscapes. In Nantes, the contemporary approaches accentuated the fundamental desire for landscape in general, and for heritage landscapes in particular, in our societies.

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Short papers

TOPIC 1
Guiding cities through what is alive: Cities as ecosystems

GUIDING THE CITY: PARKS TRANSFORMED FROM FORMER AIRFIELD BERLIN TEGEL

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Keywords: landscape architecture, Berlin Tegel Airfield, heath landscape, brownfield conservation, ecology from a design perspective

Abstract

The neighborhood park and the landscape park in Berlin-Tegel are transformed from the former airfield of Berlin-Tegel Airport. They guide residents of the new neighborhood towards the surrounding heath landscape. This article uses this project as an example to illustrate how a clearly readable design structure that incorporates natural elements and enhances spatial quality can be used to guide the city.

The design is proposed with the concept of 'A Heath Bridge', which guides the city into the existing Tegel Heath through the 'adaptive heath'. In the landscape park, they are designed and maintained extensively as Heath Succession, whereas in the neighborhood park, they are designed and maintained more intensively as Intensified Heath Meadows. All kinds of heath landscapes together serve as the area's ecological and aesthetic backbone. More relevant landscape elements, such as pine groves providing an additional vertical link and evaporation daylily meadows contributing to rainwater management, are compositionally structured in the form of a series of stepping stones. Furthermore, exotic prairie and steppe perennials constitute a marked contrast to the local landscape, following the same grammar of stepping stones. The same applies to the outdoor lounges where residents can relax, as well as to the playgrounds and sports fields for children and adults. Additionally, climate-adapted trees and native trees in the neighborhood park reinforce this local and exotic contrast in the lawn areas and extend to the landscape park.

In conclusion, developing the concept further involves basing it on a strong, clear idea relating to the site, associating it with relevant concepts, emphasizing contrast and simplifying the less important elements. A clear form, defined by compositional principles that match the concept, provides a structure for the spatial formation. The design rules for the utilization of natural and artificial materials should be referred to. This will guide visitors' understanding of the site.

Landscape urbanism (Charles Waldheim et al., 2006) has led to the further development of landscape architecture, enabling landscape architects to avoid merely filling in the gaps left by architects or adding superfluous embellishments. Just like the landscape axis through the gardens and park of Versailles, and the water supply system connecting the Three Mountains and Five Gardens[i] in the north-west of Beijing and the Forbidden City via a series of public and imperial gardens, each demonstrates a unique approach to guiding the city. The cultural differences result in divergent forms, yet both show a distinct yet comprehensible spatial structure.

Meanwhile, the participation process collects concrete and abstract ideas from the public. This sociological measure enables landscape architects to understand the specific demands of the design site. However, this presents a challenge for landscape architects, who must consider these ideas and use their spatial organization skills to arrange them, rather than simply laying them out on the ground like children pouring their toys from a bucket. Therefore, it is also quite necessary to have a readable design structure that incorporates natural elements and enhances spatial quality.

The neighborhood park and the landscape park in Berlin-Tegel are transformed from the former airfield of Berlin-Tegel Airport. They guide residents of the new neighborhood towards the surrounding heath landscape. This article uses this project as an example to illustrate how a readable spatial structure guides the city.

1. Guiding the City: A Heath Bridge as the Design Concept

The local vegetation of the heath landscape predominates over the flat expanse of the Tegel-Airfield site (Fig. 01), a phenomenon that can be attributed to the dry and warm climate characteristic of the region. Other than representing the aesthetic of the national landscape of Germany, the on-site heath shows a distinctive feature of the site; rather than deterring people from nature conservation and preservation, it works as a medium that connects the new neighborhood and the existing landscape, thereby encouraging exploration[ii].



Figure 1. Tegel Heath on the Airfield.

The design is proposed with the concept of '**A Heath Bridge**', which guides the city into the **existing Tegel Heath** through the 'adaptive heath': they are designed and maintained extensively in the landscape park as **Heath Succession**, whereas in the neighborhood park more intensively as **Intensified Heath Meadows** (Fig. 02). All together they create an ecological and aesthetic backbone of the bridge. The bridge can be created in a variety of ways and to different extents: three options of minimal, balanced and maximum were discussed, from which the balanced one was determined.



Figure 2. The Heath Bridge as an 'adaptive heath' responds to the landscape and urban context.

2. A Clearly Structured Guidance: Composition in the Form of Stepping Stones

The components of 'adaptive heath' are arranged on the north sides of the parks, forming a chain-like configuration that creates a connection from west to east. The various elements of the adaptive heath landscape have been meticulously proportioned to convey the fundamental atmosphere of the concept of the heath as an expansive terrain. This is

followed by the further differentiation of heathland elements, including **evaporation daylily meadows** and **pine groves** with perennial plants of North American **prairies** and Asian **steppes** as accents. Thematic elements are interwoven and repeated in the form of stepping stones, in adherence to the spatial rhythm that is characteristic of analogous spatial languages (Fig. 03).

Additionally, recreational areas equipped with **lounges**, **playgrounds** and **fitness facilities** have been incorporated into the design. Spacious **lawns** complement the adaptive heathland and meet the existing Tegel Heath in the landscape park.



Figure 3. Stepping stones form the structure of the Heath Bridge.

Heath Succession and Intensified Heath Meadows

The heath succession leading to the existing heath landscape and the intensified heath meadows in the neighborhood park, build up an ecological and aesthetic backbone. In the landscape park, the size of heath succession is huger to encompass other elements, such as pine groves or playgrounds. The intensified heath meadows are mostly in the neighborhood park and extend to the west in order to blur the boundary of the two parks (Fig. 04, Fig 05). The intensified heath meadow is delineated by a ditch that collects rainwater from the open space. A sunken and water-permeable path provide access, with changing slopes on both sides. The additional topography strengthens the spatial effect, creating an impression of place. This unique introverted place attracts people to explore.



Figure 4. Intensified heathland meadows and evaporation daylily meadows follow the grammar of Heath Bridge.



Figure 5. View of the heath landscape.

Evaporation Daylily Meadows

The evaporation daylily meadows were developed as part of a separate research project involving the study and cultivation of perennial herbs capable of surviving in evaporation areas. Spatially, these evaporation areas are sunken so as to be observed and multiply spatial experiences in the Heath Bridge. Functionally, they are the final destination for rainwater from the neighborhood to the north. The experimental site has been built for observation purposes, and the research is still in progress (Fig. 04, Fig.06).



Figure 6. View of the evaporation areas.

Pine groves

The pine groves represent a further local vegetation type that guides the transition from the urban area to the landscape of Jungfernheide Forst in the background (Fig. 07). The pine groves in the landscape park are primarily situated in the area of heath succession, with an exception in the existing Tegel Heath (Fig. 08). In the neighborhood park, they are framed by 30 cm reused granite curbs and paved with an air- and water-permeable covering. Beaches and tables, known as 'lounges', are located in the center. The outer space is defined by a circumferential pavement made of small granite stones. These are a mixture of reused materials from the former airfield (approximately 70%) and new, colorful pieces. (An exception is on the Sun Down Plaza, where the outer space is withdrawn due to limited space.) Fitness facilities, seating and bike parking are always available. The pine trees structure the space and provide residents with a peaceful place to relax, even in winter.



Figure 7. Pine groves continue throughout the parks in the form of stepping stones.



Figure 8. Pine groves provide a vertical link.

Prairies and Steppes

The local landscape is distinguished by mixed planting the perennial plants of North American prairies and Asian steppes within designated floral beds (only) in the neighborhood park (Fig. 09). The quality of the granite stones as pavements continues to be similar to that found in the pine groves. Distinct from the adaptive heath that are in red, violet, or pink, the mixture of grasses and flowering perennial herbs exhibits a harmonious arrangement of yellow hues, interspersed with occasional contrasting colors. The height is set at eye level to differentiate it from the evaporation areas. The utilization of geophytes for springs and plants for different structures during winter is a critical factor in the extension of the duration of attractiveness. Beige wide granite stones are used as edging at seat level, and the seat hollow invites people to enjoy certain views. This extroverted space offers both the opportunity to watch in and out (Fig. 10).



Figure 9. Prairies and steppes within floral beds can be found jumping along in the neighborhood park.



Figure 10. Prairies and steppes within floral beds as an extroverted space offers both the opportunity to watch in and out.

Lounges, Playgrounds and Fitness Facilities

The layout of the lounges follows the same grammar as the stepping stones. As mentioned above, they are located in the center of the pine groves in the neighborhood park. However, they ‘escape’ from that and spread out in the landscape park (Fig.11). The playgrounds are located close to the future school and kindergarten. Sports fields of decreasing size are available for children and teenagers, while more playgrounds can be found in the landscape park along the taxiway, as well as standard sports fields along the retained runway. Furthermore, the systemic design of outdoor

activities is to be completed by fitness facilities that are located at specific points (Fig. 12).



Figure 11. The lounges are embraced by pine groves and open out into the landscape park.



Figure 12. The playgrounds are part of the structure of the composition, and the fitness facilities are located at the edge of the lawn areas.

Lawn areas

In comparison with the heath bridge, an area of lawn interspersed with groups of trees offers a more straightforward configuration. By means of figure-ground relation, the heath bridge can be underline. A thoroughly designed topography contributes both for vista with composition of trees and as infiltration areas for rainwater management. Together with relaxing facilities, the lawn areas offer greater opportunities for the residents in different seasons.

In summary, the concept of the health bridge refers to the site, which is an important and relevant issue for new forms of nature in the city, and one that has broad acceptance and high social relevance among citizens. It establishes a robust spatial framework that citizens can understand, creating ecological qualities such as a biotope network and biodiversity for plants, insects and fauna. It also promotes pollinator-friendliness and protects bees, which are an important component of sustainable urban district development. Diverse leisure activities in the park are thus combined with opportunities to experience nature, creating a coherent place that is closely linked to the urban nature.

3. Vegetation Fabrics: Contrasting Local and Exotic Vegetation

Vegetation plays an important role in the composition of the heath bridge and in the spatial formation of the lawn areas. The design process involves an in-depth discussion of specific design principles for planting, particularly contrasting local and exotic vegetation. Great attention is also paid to soil quantity and quality, and long-term maintenance of existing and newly planted landscapes.

Maintenance of the Existing Tegel Heath and Cultivation of a New Generation of Heath

The maintenance of the existing Tegel Heath adapts to the changing overwinter strip: once in the south and once in the north. During the summer months, the mowing process is conducted in a scheduled manner, with different sections being addressed at various times, specifically in June, August and September (Fig. 13). The creation of raw soil sites is achieved by the removal of the humus layer, with the addition of approximately 20 centimeters of sand devoid of humus. This procedure facilitates the initial colonization of the site by plants and animals[iii]. In areas not designated for cultivation, a mixture of seeds will be sowed with the intention of cultivating a new generation of heath. Once the process of humus formation has been initiated, the sandy soil can be excavated at regular intervals.

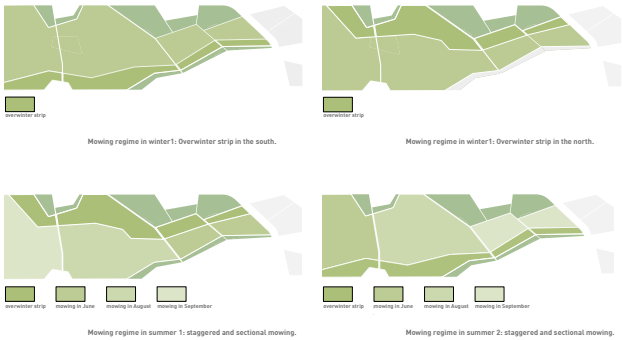


Figure 13. Proposal for mowing regime for the existing Tegel Heath

Establishment and Maintenance of the Intensified Heath Meadows

The intensified heath meadows are framed by block-planted ground-cover plants, on which *Rosa* are scattered throughout. The path is marked with *Juniperus* and *Pinus*, which leads through dry-tolerant grassland consisting of wild flowers (50%)

and grasses (50%) mixed with perennial herbs. Groups of cultivated *Calluna* (67%) and *Erica* (33%) interspersed throughout the areas highlight the Genius Loci of the site. The composition of this mixture is determined by comparing different variants based on aesthetic and maintenance considerations (Fig. 14): (1) A sandy to loamy substrate (with 2.5–4% humus) and bark mulch are applied to provide ground cover and ensure that a clear framework for the heath meadow is established, even in winter. (2) Sandy grassland requires a sandy or slightly loamy and silty sandy substrate (with 1.5–2% humus). (3) *Calluna* and *Erica* should be planted in an additional 5 cm layer of peat to simulate their natural habitat. This solution enhances the heath landscape while requiring less maintenance: additional watering is only necessary during the first one or two vegetation periods, and fertilization is only required if deficiency symptoms appear. After flowering in March, *Calluna* and *Erica* should be cut back by a third, while the dry grassland should be mown close to the ground (4-8 cm) from autumn to March.



Figure 14. A conceptual design of the intensified heath meadows: 'Impressionistic natural landscape'

Pine Grove as another Type of Local Vegetation

The construction of pine groves involves a combination of *Pinus sylvestris, Pinus sylvestris* 'Glauca', *Sorbus aucuparia* 'Edulis' and *Carpinus betulus* 'Fastigiata', which creates variations in color and density, and changes throughout the seasons (Fig. 15). 12 m³ of substrate is provided for each tree, taking into account the area covered and human activities. Due to the covering, the invisible underfloor anchorages are applied. A 40 cm radius ring is used to allow the trunk to separate from the pavement, considering the growth of trees. Before the trees grow, beige chippings are used as mulch to match the air- and water-permeable covering.

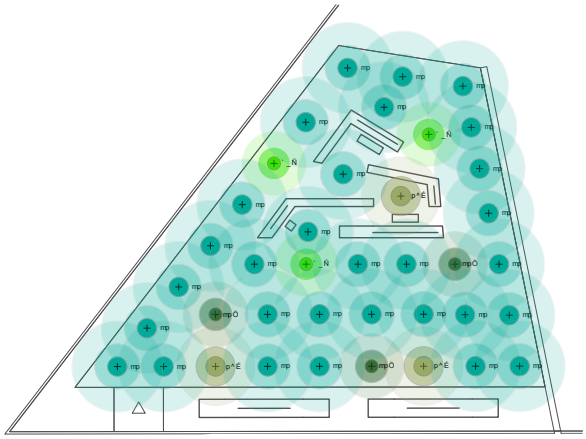


Figure 15. The pine groves are dominated by *Pinus*, with scattered *Sorbus* and *Carpinus*.

Prairie perennials as exotic vegetation

In contrast, prairie perennials create a diverse effect with their variations in height, vertical accents, leaf shapes and colors. In the outer border, the perennials are planted at a density of 9/m², with a spacing of 35–40 cm between them. Shorter plants are used here, around 30 cm in height, including *Aster*, *Geranium* and *Veronica*, etc. Grasses such as *Festuca* and *Stipa* are used to create a textural contrast. In the middle, a matrix of higher species is planned at a density of 7/m². *Echinacea*, *Eryngium*, *Centaurea*, etc. are planted. Furthermore, *Allium* and *Tulipa* are used as spring geophytes; *Baptisia*, *Asclepias* and *Andropogon* are used as accent plants and scattered in the middle. A loamy, sandy or strong, sandy loamy substrate with a low humus content can be used with granite mulch. Beneath this, a loosened soil with a low humus content and a texture ranging from loamy sand to very sandy loam is required to a depth of 20 cm to avoid accumulated water. The mowing season runs from January to mid-February and the frequency of watering and fertilization is the same as in the intensified heath meadows. Moreover, the concept is further enriched by integrating "animal-aided design" principles to benefit local bees and other species, such as *Centaurea jacea*.

Native and Climate-adapted Trees: Continuing the Contrast

Native and climate-adapted trees reinforce the local-exotic contrast in the lawn areas (Fig. 16): On the one hand, the 'Brandenburg-Pannonian'[iv] groves in the north consist of 80 % high straight-trunked trees and 20 % multi-stemmed trees of various sizes, including *Quercus*, *Carpinus* and *Tilia*, among others. To enhance the complexity of vegetation fabrics, trees with pinnately compound leaves, such as *Fraxinus*, *Koelreuteria* and *Gleditsia*, grow next to them. By contrast, the south is home to non-native species, for example, *Liquidambar*, *Liriodendron* and *Ginkgo*. These trees have adapted to the warm climate and provide colorful autumnal displays. These principles of composition of trees extend further to the landscape park. In addition, shrubs along some edges of the neighborhood park attribute the biodiversity of flora and fauna.

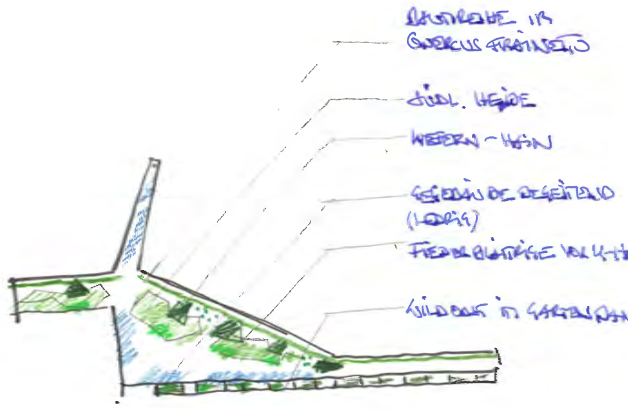


Figure 16. native and climate-adapted trees continue the contrast

4. Guiding by a Readable Spatial Structure Matching the Concept

The Tegel Project demonstrates how a readable spatial structure can be created to match the concept. Firstly, ideas are developed into a concept: the heath bridge is strengthened by transferring elements of the existing heath landscape to heath succession and intensified heath meadows. These diverse expressions come together to form a strong, clear concept. To complete the concept, relevant ideas are associated with it (such as pine groves, evaporation daylily meadows), contrast is emphasized (the prairies and steppes), and the less important elements are simplified to clarify (the lawn areas). Secondly, the space is structured by a clear form defined by compositional principles that match the concept: the form of stepping stones efficiently organizes all the elements, and clear spatial formation rules are set out. Even through there is slight deviation from these rules to create a sense of relaxation. Thirdly, the use of materials, whether natural (such as plants) or artificial (such as facilities), continues the structural design philosophy. Taken together, this creates a coherent spatial structure, which matches the design concept, that guides visitors' understanding of the site.

Notes:

[i] The Three Mountains with Five Gardens includes Mt. Xiangshang, Mt. Yuquan, Mt. Wanshou and Jingming Garden, Jingyi Garden, the Old Summer Palace, the Summer Palace and Changchun Garden (now in Beijing University).

[ii] In her article about the afterlives of airports, Sonja Dümpelmann mentioned Tempelhof Feld and the Nature and Landscape Park Johannisthal. These two former airports represent different design approaches, as does Tegel Airfield. See more in Dümpelmann, 2013.

[iii] This exact method is implemented and described within Biodiversity Exploratories working groups, specifically under the REX, LUX, and FOX experimental sites. See more to https://www.biodiversity-exploratories.de/en/

[iv] The term 'Brandenburg-Pannonian' is a combination of two typical landscapes, not an ecological term, and is used as inspiration for planting design.

Figure resources: Figure 1: Photo by Jürgen Weidinger. Figures 14 and 16: sketches by Jürgen Weidinger. All other figures: copyright Weidinger Landschafstarchitekten GmbH.

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FROM GREY TO GREEN: MODELLING EUROPEAN INDUSTRIAL CITIES THROUGH NATIVE ECOSYSTEMS AND DIGITAL LANDSCAPE INNOVATION

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Keywords: Native Ecosystems, urban landscapes, sustainability, digital, European cities

Abstract

Native ecosystems predate human settlements, and native plants have always maintained their existence through interactions with animals and microorganisms. As European industrial cities aim for sustainability, recent research highlights the pivotal role of urban green spaces in biodiversity conservation and ecosystem resilience. Our paper examined how native ecosystems, when integrated with digital innovation, can help redefine urban landscapes and restore ecological functions. We aimed to ascertain (a) if natural rehabilitation methods and technology can develop a comprehensive strategy for reviving the landscape of degraded cities and urban areas that have undergone industrial decline, rapid urbanization, or climatic stress and (b) how we can use artificial intelligence to enhance our understanding of native environmental patterns to optimize landscape interventions. The methodology involved a comparative case study analysis of papers that discussed the role of technology in preserving native ecosystems and the application of Artificial Intelligence (AI) in landscape architecture. The conceptual framework focused on ecological urbanism, nature-based solutions, and digital landscape innovation. Our findings suggest that nature-based rehabilitation methods, such as community gardens, urban living labs, and policy-led greening strategies, have been instrumental in ecological restoration and social regeneration, especially in post-industrial cities. While AI was not widely applied in current case studies, its potential for ecosystem monitoring, afforestation planning, pollution modelling, and predictive analytics is evident. We conclude that native ecosystems, supported by AI-driven planning and digital tools, can offer replicable, performance-tested, and sustainable strategies for post-industrial urban transformation. Future studies should focus on developing context-specific AI applications and enabling supportive policy frameworks to integrate digital and ecological approaches in urban planning.

1.1 Introduction

1.1.1 The effect of industrialization on European cities

In the 18th century, Europe experienced a rise in industrialization, with England and Scotland at the epicenter; this process shaped the spatial development, human population, and economy of the cities where it occurred, pushing away from an agricultural and towards an industrial economy [1]. However, degradation of their natural environments was the price for the economic boom and expanded job market which they enjoyed [1]. Also, the rural-urban migration to industrial cities during that era created a negative impact on the environment, through pollution from industrial activities and greenhouse gas emissions, resulting from long-distance vehicular transportation of goods [2]. Additionally, the intense impact of climate change aggravated the vulnerabilities of their environment while also

highlighting the limitations of traditional grey infrastructure in adapting to contemporary urban needs [3]. Subsequently, when Europe shifted towards globalization and the industrial era was brought to a halt, these cities were left with land and infrastructure that needed repurposing [1].

1.1.2 The Grey-to-green concept

In the management and planning of cities, "grey" refers to built-up up urban areas while "green" refers to areas of vegetative cover [4]. The interplay of grey and green spaces could be valuable for planning urban growth and ensuring sustainability in urban areas [4]. Green spaces in urban areas have been shown to confer benefits including improved quality of human life, enhanced thermal comfort, strengthened food security, and mitigation of the impacts of climate change [5]. Thus, we discuss the concept of "Grey to Green" as a transition from construction-dominant urban and landscape design solutions towards nature-based vegetative strategies. A good example of this transition occurred in Mirafiori, where greening projects became integral to the regeneration of post-industrial areas, improving social spaces [2].

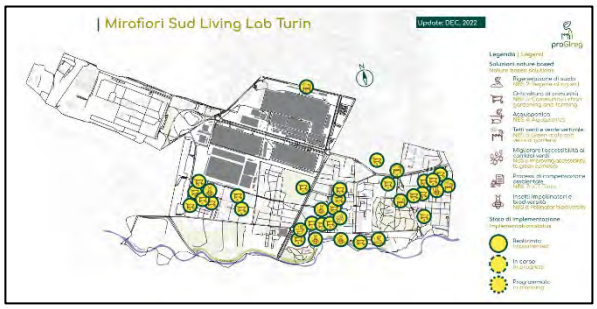


Figure 1. Map of Mirafiori Sud urban living lab, from proGIreg

1.1.3 Native Ecosystem

By definition, a native ecosystem is one in which plants, animals, and microorganisms coexisted prior to human disturbance. Essential species, such as dominant photosynthesizing plants, top carnivores, significant decomposers, and nitrogen-fixers, are necessary for a native ecosystem to sustain itself and operate independently [6]. Native ecosystems possess distinctive characteristics, and the substitution of native flora with non-native species can significantly disrupt urban food networks. Moreover, native plants adapt better to local soil and climate, support a greater diversity of local wildlife, and require less maintenance than non-native options [7]. Crucially, a shift to green infrastructure is not merely aesthetic or ecological, as it requires functionality that targets urban resilience, public health, biodiversity restoration, and spatial justice. It would involve the successful integration of permeable surfaces, biodiverse green spaces, green roofs, and restored water systems to replace or overlay grey systems [8]. It is reasonable for us to infer that NBS are well-suited for a grey to green transition in cities.

1.1.4 Digital landscape innovations

Digital landscape innovations are transforming how degraded urban landscapes undergo rehabilitation and redesign. For example, digital twins (DT) can be used to replicate digital models of real-time physical systems through simulations that enhance urban analytics and city planning [9], and so it can be used alongside native ecosystems in post-industrial European cities to support participatory design and continuous monitoring, ensuring green interventions are resilient, sustainable, and responsive to changing climates and social needs. Teutscher, D et al. (2025) presented a novel urban-focused DT that can be used to produce advanced simulations for pollution analysis and urban airflow modelling [9]. Such innovation can inform planners on effective application of nature-based solutions (NBS) to tackle adverse environmental effects of air pollution in urban landscapes. Furthermore, machine learning and AI can enhance our understanding of native environmental patterns to optimize landscape interventions by monitoring ecosystems and biodiversity, managing afforestation and deforestation, minimizing adverse environmental impacts in agriculture via disease detection, weed detection, soil sensing, and protecting peatlands to preserve these vital ecosystems [10]. Planners can identify the most suitable native species and optimal locations for ecological corridors and predict resilience scenarios using AI models trained on native plant species and urban performance measures. This adaptive quality raises the question of whether AI can enhance our ability to create urban spaces that are biodiverse, sustainable, performance-tested, and replicable in the real world.

1.1.5 Aim and research questions

This paper aimed to develop a strategy that utilizes native ecosystems and digital innovation to revitalize post-industrial European cities. The questions guiding our paper are as follows:

a) Can natural rehabilitation methods and technology develop a comprehensive

strategy for reviving the landscape of degraded cities and urban areas that have undergone industrial decline, rapid urbanization, or climatic stress?

b) Could artificial intelligence be used to enhance our understanding of native environmental patterns to optimize landscape interventions, and how?

2.1 Literature review

The transformation of NBS into a fundamental component of sustainable urbanism reflects a broader shift from reactive environmental policies to proactive, systems-oriented design. Nature-based solutions refer to actions that protect and promote sustainable use of land and water ecosystems, tackle social, economic and environmental problems effectively, and simultaneously provide human well-being, ecosystem services and biodiversity benefits [2]. Russo et al. (2025) examined the contributions of both native and non-native plant species to biodiversity and ecosystem services. They emphasised the ecological value of native plants for supporting local wildlife, acknowledged the potential for non-native species to disrupt ecosystem dynamics, and advocated for the use of conservative strategies, which would integrate native species to ensure the preservation of ecosystem function in urban areas [5]. Hansen et al. (2015) emphasized the importance of integrating ecosystem services into urban planning [3]. However, critiques of NBS highlight concerns about implementations that prioritise aesthetic appeal over ecological integrity, a practice sometimes described as "greenwashing". Zarei and Shahab (2025) caution against bureaucratic or top-down NBS implementations that risk excluding local communities or failing to consider site-specific environmental histories. They support the collaborative development of green infrastructure adapted to local sites, particularly in European post-industrial cities with complex property ownership and zoning issues [8]. A good example of such collaborative planning is seen in Salzburg, Austria, where the city used public engagement to implement a policy (green space declaration 1985) which was later incorporated into the city's development concept in 2007 [3].

Europe can benefit from policies that have been promoted by the European Union (EU), such as the biodiversity strategy for 2030, the green infrastructure strategy 2013, and common agricultural policy (CAP) reform 2023-27. Meanwhile, Stockholm in Sweden, is praised for being a forerunner for sustainable urban development, as it stands out for early adoption of the ecosystem services concept since the early 2000s [3]. Ecosystem services should integrate significant environmental issues in planning or political agendas to meet the needs of urban planners and managers. An analysis of plans in Polish cities showed that ecosystem services with a market orientation receive more attention in planning [3].

The opportunities for modelling and predicting the effects of green infrastructure are on the rise because of digital innovation. Cristina et al. (2020) discussed how Landsat data archives combined with advanced image processing and analysis methods are used to monitor the changes of green areas across 10,000 urban centres [4]. AI and machine learning was employed to analyse urban change, using built-up surface grids to model population distribution, and time series of high-resolution NDVI composites to extract and monitor vegetation from satellite data [4]. Digital twin technology is also used a lot in urban planning for environmental monitoring. Teutscher et al., (2025) present a digital twin framework for urban planning that integrates real-time meteorological data and computational fluid dynamics to enhance pollution predictions and support adaptive urban planning [9]. Although there has been an increase in initiatives using machine learning (ML) and artificial intelligence (AI) to address societal and global issues, there is still a need to determine how these technologies can be most effectively used to combat climate change [10].

3.1 Methodology

This study adopted a qualitative, comparative case study approach to analyze the integration of native ecosystems and digital tools in green strategies for post-industrial European cities. Our conceptual framework for understanding the dimensions of landscape transformation in formerly industrial areas draws upon theories of ecological urbanism, nature-based solutions, and digital landscape innovation. These perspectives provide a lens through which to explore how to leverage emerging technologies and native ecological processes to transform degraded urban landscapes. We began our methodology by identifying five analytical themes through a review of current discourse in urban landscape architecture: ecological restoration, digital innovation, design

approach, community and policy integration, and outcomes of ecological intervention.

The next phase involved a keyword search on online databases and identified 250 articles published within the last forty years. These studies were passed through title screening and were subsequently narrowed down to 25 papers. To ensure relevance to the analytical themes, we then conducted abstract screening using our inclusion criteria to narrow the literature down to ten papers.

Next, we progressed to the third phase, which sought to reduce the literature to ten cases that qualify for the case study analysis phase; using our inclusion criteria, we selected studies that:

a. Focused on cities with a post-industrial heritage.
b. Documented existing or ongoing green transformation projects.
c. Incorporated the use of native ecosystems; and
d. Demonstrated application of digital tools and/or artificial intelligence (AI) in planning or environmental monitoring.

We initially utilized OpenAI's ChatGPT to grade each of the ten papers as either having fully met, partially met, or not met the screening criteria. Next, we reviewed the same papers to confirm their selection and identified three relevant case studies. involved. Although none of these three satisfied all four inclusion criteria, these satisfied at least three criteria. Finally, we conducted a thematic analysis of each study before interpreting and then narrating the findings.

4.1 Results and Discussion

4.1.1 Case 1: Urban green resilience (Starczewski et al., 2023)

This paper examined the patterns of green space coverage in 32 Polish cities (including 12 post-industrial cities) between 2006 to 2018. The authors analyzed the direction of transformation of green spaces during the 12-year timeframe using QGIS software, to ascertain whether there had been increased green spaces within urban areas in the cities. The authors sub-grouped the cities into low, medium and high intensity zones, depending on how much development the zones had undergone over the 12-year period.

Their findings revealed that the overall green space coverage in the post-industrial cities reduced by 0.1%, and low intensity zones were the only regions to realize a rise in green spaces. 2.6% of green spaces were converted to brown areas, with the overwhelming majority (approximately 50%) being converted to industrial and urban units. An overwhelming majority of green spaces (88%) were realized from agricultural land via secondary succession, with only a marginal (10.5%) proportion reclaimed from industrial and construction sites. In one of the post-industrial cities (Lódz´), the authorities sought to introduce policy to improve greening efforts by withdrawing from the sale of land for urban use. Another process suggested for greening was revitalization, which would involve restoring degraded urban areas while retaining their historic rhetoric value, with the benefit of aiding tourism and encouraging local engagement among residents.

The study showed that natural rehabilitation methods can be applied to revive the landscape of degraded cities, although there were concerns about costs when applying such changes in highly urbanized regions, and they were preferably applied to regions that had fewer concrete structures.

There was no mention of the use of artificial intelligence to study environmental patterns. However, the use of the Urban Atlas which utilizes satellite imagery, as well as the use of GIS, proves that there is a place for technological advancements in reproducing the environments being studied. We could therefore hypothesize that there is room for the use of AI in studying and generating green patterns, which would generate data quickly and accurately based on available and verifiable databases.

4.1.2 Case 2: Reviving urban greening through nature-based solutions (Dogan et al., 2023)

In this case study, the authors discuss the transformation of vacant post-industrial land in the Mirafiori Sud region of the city of Turin into urban living labs (ULLs). The paper highlighted

policy changes aimed at creating green spaces in Mirafiori, including the Green Infrastructure Strategic Plan by the City of Turin which focused on ecosystem services, the FUSILLI project which sought to blend food and art with green transformation, and European-led projects (proGIreg and CONEXUS) which were focused on NBSs.

The paper proves that comprehensive environmental rehabilitation strategies can be developed using natural methods, as the urban living labs projects are heavily based on NBS, with Orti Generali being a prime example. Orti Generali are achieving food production and social inclusion through establishment of green spaces and community gardens while simultaneously replacing degraded land. Also, in collaboration with Mirafiori Foundation, Orti Generali created long-term projects "the Grand Galà of Mirafiori" and "Being elderly in Mirafiori Sud", projects which attracted many young and elderly people to take care of green areas. Additionally, the success of Orti Generali's circular kiosk which utilizes the products cultivated in the garden and creates a space for social cohesion, and a collaborative policy push, led to the city of Turin officially implementing the idea of the "circular pizza" which promotes sustainable cooking processes in the preparation of pizza.

This study did not directly refer to the use of artificial intelligence, but we could identify an opportunity for the use of artificial intelligence in the early phase of some projects. At the early stages of their project, proGIreg and FUSILLI proposed activities to convert local creativity into experiments and ended up engaging a wide selection of individuals to aid their experiment design prior to commencement of proper testing. The use of artificial intelligence in such experimental phases could potentially reduce time, personnel and financial costs in similar projects, and as such, may result in an increased capacity to run multiple studies simultaneously while reallocating expenses elsewhere.

4.1.3 Case 3: Tackling climate change with machine learning (Rolnick et al., 2022)

In our opinion, it is impossible to envisage a modern city without electricity. However, this study highlights that electricity systems are responsible for approximately 25% of global man-made greenhouse gas (GHG) emissions annually. This underscores the urgent need to transition to low-carbon energy sources such as solar, wind, hydro, and nuclear power. Machine learning (ML) enables this transition by forecasting electricity supply and demand using historical data, physical model outputs, images and even video data. It also balances electrical systems by determining optimal output from controllable generators and supports the efficient placement and maintenance of controllable sources like geothermal plants, nuclear facilities, and hydropower dams, using seismic and satellite data. Moreover, ML can reduce fossil fuel emissions by detecting methane leaks in natural gas pipelines and compressor stations via sensor networks or satellite data, prompting timely maintenance actions.

Similarly, transportation systems are vital to urban life but account for another 25% of global energy-related CO_2 emissions. Unlike electricity, transport emissions are harder to mitigate due to factors such as policy influence on end-users and the high energy density requirements of vehicular fuels. Nonetheless, emissions can be reduced through strategies such as minimising travel demand, improving vehicle efficiency, adopting alternative fuels and electrification, and shifting to lower-carbon transport modes. ML-based disruptive technologies could reduce or replace transportation demand altogether. Additionally, ML contributes to vehicle energy efficiency through advanced consumption design, aerodynamic efficiency improvements, and autonomous vehicles (AV). It can also analyse travel behaviour, aiding in the optimal planning of public transport routes and infrastructure.

Traditionally, building energy modelling and temperature forecasting relied on detailed physical models. However, ML methods like deep belief networks can improve accuracy with less computational cost. Satellite radar images can generate a global map of human settlements at meter-level resolution. Therefore, high-resolution satellite image segmentation can now precisely outline building footprints on a national scale. Meanwhile, ML can extract data on urban climate issues using web-scraping and text-mining. The integration of

large, diverse data sources is essential for smart cities, with machine learning techniques such as data matching, fusion, and ensemble learning playing a critical role. When incorporated into urban planning, these smart city initiatives can significantly enhance sustainability and encourage low-carbon lifestyles. For example, ML and AI can coordinate heating and cooling networks, solar power, EV and bike charging stations, and optimize public lighting by adjusting intensity based on foot traffic patterns.

Precision agriculture has the potential to reduce soil carbon emissions while simultaneously enhancing crop yields, thereby contributing to reduced deforestation pressures. To support this, satellite imagery plays a critical role in estimating carbon sequestration and monitoring GHG emissions from terrestrial ecosystems. ML techniques can be employed to cost-effectively monitor forest and peatland health, predict fire risks, and support sustainable forestry practices. Given that peatlands store more carbon than any other terrestrial ecosystem makes their degradation a significant threat to climate stability. When peatlands dry, they release substantial amounts of carbon through decomposition and become highly susceptible to fire. Therefore, monitoring and protecting these ecosystems from drainage and drought is essential to preserving their carbon storage capacity and mitigating GHG emissions. Additionally, ML supports the automation of afforestation by identifying suitable planting sites, monitoring plant health, detecting weed presence, and analysing long-term ecological trends. Combined with remote sensing technologies, ML can also facilitate the automatic detection of tree cover and deforestation through aerial imagery analysis. While forest fires contribute to atmospheric CO_2 emissions, it is important to recognise that low-intensity fires play a natural role in maintaining forest ecosystems. However, excessive fire suppression can lead to the accumulation of combustible biomass, thereby increasing the risk of large, uncontrolled wildfires. Such events can result in the destruction of mature trees, topsoil erosion, substantial carbon emissions, biodiversity loss, and prolonged ecosystem recovery. By leveraging advanced tools to identify high-risk regions, firefighters can implement controlled burns and strategically clear vegetation to reduce fuel loads and prevent catastrophic fire outbreaks.

While this case study does not focus on cities, it combines evidence from multiple urban systems to demonstrate how AI and machine learning can support green transformations in post-industrial cities. The emphasis has been placed on demonstrating the capabilities of artificial intelligence to detect, analyse, and model environmental data, to inform the restoration of native ecosystems. The opportunities of urban decarbonisation, climate resilience, and the challenge of ecosystem degradation are acute in post-industrial cities, therefore, the study establishes a conceptual and methodological foundation that cities with post-industrial histories can adapt when implementing native ecosystem restoration and smart landscape planning. Future research will focus on specific case studies where these innovations have been directly integrated into green urban rehabilitation frameworks.

5.1 Conclusion

Our study has examined the potential for the integration of native ecosystem and digital tools to serve as mutually reinforcing strategies in the sustainable transformation of post-industrial European cities. We sought to ascertain if natural rehabilitation and technology can create robust strategy for reviving landscape, coping with rapid urbanisation and climate change, and how landscape interventions can be optimised by using artificial intelligence to study environmental patterns. The research questioned whether natural rehabilitation methods and technology could revive degraded urban landscapes, and if AI could enhance our understanding of native patterns for the landscape interventions.

The findings show that the use of native flora as part of nature-based solutions is essential in the rehabilitation of post-industrial cities, due to cost efficiency, sustainability and adaptability. This is evident in initiatives such as the Mirafiori urban living labs and urban greening policies in Polish cities, where community engagement and ecological restoration

improved environmental quality and social cohesion. However, limitations exist in highly urbanised zones due to cost and land use constraints. While few existing projects explicitly applied AI in these interventions, the literature highlights significant potential for AI and machine learning in urban sustainability. AI can enhance the design, implementation, and management of urban greening projects in various ways, including predictive modelling for pollution and climate scenarios, ecosystem monitoring, afforestation planning, and carbon stock estimation. Its use can improve efficiency, precision, and scalability in ecological planning.

Future research could explore the development of AI models trained on local biodiversity and urban performance data to support context-sensitive interventions. Policymakers should promote collaboration between ecologists, urban planners, and data scientists to support inclusive, digital, and ecologically resilient urban development. Integrating digital landscape tools into mainstream urban policy could position European cities at the forefront of climate-resilient planning in the 21st century.

Author's declaration
The authors declare no conflict of interest.

Contributions:
Precious Ovat – Conceptualization, Data gathering, Writing (original draft preparation), Writing (review and editing).

Faithman Ovat – Data gathering, Writing (review and editing).

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RESIDENTIAL AND SHARED GREENSPACES CONTRIBUTIONS TO BIODIVERSE AND PERMEABLE CITIES

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Abstract

Cities adopt efficient policies which increasingly rely on nature-based-solutions (NBS) to conserve, restore and improve urban soils and vegetation to address urban challenges such as overheating or flood mitigation, improvement of physical and mental health of residents, reduction of pollution, as well as protection and restoration of functional biodiversity and ecosystems. Such urban planning policies are central to the ecological transition to sustainable cities. However, excessive land-take by cities, i.e. urban sprawl, has negatively impacted biodiversity and food production, affected social structures and increased the emissions of greenhouse gases from transportation networks. Compact city models implemented through legislation such as the net-no-land-take 2050 in France might conflict with green models by densifying extant as well as planned housing. The residential greenspaces (RGS) of single- and multifamily homes are often considered artificialized and responsible for urban sprawl, and therefore at risk. RGS have been shown to have the potential to deliver the services expected in a sustainable, green city. But are they good enough when considering the damages caused by sprawl? The objectives of the Villegarden project are (1) to assess the ecological performance of RGS (2) to evaluate environmental and social factors determining performance, in order to find solutions to improve RGS planning, design and management, (3) to confront the results from spatially explicit models to current planning documents. These objectives will be carried out by a 9-city (Angers, Dijon, Lyon, Marseille, Montpellier, Nancy, Nantes, Paris and Toulouse) nationwide consortium of social scientists (sociology, geography, urban planning), soil scientists and ecologists, working with urban stakeholders including territorial authorities, associations, social housing landlords, private companies and most important, citizens, as residents, owners or users of RGS. Performance of ecological processes can be measured and its explanatory factors explored at different scales and their constraints into our urban areas: WP1 looks at city scale processes and factors, based on vegetation, ownership, environmental and social geographic layers joined in a project GIS covering six cities. In WP2, performance will be measured using soil and biodiversity indicators as well as performance perception by stakeholders, in 200 RGS in seven cities. In WP3, neighborhood-scale processes such a relationship with public greenspaces, gardening and landscaping practices, features of ecological networks invisible from aerial photography (e.g. walls, domestic animals) will be explored. Understanding performance and its determining factors will allow innovative modeling of RGS ecological services (e.g. biodiversity support, soil permeability, evapotranspiration, human well-being) at city-scale. This, when confronted with planning documents, could improve the performance of the entire green infrastructure and have deep-reaching impacts on city livability for humans and biodiversity. Villegarden is also about co-constructing knowledge and methods with stakeholders: this will be addressed using long-term online and in-person exchange hubs we call forums (on urban feedbacks and perspectives, on soils and on biodiversity).

1. Introduction

1.1. General context

Urbanization, as a widespread and global phenomenon, plays a central role in the three interconnected crises of the Anthropocene: accelerating climate change, collapsing biodiversity, and a growing threat to the planet's habitability for both humans and non-human life [1]. These challenges make it necessary for urban populations to develop solutions that enhance the livability of their local environments - for both biodiversity and themselves - while also reducing their global impact on all three fronts. Cities, as hubs of development and innovation, are well-positioned to lead the way by adopting effective, biodiversity-friendly, and permeable policies - often referred to as "green" policies. These approaches rely on nature-based solutions (NBS) that aim to conserve, restore, and enhance urban soils and vegetation to tackle challenges such as overheating or flood mitigation, improvement of physical and mental health of residents, reduction of soil, air and water pollution, as well as protection and restoration of functional biodiversity and ecosystems. These "green, cool, and permeable" urban planning policies are essential components of the ecological transition toward sustainable cities. However, the excessive land-take by cities - also known as urban sprawl - has led to significant negative consequences, including biodiversity loss, reduced food production, the disturbance of social structures, and increased greenhouse gas emissions from transportation networks through the conversion of agricultural and natural lands [2].

1.2. Urban sprawl in France

In France, a 19% increase in population between 1981 and 2019 has led to a disproportionate 70% expansion in urban surface, whose 42% attributed to residential use. To mitigate the impacts of urban sprawl, urban planners are increasingly turning to denser urbanization models (e.g., "compact city" model), which is now shaping planning approaches across all territorial scales. However, balancing compact urban growth with environmental sustainability presents both a dilemma - often framed as a conflict between grey (built) and green (natural) development - and a paradox, where efforts to enhance livability at the local scale may undermine it at the regional scale. This tension frequently results in the reduction of green spaces, particularly within residential areas.

Residential greenspaces (RGS), either associated with single-family or multi-family housing, serve multiple functions ranging from recreation and food production to mitigating urban nuisances. In French urban areas, RGS represent the largest portion of total greenspace. For example, in the Métropole de Lyon, public green areas account for 25.44% of the total green surface (excluding roadsides and unused plots), while single-family and multi-family residential greenspaces comprise 35.26% and 9.1%, respectively [3]. On a broader scale, single-family RGS represent more than 50% of urban green space in the Île-de-France region [4]. Despite their clear importance in supporting urban biodiversity, permeability, and cooling, and despite their high demand by citizens, RGS are increasingly at risk (Figure 1). Compact city strategies aimed at densifying urban environments have made these spaces vulnerable to rapid reduction and further land artificialization.

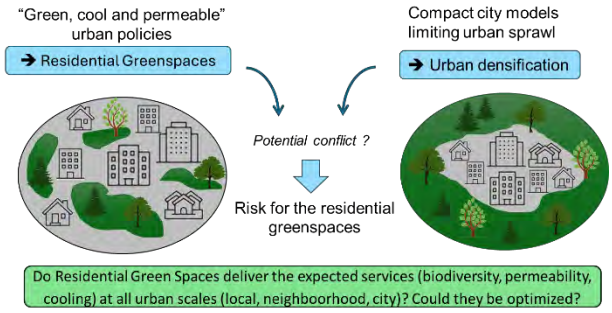


Figure 1. Potential conflict between "Green" urban policies and compact city models and how it raises questions about the role of residential greenspaces in urban environments.

Densification often involves converting single-family into multi-family housing, which results in a significantly lower household-to-green-space ratio. Alternatively, new single-family units may be built on existing residential greenspaces (RGS). Both of these scenarios lead to a reduction in overall greening, causing a loss of ecosystem services provided by soils and a decline in biodiversity. Public green spaces cannot fully offset these losses due to their limited size.

In France, compact urban models are framed within the national "zero-net artificialization 2050" target, outlined in the 2021 "Climate and Resilience" law. This legislation aims to halt urban sprawl and drastically limit the creation of new artificial surfaces. It introduces an ecological definition of artificialization: the permanent alteration of a soil's ecological functions - such as its biological, hydric, climatic, and agronomic functions - due to

land use changes. Until 2031, the consumption rate of natural, agricultural land and forest must be reduced by 50%. From 2031, the implementation of the zero-net artificialization would imply that vegetated surfaces such as public parks or gardens are considered non-artificialized, whereas any green space smaller, than 2,500 m², linear green spaces narrower than 5 meters, or residential, commercial, or industrial greenspaces with less than 25% tree cover are categorized as artificialized. But current discussions between legislators may lead to reconsider some parts of the law.

1.3. Knowledge on Residential Greenspaces (RGS)

The contributions of RGS to livability remain mostly unassessed in a France or continental Europe, which is worrisome in a context where compact city models are fast gaining hold.

The implications of the afore-mentioned taxonomy are numerous and question the existence of RGS, as most single-family and many multiple-family RGS are <2500m² and <25% tree cover. The "Climate and Resilience" law recognizes 7 drivers for achieving the 2050 objective, including optimizing the density of urban areas to preserve natural soils. This implies that new developments should prioritize sites with already artificial surfaces, especially those that can increase urban density. If RGS are considered artificial, their large size makes them prime candidates for redevelopment. While it's difficult to predict the precise impact of this approach on livability, there's a risk of creating an ecological vicious cycle, where regulations intended to improve sustainability may inadvertently exacerbate the very issues they aim to address.

The capacity of RGS to fulfill "all or part of the soil's ecological functions" and support substantial biodiversity has not been systematically studied in France. Most existing research has been conducted in the UK, where single-family RGS constitute the majority of urban areas [5]. Overall, such gardens have been shown to enhance urban biodiversity and permeability, contribute to human health and well-being, provide habitats for diverse species, support pollinators, and may improve functional connectivity between habitat patches for different biodiversity taxa [e.g., 6, 7, 8]. With time and proper management, garden soils can evolve from compacted, biologically poor urban technosols to more fertile and active hortisols, thereby enhancing ecosystem service performance [8].

However, several authors have highlighted limitations in RGS performance at both the plot and city scales. In less affluent neighborhoods, biodiversity within RGS tends to be lower, likely due to smaller garden sizes and reduced access to diverse plant species [9]. In the UK, a concerning decline in RGS area and tree cover has been observed, suggesting reduced effectiveness in supporting biodiversity, water permeability, and urban cooling [5]. Moreover, gardens alone have proven insufficient to maintain landscape connectivity for species like shrews and surface-dwelling arthropods, underscoring the need for a multi-scale approach to better understand and enhance soil biodiversity in RGS [7]. At broader spatial scales, suburban areas with extensive RGS coverage generally host higher biodiversity compared to both inner-city environments and adjacent agricultural zones [6]. Yet, biodiversity and ecosystem services within RGS of multi-family housing remain largely unstudied - representing a significant knowledge gap, especially as these spaces are expected to comprise an increasing share of urban green areas. Assessing the broader ecological role of RGS at the city scale is also challenging, as it requires integrating rarely available datasets, such as detailed land-use typologies (e.g., residential vs. other uses; single- vs. multi-family housing), high-resolution, multi-layer vegetation data, and plot-specific characteristics.

1.4. What is to be explored: objectives of Villegarden project

There is therefore an urgent need to evaluate the role of Residential Green Spaces (RGS) in supporting both human livability and biodiversity. How do RGS contribute to ecosystem services at the plot level, where people and wildlife interact daily? And how do they function at broader scales—such as neighborhoods, where planning and maintenance decisions are made, or across entire urban areas, where challenges like heat islands, air pollution, and flooding emerge, and major policy choices take place? The Villegarden project aims to fill these critical knowledge gaps. We propose that while all types of RGS contribute to ecosystem services across scales, there is significant variability in their performance. This variability is shaped by a wide range of social, environmental, and geographic factors. Rather than viewing this complexity as a barrier, we see it as a valuable resource—offering diverse examples and opportunities for innovation in the design and management of RGS, both individually and as integral components of urban green infrastructure.

Adopting a multidisciplinary approach co-designed with urban stakeholders, we will evaluate the RGS performance in delivering soil-related and biodiversity ecosystem services. By identifying the key social and environmental drivers influencing

their performance, we aim to develop strategies to enhance RGS contributions—taking into account both stakeholder dynamics and environmental processes across plot, neighborhood, and city scales.

The Villegarden project brings together a consortium of over 80 environmental and social science researchers from nine urban areas in France (Figure 2), alongside partners from local authorities, associations, and private companies. This collaboration will foster the creation of a long-term, cross-sectoral community that bridges professions, disciplines, and territories. Establishing such a community is essential for advancing interdisciplinary research, widely recognized as a catalyst for innovation and a necessary path toward solving the world's most complex challenges. Innovation will also be driven by the use of advanced technologies, including automated transcription of interviews, environmental DNA (eDNA) analysis, AI-assisted sensors, geomatics, and citizen science. These tools will support the collection, structuring, and analysis of diverse data, enabling a comprehensive and integrative understanding of RGS performance.

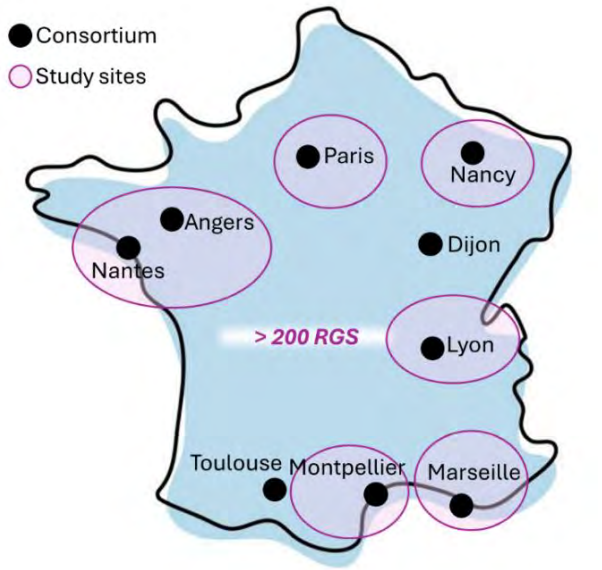


Figure 2. General map of the consortium and field study of the project Villegarden

2. Scientific description of Villegarden

The Villegarden project pursues three main objectives (Figure 3). Objective 1 is to evaluate the performance of key types of Residential Green Spaces (RGS) - particularly single-family and multi-family- regarding soil functions and biodiversity across plot, neighborhood, and city scales. Objective 2 focuses on identifying the environmental and social factors that influence this performance, and using them to model and enhance ecosystem service delivery across all scales. Objective 3 aims to compare these models with existing urban planning documents, in order to develop practical decision-making tools and guidelines for a wide range of stakeholders.

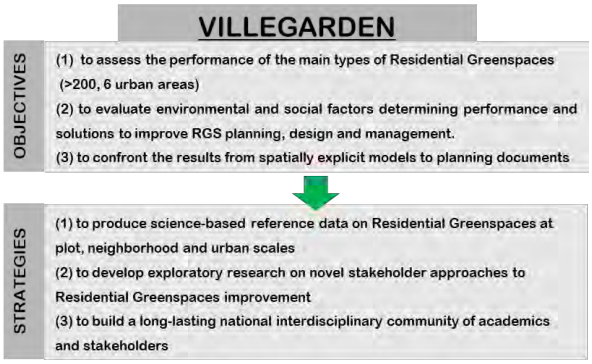


Figure 3. Main objectives and strategies of the project Villegarden

The project is structured in three scientific work packages (Figure 4), each aligned with a specific spatial scale. This reflects the understanding that ecological and social processes, as well as stakeholder responsibilities, differ depending on the scale - and that data collection and analysis must also be tailored accordingly. WP1 looks at city scale processes and factors, based on vegetation, ownership, environmental and social geographic layers joined in a project GIS covering seven cities. In WP2, performance will be measured using soil and biodiversity indicators as well as performance perception by stakeholders, in more than 200 RGS in seven cities. In WP3, neighborhood-scale processes such a relationship with public greenspaces, gardening and landscaping practices, features of ecological networks invisible from aerial photography (e.g. walls, domestic animals) will be explored. Understanding performance and its determining factors will allow innovative modeling of RGS ecological services (e.g. biodiversity support, soil permeability, human well-being) at city-scale.

2.1. Objective 1: Performance of the main types of RGS

RGS performance assessment is based on plot scale biodiversity and soil data to be collected in >200 RGS in 7 cities (Figure 2) and compared to baseline data from urban parks managed for biodiversity (obtained from other projects, see e.g., Collectifs: https://collectifs-biodiversite.universite-lyon.fr/). Performance is defined by comparing indicator values among and between RGS and urban parks. Performance is assessed by the 3 indicators:

i) **soils**: physico-chemistry, structure, agronomical quality, pollutants (trace metals, hydrocarbons, pesticides) [10],

ii) **biodiversity**: eDNA diversity and composition of bacteria, fungi, soils eucaryotes, earthworms, morphological diversity of collembola and plants, citizen-science, acoustic diversity of birds,

iii) **ecosystem functioning**: nitrogen cycle bacterial functions, GHG production, tree evapotranspiration and health, pollination success, soil indicators of functioning.

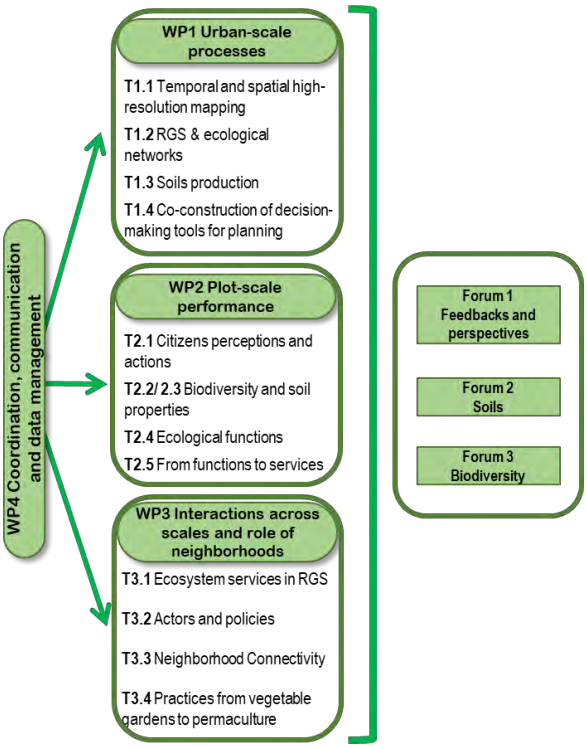


Figure 4. Organization of the project Villegarden

2.2. Objective 2: Factors determining RGS performance

Factors determining RGS performance will be measured or modeled at all scales. High-resolution maps will be produced for all urban areas, where 1m resolution vegetation maps were produced with 2 (herbaceous vs trees, no LIDAR data) or 5 vegetation classes (herbaceous, shrubs<2m, shrubs 2-4m, trees 4-15m, trees>15, with LIDAR data). When aerial imagery and LIDAR data are available, vegetation maps will be produced for two or three dates (2012, 2018 & 2024 or 2025). Production of these maps will be realized with the support of the national observatory system Observil. New satellite data with both high temporal (1 day between images) and spatial (30-50cm) resolution should become available within the time frame of the project, and could be used to study day-to-day evolution of soil humidity, plant health and evapotranspiration. Spatial data will be used to measure factors (plot plant cover, neighborhood and city landscape composition and conformation) for the 200 plots, but also for all RGS within each city by combining vegetation mapping with fiscal plot ownership data on e.g. typology (residential, commercial or public) and number of households [3]. Environmental data for conditions not measurable at plot level, e.g. urban heat island effect, noise, light, air and soil pollution will be mapped using lower resolution data or models. Data on neighborhood scale processes such as gardening practices, morphological details difficult to obtain from aerial imagery (presence of ponds and pools), small impediments to animal movement (e.g. walls) or densities of domestic animals will be obtained through interviews and questionnaires. At plot-scale, garden age (for soil and trees) and soil origins, present and past changes in morphology and practices will be recorded. The functions of RGS intended by residents encompass recreation, food production, buffering urban pollutions (e.g. noise, exhaust fumes, neighbors) and aesthetic considerations. Analytical methods to sort factors, measure collinearity and explanative power will include multivariate analyses and statistical modeling.

2.3. How to improve RGS performance ?

Villegarden seeks to develop methods to improve RGS performance. The first source of improvement will be found in the expected variability of RGS performance, and the determination of factors favoring performance. Additional sources of data and processes for improvement will come from interaction with stakeholders, through three focused actions that Villegarden researchers have started in linked projects. In 2022-2024, the Métropole de Lyon offered financial incentives to multifamily housing estates to upgrade their greenspaces with the advice of professional landscape ecologists and paying up to 50% landscaping works by residents or private companies. Fourteen of the 28 multifamily RGS studied for soils and biodiversity in the Collectifs project were included in that scheme. We will therefore assess the effects of the upgrade (using the 14 non-upgraded RGS as controls) from an ecological as well as social perspective in 2028, a 4-6 years interval. Novel gardening methods, such as permaculture, designed to protect soils and biodiversity, are gaining traction, but their effect on performance and on intended functions are unclear, this will be explored in periurban agglomerations east of Lyon. The cultural background of gardeners influences practices, and adoption of new methods (e.g. no pesticides, no artificial fertilizers, agroforestry); this can be hampered by a cultural misalignment between empirical gardeners

(i.e. laypersons) and experts, which might limit publicly supported effort to improve RGS. Empirical gardeners could also attempt novel methods which experts might find inspiring. This question will be studied with groups of communal gardeners in Nantes and the Ile-de-France region.

2.4. Objective 3: Planning documents and scenarios

Confronting spatially explicit models including RGS with planning documents and scenarios is one of the most consequential parts of Villegarden. To investigate how to combine green and compact city models, density scenarios with realistic ranges of residential morphology and RGS performance will be modeled [3]. Plot performance data will be used to model RGS performance at urban-scale, especially as habitats for wildlife and components of ecological networks. The latter will be modeled with Graphab under different scenarios of past and future changes (of practices, of conversion to more or less vegetation). These models, along with connectivity models, will provide the bases for a prospective approach co-constructed with territorial stakeholders in the dedicated forum on "urban feedbacks and prospective planning", designed to stimulate exchange among researchers and stakeholders from different backgrounds and urban areas. Its outcome will be the production of decision-making tools to help stakeholders consider RGS ecosystem services using explicit models applied to their territories.

3. Conclusion

Villegarden is a promising project addressing specifically both biodiversity and soil in RGS, and aiming through involvement of various stakeholders to highlight ecological and social performances of RGS influencing their consideration into urban planning. RGS mapping is in progress before selection of neighborhood, citizen recruitment and fieldwork in 2026.

ACKNOWLEDGMENTS

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FIFTEEN FACES OF URBAN NATURE: TYPOLOGIES, TEMPORALITY, AND ECOLOGICAL EMPATHY

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Keywords: Ecoliteracy, Urban ecology, Human-nature interaction, Ecological care

Abstract
During the sixth mass extinction and intensifying environmental crises, the traditional view of cities as isolated from nature is no longer defensible. Instead, urban areas must be understood as living ecosystems or hybrid landscapes where built and unbuilt, human and non-human, organic and inorganic coexist in evolving relationships. This paper presents "The Habitat Types of the Built Environment and the Assessment of Their Ecological Condition," a Finnish framework developed collaboratively by researchers, ecologists, and urban practitioners. It defines fifteen dynamic urban nature types, evaluated through robust and clearly defined ecological indicators. These allow practitioners to systematically assess and value the overall ecological state of metropolitan areas. Complementing this scientific rigor, each nature type is paired with a unique anthropomorphic illustration designed to spark interest, emotional engagement, and memory retention. The dual approach, combining tough science with accessible design, provides a powerful toolset for communicating and applying complex concepts in urban ecology and social-ecological systems. The paper concludes by outlining the next step: testing how the framework functions in practice and how understanding of the habitat types is formed in applied contexts.

1. Introduction

The climate crisis, biodiversity loss, and urban expansion necessitate a reconceptualization of how cities interact with nature. Historically, urban planning has operated under a binary separation between the built and natural environments, reinforcing the illusion of ecological detachment. However, as Elmqvist et al. [1] argue, urban areas are increasingly understood as hybrid socio-ecological systems. In this context, cities are not merely hosts to fragments of nature but are themselves evolving ecosystems. Emerging urban ecological theories advocate for viewing cities as active participants in natural processes, as the hybridization of urban and environmental elements yields layered co-evolving systems [2]. This shift requires planners to move beyond superficial, technology-oriented greening measures and toward the systemic inclusion of ecological processes.

This paper introduces a novel framework from Finland: "The Habitat Types of the Built Environment and the Assessment of Their Ecological Condition," which facilitates the integration of scientific and service design principles in urban planning. The framework's fifteen urban habitat types combine rigorous ecological assessment with clear and tempting visual communication, enabling new ways of perceiving and planning urban ecosystems. The framework aims to provide a description of habitat types in the built environment and to establish criteria for assessing their ecological condition. These enable the calculation of nature value hectares for urban nature, which in turn allows, for example, the impacts of land-use projects on both human-created and naturally occurring habitats to be comprehensively and consistently assessed in terms of nature loss or gain.

McBride et al. [3] emphasize ecoliteracy as the foundation for ecological citizenship. In urban contexts, fostering empathy toward non-human actors enhances care practices. To increase the understandability of the framework, the anthropomorphic characters developed for each nature type serve as service design tools, bridging the gap between complex ecological data and public understanding. By representing each habitat as a human-like character, this approach renders abstract ecological concepts more tangible and emotionally resonant. This anthropomorphic strategy helps bridge the cognitive and emotional gap between humans and non-human nature, encouraging a shift from passive observation to active stewardship in urban design and planning.

2. Materials and Methods

2.1 Typological Structure

The fifteen habitat types include wooded parks, thickets, wetlands, ruderal areas, green roofs, and more. Each habitat type comprises a set of clearly defined ecological indicators (e.g., species richness, soil structure, presence of deadwood) that will enable assessment of the environmental condition of a specific habitat (fig. 1).

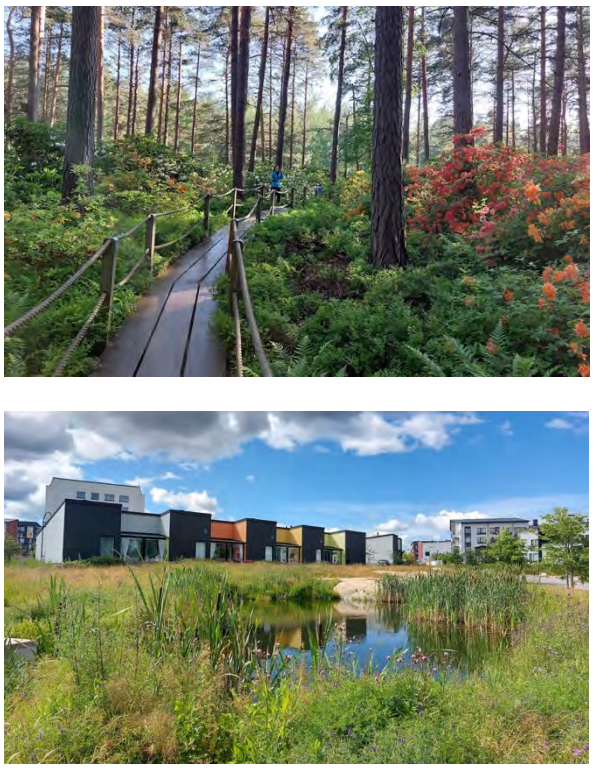


Figure 1. An example of a wooded park habitat (above) and a built wetland (below). (Pictures: Anna Pursiainen / ARVO -project)

The typology was developed through interdisciplinary collaboration within the ARVO project, funded by the European Regional Development Fund, and the BOOST project, funded by the Strategic Research Council of Finland. Researchers organized a set of workshops between December 2024 and February 2025, bringing together almost 40 Finnish experts in urban ecology. Based on background data gathered from existing ecological field surveys and urban planning documents, researchers created a preliminary typology that was further refined in small expert groups during workshops. As the typology was established, experts co-designed indicators that reflected the structural and biological complexity of urban nature. The criteria were carefully calibrated to allow comparative assessment of ecological condition across diverse urban contexts.

The habitat type classification and related criteria are being piloted during the summer of 2025. The piloting involves seven different case sites, where the habitat types and their condition will be assessed as part of a fieldwork run by an urban ecologist. The user experience and results will be collected at the end of the summer, and the typology and criteria will be re-evaluated based on the piloting results. The aim is to develop a user-friendly yet accurate framework for assessing all vegetative areas in Finnish cities.

2.2 Visual Communication

To enhance the representation, each habitat type is depicted as a human-like figure embodying its characteristic flora, fauna, and associated human uses (fig. 2). These characters make the typology memorable and emotionally resonant. They are designed not only to capture attention but to serve as cognitive anchors for understanding complex ecological relationships.

The visualizations include a pun as the Finnish word “tyyppi” can refer to a (habitat) type as well as an individual. This highlights the characteristics of each habitat type, enabling you to recognize them as something you can learn to know and appreciate. Furthermore, it can be literally seen how each character bears specific biodiversity and human activities upon its shoulders.

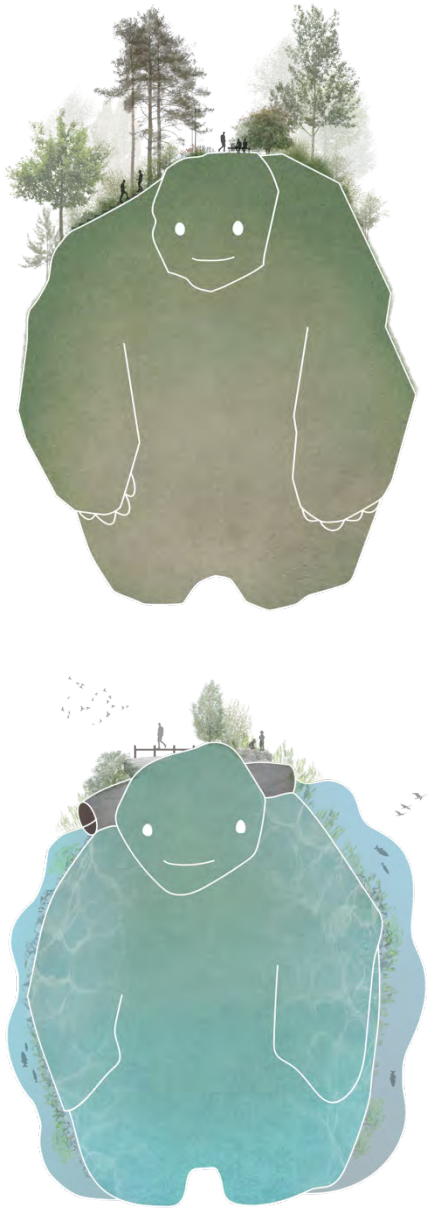


Figure 2. An example of the "wooded park" habitat character above, as well as the "wetland" below.

The characters are based on the original idea of two landscape architecture students, Sara Korkeamäki and Nea Vesterinen, and a project work they created as part of the landscape architecture studio course at Aalto University (spring 2024). In their work, Sara and Nea illustrated two natural habitats of Finnish coastlines as human-like characters to increase recognition of endangered habitats and empathetic feelings towards them. The students were tasked with creating a set of characters for the new urban habitats classification. Urban ecology experts commented on the draft versions so that the details illustrated are accurate and factually correct.

3. Reframing Urban Nature

3.1 Evolving Urban Landscapes

The framework challenges visual and functional expectations of urban green space. Urban nature is not stable but reflects temporal and environmental dynamism, evolving over time. Habitat classifications within the framework are flexible in the sense that a specific vegetative patch of urban nature can transition from one habitat class to another through succession. This highlights the importance of setting strategic goals and implementing related design and maintenance measures for urban open spaces.

For example, in an open park, positive structural features such as topographical variety, diverse vegetation, continuous flowering throughout the growing season, a variety of tree species growing on a site, or the absence of invasive species can be enhanced by design solutions and maintenance to increase the site's ecological quality. The other option would be to let the site (or part of it) develop into a different type of habitat, such as a meadow or a wooded park. For a meadow, a patchy bare ground, an established community of culturally influential plant species, and the absence of shadowing trees would be additional, ecologically essential features. For a wooded park, the criteria are more closely related to the quality and quantity of the trees: the tree stand should be of mixed ages, with some trees reaching species-typical old age. The canopy cover should be over 10% and comprise multiple species. Most of the tree species should be of Finnish or European origin. Additionally, there should be an abundance of large and multi-species deadwood, forming a continuous gradient of deadwood. The trees should contain cavities or hollows, and deadwood should be present in both standing and fallen forms, across various microclimates.

The example above clarifies how, with the help of precise ecological features, it is easier to set a target for the level of ecology on a site and reconcile these with other site functions, such as recreational needs or aesthetic aspirations. Furthermore, by leveling their ecological importance through indicators, elements like deadwood or uneven terrain become signs of vitality, not neglect. This redefinition is crucial in shifting public and professional attitudes, as ecological processes, such as succession, decay, and regeneration, unfold over variable timelines that frequently conflict with urban planning cycles driven by political and financial constraints [4,5].

Moreover, the framework supports general ecoliteracy skills by portraying habitat as dynamic, living actors within the urban ecosystem, deserving of care and attention. Ideally, this perspective will foster a reciprocal relationship between urban residents and green spaces, encouraging shared responsibility for their ecological integrity and resilience. In this way, urban habitat types become not merely decorative background elements of urban life, but integral co-inhabitants of the city, evolving alongside and in dialogue with human communities.

3.2 Practical implications

Besides a potential shift in attitudes and priorities towards urban nature, the framework of habitat types and the assessment of their ecological condition provides a foundation for a set of new practices at various scales of urban landscape planning and design. First, in the land use scale, the framework may be broadly employed as a metric for assessing and monitoring the impacts of both degrading and restorative interventions in urban nature. This, in turn, allows for comparison of land-use alternatives based on their ecological consequences, provided that the habitat type and potential ecological condition of future green areas are valued.

Second, on the design scale, the framework can be utilized as a concrete tool creating guidelines for designing, implementing, and verifying novel ecosystems. In urban settings, novel ecosystems refer to self-sustaining vegetated or semi-natural sites whose species compositions, structures, and ecological processes have emerged through continuous, irreversible human alteration and which no longer resemble historical states, but which nonetheless provide valuable environmental functions and cultural meanings [6,7]. The framework helps integrate novel ecosystems into urban planning, shifting the focus from rigid design or restoration targets to adaptive, process-based stewardship that embraces the ecological potential embedded in the urban fabric. Furthermore, the framework encourages adaptive learning by enabling comparative assessments between different occurrences of the same type of novel ecosystems. This allows the development of place-based design and management practices that take into consideration the local context, both ecological and social features of the site

3.3. Further research needs

Despite the initial introduction and piloting of the framework in 2025, the implementation into practice requires further work and monitoring. It will be essential to follow whether the framework is utilized and generates a shift in the urban greening framework in Finnish municipalities.

The clear assessment criteria will enable a consistent ecological benchmarking across future landscape design projects. Additionally, the use of anthropomorphic illustrations in stakeholder interactions is an interesting aspect to explore. It might impact public opinion, and green spaces once deemed "messy" might gain recognition for their ecological functions.

4. Conclusion

By combining ecological assessment, typological clarity, temporal awareness, and empathetic illustration, "The Nature habitats of the Built Environment" offers a comprehensive framework for reimagining urban nature. The dual emphasis on scientific criteria and communicative design fosters a more holistic understanding of urban ecosystems. The following steps involve both empirical validation and potential future evaluation of how the interpretation and application of the typology evolve through practical implementation and stakeholder engagement.

As a concluding note, it can be stated that ecological systems are inherently resistant to control. Accepting this requires flexible planning and design approaches, as well as adaptive maintenance regimes. The combination of rigorous ecological indicators with engaging, character-based communication exemplifies a productive fusion of science and service design. Anthropomorphic representations do not replace data but amplify its communicative power. This combination is crucial for integrating new ecological classifications into planning practice and public discourse. The framework allows place- and process-based design, which accepts spontaneous vegetation, uneven growth, and decay as indicators of environmental health. This approach further fosters resilience and aligns urban management with natural rhythms. Embracing this perspective will be crucial for cities aiming to evolve as living, adaptive ecosystems that support both human wellbeing and biodiversity.

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REFRAMING URBAN MEMORY THROUGH PUBLIC SPACE: THE CASE OF NALBANTOĞLU STREET

TOPIC: Guiding cities through what is alive: cities as ecosystems (example)

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Keywords: Urban memory, public space, landscape design, collective identity, Bursa.

Abstract

Urban spaces serve as the physical manifestations of collective memory, where historical narratives, artistic expressions, and social interactions converge. Within this context, streetscapes function as dynamic public realms that sustain the continuity of urban identity while adapting to contemporary urban interventions. Bursa's Nalbantoğlu Street, a historically significant urban corridor, has recently undergone a series of spatial modifications. This study critically assesses these interventions, situating them within the broader discourse on public space transformation, and participatory landscape design.

The integration of natural and built elements in urban environments is pivotal for both ecological sustainability and spatial memory retention. Green infrastructure and artistic interventions contribute to the sensory experience of a place, reinforcing its identity and fostering emotional connections among users. Beyond ecological and functional concerns, the street's transformation raises important questions about social inclusivity, and intergenerational engagement in shaping urban narratives. The design of public spaces today increasingly necessitates the involvement of local stakeholders, designers, and residents, ensuring that projects not only reflect community values but also serve as platforms for cultural expression and social cohesion. In the case of Nalbantoğlu Street, the role of memory as a design resource is particularly relevant: How can landscape interventions reveal the layers of history embedded in the site? How do such interventions shape user experiences and perceptions of place?

This research emphasizes the necessity of the relationship between urban memory and design approaches that bring together ecological and cultural dimensions. By framing the interventions on Nalbantoğlu Street within a broader discussion on landscape infrastructure and collective memory, this study contributes to current debates in landscape architecture. The study aims to examine the relationships between social, cultural, and natural components, space, urban memory, urban identity, and society through field surveys, while also conducting structured interviews with the area's users to gather their perspectives. The findings emphasize the importance of public spaces that embrace urban memory as a fundamental component of

urban identity. As a result, this research advocates an integrated approach that respects historical continuity while enabling new synergies between landscape architecture, urban memory and community.

1. Introduction

Urban spaces are more than functional arrangements of infrastructure and architecture; they are socio-cultural constructs deeply embedded with memory, identity, and meaning. As cities evolve under the pressure of demographic shifts, technological advancement, and environmental challenges, public spaces emerge as critical arenas where collective narratives are maintained, contested, or reimagined. Streetscapes, in particular, are not passive conduits but active participants in shaping everyday urban experience. They accommodate movement and economic exchange while simultaneously hosting expressions of shared history and cultural continuity [1].

Among the many lenses through which urban transformation can be interpreted, memory has become a particularly significant concept. Urban memory refers to the embedded historical consciousness of place, maintained through physical artifacts, symbolic forms, and recurring practices [2]. Memory is neither static nor singular; it is dynamic, plural, and often contested. As such, urban design must navigate not only what to preserve, but also how to support evolving forms of remembrance and meaning-making.

Recent work in landscape architecture has expanded this conversation by highlighting the role of ecological systems in enriching spatial experience and sustainability [3]. The notion of landscape infrastructure represents a shift from decorative greening toward integrated ecological networks that support both human and non-human life. Within historically saturated contexts, these systems must be implemented with sensitivity to both the visual and symbolic landscape. Artistic interventions, green elements, and sensory strategies can reinforce spatial memory while providing environmental benefits [4].

The relevance of these discussions becomes particularly pronounced in heritage environments, where the layering of history, meaning, and material form necessitates a nuanced approach to intervention. In such contexts, green infrastructure must be more than a technical solution—it must function as a narrative medium that complements existing spatial memory. When integrated thoughtfully, natural elements and ecological strategies can enhance not only environmental performance but also emotional resonance and a sense of place continuity [5]. This convergence of ecological and cultural dimensions is critical for shaping urban spaces that are both resilient and deeply rooted in local identity.

The case of Bursa's Nalbantoğlu Street provides a valuable context for exploring these questions. Situated within the historical core of the city, the street exemplifies the spatial and temporal layering that characterizes memory-rich urban environments. As a traditional axis of social, commercial, and cultural life, it reflects long-standing practices of interaction and exchange [6]. In recent years, municipal initiatives have introduced spatial modifications such as new paving materials, street furniture, curated vegetation, and site-specific artworks, with the stated aim of revitalization and enhancing spatial quality. While these interventions aim to revitalize the area, they also provoke reflection on what is gained or lost in the process.

This study seeks to critically assess the transformation of Nalbantoğlu Street by analyzing the extent to which landscape interventions contribute to spatial memory, ecological sensitivity, and local identity. It examines how

physical design choices mediate users' perceptions of place and how natural and built elements together influence emotional and historical engagement. The research is informed by a mixed-methods approach, including field observation, user interviews, and application of the Place Standard Tool. Through this investigation, the paper contributes to ongoing debates in urban design and landscape architecture regarding how memory and sustainability can jointly inform the shaping of public space.

2. Materials and Methods

This study adopts a mixed-methods research design to evaluate the spatial interventions on Bursa's Nalbantoğlu Street, integrating both qualitative and semi-quantitative approaches. The methodology is shaped by the need to capture not only the physical changes in the urban fabric but also the lived experiences, emotional attachments, and mnemonic associations of users with the site. The research was conducted in three main phases: site observation and documentation, user engagement through structured interviews, and spatial assessment using the Place Standard Tool.

The initial phase involved detailed fieldwork aimed at recording the morphological and material alterations introduced during the recent transformation. This included photographic documentation, spatial mapping, and inventory of added green and artistic elements. Observations focused on spatial continuity, pedestrian movement, material coherence, and the integration of ecological features. Similar methodological frameworks have been employed in recent studies that combine morphological analysis with photographic and environmental documentation [7][8].

The second phase comprised structured interviews with local users, shopkeepers, and passersby to gain insights into subjective experiences of place. Participants were selected using purposive sampling to ensure diversity in age, gender, and frequency of site use. Interview questions were designed to probe respondents' perceptions of memory retention, identity continuity, ecological comfort, and emotional resonance. This method allowed the research to uncover layers of meaning not immediately visible in the spatial configuration of the street.

To complement the qualitative data, the Place Standard Tool (PST) was applied as a diagnostic framework for assessing the street's social and physical qualities. The PST evaluates 14 key dimensions including identity and belonging, green space quality, traffic and mobility, and care and maintenance [9]. This tool was chosen for its flexibility in addressing both tangible and intangible dimensions of place, and its capacity to support comparative and participatory assessments in urban environments [10]. Data from PST sessions were analyzed using descriptive statistics to identify perceived strengths and weaknesses in the intervention outcomes.

Throughout all phases, the research remained attentive to the interplay between ecological elements and spatial memory. By triangulating data from field observations, user narratives, and spatial assessment tools, the study ensures a holistic understanding of how the recent landscape interventions affect the urban identity and experiential quality of Nalbantoğlu Street.

3. Anticipated Findings

Although fieldwork has not yet been completed, preliminary observations and theoretical groundwork suggest several key expectations. It is anticipated that the integration of green infrastructure and artistic elements will enhance visual continuity and sensory identity while raising concerns about authenticity and cultural relevance. Material changes such as new paving and furniture may improve accessibility but also generate nostalgia and perceived loss of historical continuity among users.

Symbolic interventions—such as artworks and signage—are expected to provoke varied

responses based on generational and cultural differences. While younger users may engage with modern visual cues, older residents may prefer subtle, embedded references to history. Finally, the application of the Place Standard Tool is likely to reveal imbalances between emotional attachment and perceived community agency or ecological satisfaction, helping identify both successes and deficiencies in the transformation.

These anticipated findings offer a framework for interpreting upcoming empirical results, framing Nalbantoğlu Street not simply as a design project but as a layered urban narrative shaped by both memory and material interventions.

4. Conclusion

This study clearly shows that transforming urban memory and public spaces is not only about physical changes. Design is much more than just a technical intervention; it is also a powerful social, cultural, and spatial tool that shapes the relationship between people, place, and history. The case of Nalbantoğlu Street, located in the historic city center of Bursa, Türkiye, is a strong example of how public space design is deeply connected to urban memory, collective identity, and users' everyday experiences.

Field observations and user interviews conducted in the area reveal that introducing green infrastructure and artistic elements into public spaces strengthens the memory of the place and enhances the sense of belonging among users. However, these interventions are not perceived the same way by all groups in society. Different generations and social groups often have different expectations, experiences, and emotional connections with the place. As a result, while some users view these interventions as positive improvements, others may feel that the historical identity of the area is being lost or altered.

This situation is especially critical in urban areas that have a rich historical fabric, where architectural heritage, cultural memory, and daily life are layered together. Design interventions in such areas can help people reconnect with their history and strengthen the continuity of the place. However, if these interventions are implemented superficially or without understanding the cultural context, they risk damaging the historical continuity and weakening the spatial identity of the area. Therefore, careful, sensitive, and inclusive design approaches are essential for maintaining both the physical and emotional layers of historic spaces.

The study also highlights the importance of seeing landscape infrastructure not just as an aesthetic or decorative element, but as an integrated tool that serves ecological functions and supports spatial memory. Integrating green infrastructure into urban design brings many benefits beyond visual improvement. For example, adding trees, green surfaces, and other natural elements can improve the environmental quality of the area, increase climatic comfort, and promote biodiversity. At the same time, these elements help create a stronger emotional connection between people and the place, reinforcing their sense of belonging.

In the case of Nalbantoğlu Street, the recent landscaping interventions aim to improve both the environmental performance and the visibility of urban memory. These interventions include new paving materials, street furniture, green spaces, and site-specific artistic elements. While the intention is to revitalize the street and enhance its spatial quality, the research shows that the success of such projects depends largely on how well they respect the historical character and social fabric of the area.

Furthermore, the study emphasizes that spatial interventions in historic urban environments should address ecological sustainability, cultural continuity, and social inclusiveness together. These three dimensions are interconnected and essential for creating resilient, meaningful, and livable public spaces. Participatory design processes, where local residents, stakeholders, and designers collaborate, are especially important. Such processes ensure that the values, needs, and expectations of the

community are reflected in the project. When people feel included in the design process, their sense of belonging increases, and the cultural transfer between generations is supported.

The preservation of historical layers is also a fundamental element that strengthens the identity of a place and reinforces collective memory. Historic streets like Nalbantoğlu Street are not only physical spaces but also living archives of shared experiences, traditions, and stories. Protecting these layers requires design approaches that are sensitive to both the tangible and intangible heritage of the area. At the same time, cities must also adapt to contemporary needs, such as environmental challenges, accessibility, and changing social dynamics.

In this context, the case of Nalbantoğlu Street demonstrates that public space design in the field of landscape architecture goes beyond physical improvement. It plays a key role in the reproduction of urban memory, the protection of cultural identity, and the encouragement of social interaction. Streets, parks, and squares are not just places of movement and daily activity—they are also spaces where people connect with their history, express their identity, and build community ties.

Therefore, this study underlines the need for participatory and holistic design approaches that balance the protection of historical textures with the demands of contemporary urban life. Design solutions should neither freeze the past nor ignore it. Instead, they should create new opportunities for interaction, storytelling, and shared experience.

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A SELECTION OF INDIGENOUS ITALIAN FLORA FOR RAIN GARDENS' IMPLEMENTATION

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Abstract

Urban water systems are under growing strain from the combined impacts of climate change and urbanization, especially in stormwater management, as impermeable surfaces spread and extreme weather events grow more frequent. To address these challenges, cities have turned to innovative, nature-based approaches, known by various terms such as Low Impact Development (LID), Sustainable Urban Drainage Systems (SUDS), or Water Sensitive Urban Design (WSUD). From rain gardens and green roofs to wetlands and vegetated swales, vegetation is central to the performance of these systems, transforming infrastructure from purely functional to multifunctional. Selecting appropriate species has both ecological and economic benefits, rooted in their evolutionary adaptations and long-term interactions with their habitat. To maximize these outcomes, a site-specific design approach is strongly recommendable, both considering local environmental conditions and prioritizing native flora. On the one hand, it supports local biodiversity by enriching native plant and animal communities, reduces the risk of potentially invasive species' introduction, and favors the preservation of the local *taxa*. On the other, it enables the development of low-maintenance systems that can withstand the challenging conditions of urban settings. Due to prominent role of the United States in these implementations, North American flora is predominantly featured in both academic research and realizations worldwide, often preferred due to their well-understood and reliable characteristics. In comparison, native European plants have received relatively limited attention and documentation. Addressing this imbalance could enhance local ecological networks, better adapt to regional conditions, and mitigate potential threats to biodiversity. Nevertheless, the currently used *taxa* represent a valuable resource and starting point for this process. This study focuses on plant species selection for rain gardens in Italy and is based on the review of both international scientific literature and stormwater management manuals. A research method, and a selected list of species from the first outcomes, are proposed. This study intends to support further research and testing, and innovative applications of rain gardens, which in Italy are still a quite unexplored field. The diverse climatic regions of the Italian peninsula, from the cooler northern zones to Mediterranean environments, are considered using drought and heat resistance indexes, while their combination with the species' waterlogging tolerance suggests their positioning in the rain garden's moisture gradient. These indexes are derived from a combination of information from the reviewed literature and ecological characteristics specific of the European and Italian territory. The list of *taxa* presented is not exhaustive but might suggest the consideration of certain plant communities and functional traits. At the same time, the broader outcomes of the method - which encompass an extended overview of worldwide species – are intended to support further developments of the research, deepening the understanding of morpho-physiological and ecological characters to be applied to the local flora.

1. Introduction

Sustainable stormwater management comprises a range of practices centered on the implementation of green infrastructure to deliver multiple ecosystem services, while supplementing or replacing conventional, and frequently insufficient, "grey" infrastructure systems [1]. Among these practices, rain gardens – mostly considered a synonym of bioretention systems - represent a key element. These systems consist of engineered vegetated depressions filled with a specially designed substrate, intended to filter, and where feasible, infiltrate stormwater runoff [2–4].

Vegetation plays a central role in rain gardens, interacting dynamically with stormwater, the soil media, and surrounding environmental factors. These interactions collectively influence the vegetation's capacity to regulate water quantity and quality, thereby contributing to the overall sustainability and functionality of the system [3].

The present study forms part of a larger research effort on rain garden vegetation, with the following objectives: to compile, review, and compare a representative body of existing literature; to conduct ecological - and where appropriate, morphological - analyses of the *taxa* identified; and to define selection criteria for suitable species, with a particular focus on native Italian flora. The overarching aim is to enhance the value of Italy's rich plant biodiversity by proposing autochthonous species that are well-adapted to the climatic conditions of the Italian peninsula. This approach seeks to strengthen local ecological networks, while also addressing the complex and often contentious issue of alien species introduction.

This paper presents the methodology and a portion of the preliminary results. The current selection of species is based on the collation of *taxa* from existing literature, followed by comparative analysis and integration with additional ecological data.

2. Materials and methods

The literature reviewed comprises three systematic reviews [2,3,5] , encompassing a total of 111 research articles, along with two primary research studies [1,4], two reference books [6,7], and eight technical manuals. All the manuals are from the United States - where most guidelines originate – and cover a range of climatic regions, with special emphasis on California to ensure representation of Mediterranean climates. The manuals consulted include:

- "*Plants for Stormwater Design: Species Selection for the Upper Midwest*" (2003);
- "*University of Florida Green Stormwater Infrastructure Maintenance and Planting Manual*";
- "*City of Seattle Stormwater Manual: Additional Design Requirements and Plant Lists*" (2017);
- "*San Diego Low Impact Development Design Manual*" (2011); "*Low Impact Development Manual for Southern California*" (2011); "*San Francisco Stormwater Management Requirements and Design Guidelines – Appendix D: Vegetation Palette for Bioretention BMPs*" (2016); "*Santa Clara Valley Stormwater Manual*" (2024);
- "*New York State Stormwater Management Design Manual – Appendix H: Landscaping Guidance Plant Lists*" (2024).

To integrate and analyze the species listed across the literature, six databases were created: three for herbaceous species, categorized by taxonomic group (dicotyledons, monocotyledons, and ferns and horsetails which are not discussed here), and three for woody species, categorized by growth form (shrubs, shrubs or trees, trees). All species names were standardized according to the nomenclature adopted in the Kew Gardens' database Plants of the World Online. Additionally, the native and global distribution ranges of each species were extracted from the same database to identify European and Italian-native *taxa*.

Based on the characterizations provided in the literature, the following data points were compiled for each species, either directly from the sources or through custom equivalence tables developed for this study:

- Vitality index (from [2]);
- Habitat moisture gradient (as indicated in [6] or inferred from recommended rain garden placement);
- Submersion tolerance;
- Light exposure requirements;
- Watering needs;
- Climatic classification (Köppen system), based on the environmental context in which each taxon was applied or the geographic location of the manual.

All sources for each record were documented and tallied to assess both the recurrence of individual *taxa* and the nature of the supporting evidence.

In the analysis phase, the first step involved identifying the most frequently cited international species. As these were primarily of North American origin, the USDA Plants Database served as the primary reference for ecological, physiological, and morphological data where available. Additional floristic resources were used to supplement habitat descriptions. Using the selection criteria outlined above, genera that also

include native Italian species were examined, enabling cross-comparison and further characterization. This will allow the identification of functional traits potentially present in related indigenous species.

In the second phase, the analysis focused on Italian-native *taxa* cited in the literature. Excluded from consideration were species with low ornamental value, those that had proven unsuitable for rain garden applications, and obligate aquatic species. The characterization of these native *taxa* was enriched using Ellenberg indicator values [8], USDA plant classifications [9], their distribution within the Italian territory, elevational ranges, and habitat data [10]. To synthesize the information and support species selection, three functional indices were developed: Submersion Tolerance (ST), Drought Tolerance (DT), and Heat Tolerance (HT). Each index was rated on a five-point scale: very poor/none (--), poor (-), moderate (+/-), average (+), and good (++). The ST index was derived from ecological data, humidity gradient, Ellenberg values, and USDA wetland status. DT was also informed by both the climatic zones and the species' geographic ranges within Italy. HT was additionally based on altitudinal distributions of the respective habitats.

These indices collectively reflect each species' hydric requirements and tolerances, thereby informing optimal placement within rain gardens and evaluating their suitability across Italy's varied climatic zones. Furthermore, water requirements must be interpreted in relation to the specific climatic conditions to which a species is exposed - such as the need for irrigation or supplemental moisture in more arid settings. These indices also facilitate the grouping of species with similar ecological needs, thereby minimizing maintenance inputs and supporting the design of more resilient, low-input planting schemes.

3. Results

Table 1 reports the numerical results of the survey, in terms of *taxa* and geographical distribution. Table 2 indicates the most cited family and the first three species for number of citations. Table 3 reports an overview of the Italian native cited *taxa.*

Table 1. *Taxa* overview families, genera, records, *taxa* (genus or species), geographical range (North America, Europe); HD = herbaceous dicotyledons; HM = herbaceous monocotyledons; S = shrubs; S/T = shrubs/trees; T = trees.

	Fam.	Gen.	Rec.	*Taxa*	N.Am.	Eur.
HD	58	188	367	347	73%	20%
HM	18	106	308	289	60%	25%
S	54	139	294	265	67%	10%
S/T	28	38	77	75	39%	11%
T	34	67	173	139	69%	12%

Table 2. Most cited families and species (see legend of table 1).

	Most cit. family	Most cit. species
HD	*Asteraceae* (109 *taxa*)	*Echinacea purpurea* (L.) Moench, *Lobelia cardinalis* L., *Monarda fistulosa* L.
HM (grasses, grass-like)	*Poaceae* (117 *taxa*)	*Carex appressa* R.Br., *Juncus effusus* L., *Panicum virgatum* L.
HM (other)	*Asparagaceae* (17 *taxa*)	*Dianella revoluta* R.Br., *Iris pseudacorus* L., *Iris versicolor* L.
S	*Rosaceae* (37 *taxa*)	*Ilex verticillata* (L.) A.Gray, *Cornus sericea* L., *Cephalanthus occidentalis* Land
S/T	*Myrtaceae* (20 *taxa*)	*Melaleuca ericifolia* Sm., *Umbellularia californica* (Hook. & Arn.) Nutt., *Acer campestre* L.
T	*Fagaceae* (21 *taxa*)	*Betula nigra* L., *Nyssa sylvatica* Marshall, *Acer rubrum* L.

Table 3. Italian native *taxa*: Gen. = genera present in Italy with native species, also not cited; Gen.* = Italian native genera indicated by the references; Cons. spp. = considered cited species; Clim. = most frequent climate from literature among the considered species (Köppen classification); N, S = % of species present in Northern and Southern Italy (see table 1 for the rest of the legend).

	Gen.	Gen.*	Cons. Spp.	Clim.	N	S
HD	91	7	43	Cfb	95%	67%
HM	55	9	44	Csb	95%	70%
S	47	2	19	Csa	95%	79%
S/T	18	1	7	Csb	100%	86%
T	21	1	14	Cfb, Csb	79%	79%

In the following sections a selection of species is presented, including the most cited ones and other *taxa* which resulted to be an interesting combination of characteristics. Shrubs which also have the tree habit are treated with the other shrubs in section 3.3. The abbreviations used for the USDA Wetland status are: OBL = obligate wetland species; FACW = facultative wetland

species; FAC = facultative species; FACU = facultative upland species; UPL = upland species.

3.1. Herbaceous Dicotyledons

The *taxa* mostly occur on hills and mountains, suggesting a mitigation of the heat. Most species have a good, average or moderate adaptation to submersion, while having a worst adaptation to drought and heat.

Table 4. Herbaceous Dicotylendons' selection. Cit. = number of citations; ST = submersion tolerance; DT = drought tolerance, HT = heat tolerance. In **bold** characters the most cited species.

Species	Cit.	ST	DT	HT
***Achillea millefolium* L.**	**6**	**+/-**	**+**	**+**
***Lythrum salicaria* L.**	**6**	**++**	**+/-**	**+**
Lotus corniculatus L.	3	+	+	+
Geum rivale L.	2	++	-	--
Medicago sativa L.	2	-	++	+
Bistorta officinalis L.	1	++	+	--
Cerastium arvense L.	1	+	+	-/+
Eupatorium cannabinum L.	1	++	+/-	+/-
Nepeta cataria L.	1	+	+	+
Pentanema ensifolium (L.) D.Gut.Larr., Santos-Vicente, Anderb., E.Rico & M.M.Mart.Ort.	1	+	++	+/-

Achillea (grasslands, fallow lands, road margins; FACU/UPL) and *Lythrum* (riparian habitats, swamps, ditches, road margins; OBL/FACW) are both rhizomatous species. *Achillea* is a valid compromise of parameters, also for Csa climates, while *Lythrum* perfectly withstands submersion, even if it can be subject to phytosanitary issues in cultivation [5]. *L. virgatum* L. is an alternative from slightly drier environments. *Geum* is limited by drought and heat tolerance. *Lotus* and *Medicago*, which can have a certain presence in wetland contexts (FACU/UPL), might be providing nitrogen fixation. *Bistorta* (FACW) is interesting as relatively drought resistant, but inappropriate for hot conditions since it grows in fresh mountainous habitats, while *Cerastium* (FAC/FACU), *Eupatorium*, and particularly *Nepeta* (FAC/FACU) are a promising combination of all the tolerances. *Pentanema* (syn. *Inula ensifolia* L.) grows in arid environments, but also in rocky stream beds, which allows to assume a tolerance for temporary flooding.

3.2. Herbaceous Monocotyledons

As for Dicotyledons, most species have a good, average or moderate adaptation to submersion, while having mostly a poor adaptation to drought and a moderate adaptation to heat.

Table 5a. Herbaceous Monocotyledons' (grasses, grass-like plants) selection.

Species	Cit.	ST	DT	HT
***Juncus effusus* L.**	**16**	**++**	**+**	**+**
***Deschampsia caespitosa* (L.) P.Beauv.**	**9**	**++**	**-**	**+/-**
Phragmites australis (Cav.) Trin. ex Steud.	5	++	+	+
Helictotrichon sempervirens (Vill.) Pilg.	3	-	++	-
Phalaris arundinacea L.	1	++	+/-	+
Carex sylvatica Huds.	1	+	+/-	-
Imperata cylindrica (L.) Raeusch.	1	+	+	++
Juncus acutus L.	1	++	+/-	++

Juncus effusus is a species with a broad ecological range and high potential. *Phragmites* too is a remarkable species found in the whole Italian peninsula, less but still drought-tolerant, and with a prominent ecological role. *Deschampsia* (moist meadows and woods, riparian habitats, swamps; FACW/FAC) has high anaerobic tolerance, but lower drought and heat tolerance. *Imperata* (FACU/UPL) and *Juncus acutus* L. (FACW) instead, found in Mediterranean environments, are remarkably heat-tolerant and can withstand humidity fluctuations. *Helictotrichon* too is drought tolerant. Only three *Carex* species are Italian-native; *C. sylvatica* is the less water-requiring, but from fresh, shaded habitats.

Table 5b. Herbaceous Moncotyledons' ("flowering" group) selection.

Species	Cit.	ST	DT	HT
***Iris pseudacorus* L.**	**7**	**++**	**+/-**	**+/-**
***Iris sibirica* L.**	**2**	**++**	**-**	**+/-**
Gladiolus palustris Gaudin	1	**+**	**+**	**+/-**
Hemerocallis liliasphodelus L.	1	**+**	**-**	**+/-**

Iris pseudacorus L. can withstand frequent submersion but interestingly can also tolerate mesic conditions. *Iris sibirica* and *Hemerocallis* are species from humid environments, found only in Northern Italy, while *Gladiolus* can punctuate different parts of the rain garden.

3.3. Shrubs

The adaptation to submersion is good or average in half of the shrub (shrubs, small shrubs) species, while there are different drought resistant *taxa*, and heat tolerance is variable. Of the species with the tree habit too, almost all are present in the whole

peninsula, and the majority is drought and heat-resistant.

Table 6a. Shrubs (sub-shrubs, small shrubs) selection.

Species	Cit.	ST	DT	HT
***Arctostaphylos uva-ursi* (L.) Spreng.**	**2**	**+**	**++**	**+/-**
Dasiphora fruticosa (L.) Rydb.	1	+	+	+
Teucrium chamaedrys L.	1	+/-	++	++
Santolina sp. (*S. etrusca* (Lacaita) Marchi & D'Amato)	Ge	+	++	++

Arctostaphylos (FACU/UPL) and *Dasiphora* (FACW/FAC) in Italy occur in rocky environments of mountainous and subalpine ranges, while in the USA are used in the driest and warmest climates. *Santolina* is cited as a genus; here is proposed *S. etrusca*, growing in the garigue along stream banks.

Table 6b. Shrubs selection.

Species	Cit.	ST	DT	HT
***Cornus sanguinea* L.**	**4**	**+**	**+**	**+**
***Salix purpurea* L.**	**4**	**++**	**+/-**	**+/-**
Viburnum opulus L.	3	++	-/+	-
Sambucus nigra L.	2	+	-/+	+
Nerium oleander L.	1	+/-	++	++
Styrax officinalis L.	1	+	+	++

Table 6c. Shrubs' (shrubs or trees) selection.

Species	Cit.	ST	DT	HT
***Acer campestre* L.**	**4**	**+**	**+**	**+**
Hippophae rhamnoides L.	1	+	+	-/+
Vitex agnus-castus L.	1	+/-	++	++

Cornus is a valid compromise of tolerances and can be a pioneer species, occurring from riparian habitats to drier conditions, like *Acer*; it is also good nectar and berries source for the wild fauna. *Salix* (OBL/FACW) is a deep rooting, riparian species also tolerating mesic conditions. While *Viburnum* (FACW/FAC) requires a certain shading and not-too-hot temperatures, *Sambucus* is more adaptable, also colonizing urban areas; both produce berries valuable for wildlife. For Mediterranean areas, three interesting ornamental *taxa* are *Styrax*, *Nerium,* and *Vitex*. *Styrax* (scrubs and road margins) is found in Central and Southern Italy and was proved to tolerate periodic flooding. *Nerium* and *Vitex* are drought and heat tolerant species, occurring in nature in stream beds; *Vitex* withstands humidity fluctuations thanks to a deep taproot. *Hippophae* is a nitrogen fixing riparian species with less heat tolerance; its berries provide winter food to avian fauna.

3.4. Trees

Most of the species are typical of not-too-hot conditions and require a good level of moisture. Submersion and drought tolerance are variable, but heat and drought tolerance are mainly poor.

Table 7. Trees selection.

Species	Cit.	ST	DT	HT
***Alnus incana* (L.) Moench**	**2**	**++**	**+/-**	**-**
***Carpinus betulus* L.**	**2**	**+**	**+/-**	**+/-**
Alnus glutinosa (L.) Gaertn.	1	++	+/-	+/-
Populus tremula L.	1	++	+/-	+/-
Quercus robur L.	1	++	-	-
Quercus suber L.	1	+/-	++	++
Salix alba L.	1	++	+/-	+/-

Alnus incana (FACW/FAC/FACU) is a pioneer species of fresh riparian habitats, while *A. glutinosa* (FACW) is also present in wetlands; still, they both have a moderate to average drought resistance. *Carpinus* is less adapted to waterlogging but, in the drier sites, it can be a dominant species together with *Q. robur*, a lowland species withstanding 2 or 3 months of submersion. *Q. robur* is found together with *Fraxinus angustifolia* Vahl, *Ulmus minor* Mill. and, in slightly drier areas, *Acer campestre* L.. *P. tremula* has a broad ecological range and good waterlogging tolerance, but other species of the genus have even better submersion adaptation. *Salix* (FACW), adapted to submersion as a riparian species, has moderate drought tolerance. The use of Mediterranean oaks like *Q. suber* should be limited to fast draining media. From other internationally used *genera*, Italian-native species such as *Cercis siliquastrum* L., *Celtis australis* L., and *Platanus orientalis* L., are *taxa* which can also be found in Mediterranean lowland riparian forests, potentially compatible with the typical stresses of rain gardens in warmer climates.

4. Discussion and conclusions

The first general limitation of the method is its reliance on North American sources, which firstly might be different or more in comparison to the chosen manuals and secondly prioritize native species. Furthermore, manuals are not scientific production; still, they are supposed to rely on horticultural experience and consistently broaden the set of *taxa*. Another major limitation concerns the lack of data on species success rates, which is only partially addressed in reference [2]. This highlights the need for further research based on

more data sources, and direct experimental testing, such as in reference [4] and in relation to drought and heat tolerance.

In general, not all desirable ecological and physiological traits are consistently documented across all *taxa* (e.g., flood tolerance), and in some cases, available information may be inconsistent or contradictory. Standardization poses an additional challenge, particularly in the creation of equivalence tables for optimal and tolerated moisture levels. Furthermore, the climatic adaptability of species might exceed the conditions under which they were originally evaluated or reported.

The USDA Wetland Classification is a valuable tool as it indicates the existence of wetland-tolerant ecotypes; however, these ecotypes may not directly correspond to the Italian ones. Similarly, a key limitation of Ellenberg indicator values is that they reflect the species optimal distribution conditions rather than ther full ecological amplitude [8]. Another methodological constraint involves defining the specific submersion durations associated with the ST index. Drawing from the findings in reference [4], the following equivalence is proposed: *good tolerance* corresponds to at least four days of submersion (i.e., placement at the bottom of a slow-draining rain garden); *average tolerance* to at least two days; m*oderate tolerance* to one day (bottom placement in fast-draining conditions); *poor tolerance* to several hours; *very poor or no tolerance* to absence of submersion.

Preliminary analysis of the selected native species reveals that most herbaceous *taxa* exhibit limited adaptation to drought and high temperatures. In contrast, shrub species tend to display greater tolerance, suggesting their preferential use in Mediterranean climates, consistently with references [1,2] and with Californian technical manuals. In such cases, the strong emphasis on drainage supports the establishment of deep-rooted woody species and mitigates the risk of root rot. The inclusion of subsurface water storage is also recommended.

Conversely, the tree species identified in the literature generally show poor adaptation to drought and heat stress. This highlights the need for further research into drought- and heat-tolerant forbs, grasses, and tree species. Future investigations should incorporate morphological traits (not considered in the present analysis) as well as ecological characteristics of both native and well-adapted non-native *taxa*. A more comprehensive morpho-physiological characterization is warranted, as it can critically inform species' effectiveness in regulating both water quantity (via infiltration and evapotranspiration) and quality (via filtration and interactions with the soil medium).

A promising starting point for this research is the set of genera identified, which might include ecological equivalents within the autochthonous flora. Possible interesting habitats might be those with humidity fluctuations such strongly clayey substrates (subject to both waterlogging and desiccation), or contexts like rocky or sandy streambeds (especially those in ephemeral or torrential systems).

A further step should involve the reconstruction of functioning plant communities, rather than isolated species selection. The design of rain gardens in their various typologies, such as those illustrated in references [2,5], should incorporate strategic species associations based on the combined use of the three proposed indices, when properly integrated with further information (e.g. on substrates and competitiveness).

In conclusion, the selection of native species presented here may serve as a reference for both practitioners and researchers, providing a foundation for design applications and concurrent empirical validation. Nevertheless, the complexity of plant selection encompasses additional factors not addressed in this study - such as aesthetic value and maintenance requirements [1,6], together with pollutants' filtration efficiency - which represent essential future directions for research and application development.

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POCKET FORESTS: CULTIVATING RESILIENT URBAN LANDSCAPES

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Keywords: Urban Landscapes, Pocket Forests, Biodiverse Ecosystems, Microclimate

Abstract

Rapid urbanization often leads to the disorganized development of cities, resulting in vacant, barren patches of land among urban areas. These spaces are frequently used for dumping debris or garbage or become neglected areas with overgrown vegetation that can harbor pests and diseases. In developing countries, they may also turn into slums due to insufficient oversight by civic authorities. The question arises: Can these overlooked pieces of land be transformed and add value to the urban spaces? We identified such spaces in 10 cities: Thane, Pune, Kalyan-Dombivali, Ambernath, Ulhasnagar, Panvel, NaviMumbai along the coast near Mumbai, Maharashtra, India, and some in the interior with extreme climates like Jalgaon, Shirdi, and Nanded. The project was funded by the Central Government under the AMRUT Scheme (Atal Mission for Restoration & Urban Transformation). Once the space was identified, we determined ownership, selecting only those owned by civic authorities. The process began with a SWOT analysis to understand the strengths, weaknesses, opportunities, and threats of each space. Demographic and psychological analysis established potential users, their ages, and other attributes. Topographic and sunshade analyses enabled scientific transformation into sustainable spaces. The aim was to make the spaces accessible and inclusive. Transforming them into gardens would require long-term maintenance. Given that 'AMRUT' in Hindi means nectar or fruits, we explored whether we could create spaces with edible fruits, attract butterflies, insects, and birds, thereby establishing a sustainable biodiverse ecosystem. This led to the design of pocket forests in different locations, each incorporating indigenous symbiont species. Polyculture was implemented to prevent disease outbreaks during growth. Natural trails were created within each forest. Tree spacing minimized rank vegetation growth, reducing the need for weeding. Defoliated leaves provided mulch to decrease transpiration losses and ultimately enrich the soil as manure. Our design focused solely on trees—flowering trees offering fragrance and improving bird habitats. A resilient ecosystem that thrives primarily during monsoon seasons and sustains itself thereafter was achieved. As the forests matured, microclimates developed, attracting rare birds and creating spaces for social gatherings, fitness activities, and passive recreation such as painting. Pathways made of compacted soil allowed for percolation and easy walking. Proper signage and ergonomic seating encouraged frequent visits. Previously infertile soil became fertile naturally, providing shade and shelter from rain.

Some forests were themed, and named accordingly: Sanskriti Udyaan (Heritage Forest), Ayurved Van (Medicinal Trees), Saptrangi and Navrangi Vans (Forests with seven or nine colorful blooms), and Healing Forests (Medicinal Trees). The design and implementation spanned from 2015 to 2019, and today, the oldest pocket forests are nearly 10 years old. These forests act as carbon sequestration hubs, biodiversity pools, reduce soil erosion, integrate various fields like architecture, ecology, engineering, landscape, and urban planning. They have increased property values, reduced crime rates, fostered recreational legacies, and preserved genomes of different indigenous tree species. The total area covered in 10 cities by us is 1069300.87 sqm or 115 million sqft which is quite significant. Future exploration includes rainwater harvesting and the generation of carbon credits.

1.Introduction

The Maharashtra Urban Development Mission Directorate, under the guidance of the Urban Development Department, is responsible for implementing the Atal Mission for Rejuvenation and Urban Transformation (AMRUT)—a flagship national program aimed at improving urban infrastructure and liveability. AMRUT focuses on universal coverage of essential services such as water supply and sewerage, development of green spaces, and promotion of non-motorized transport in selected urban centres across India. There have been such programs in other cities like Hyderabad as an initiative by the Hyderabad ULB. [1]

As part of this initiative, M/s Aseem Gokarn Harwansh was appointed as the Green Space Consultant for ten cities in Maharashtra: Thane, Pune, Kalyan-Dombivli, Ambernath, Ulhasnagar, Panvel, and Navi Mumbai along the coastal belt near Mumbai, as well as Jalgaon, Shirdi, and Nanded in the interior regions known for their climatic extremes.

2. Methodology

The assignment spanned over three financial years—**2015–2016, 2016–2017, and 2017–2018**—with year-wise budgets allocated by the Central Government under AMRUT. Our role was to identify viable locations within these cities for the development of **urban green spaces**, followed by conceptualization, feasibility studies, and cost structuring for implementation.

2.1 Scope of work

2.1.1 Identification of projects

After annual budgets were finalized, we initiated the identification of suitable land parcels through extensive site surveys in collaboration with civic authorities. Only Urban Local Body (ULB)-owned plots were considered, ensuring clear title and administrative control. These lands were often marginal or neglected, such as stretches along nala or canal banks, spaces filled with construction debris, or reserved open spaces burdened with rank vegetation or informal encroachments.

We reviewed the respective **City Development Plans (CDPs)** to determine whether these plots were earmarked for green development. Once ownership and compliance status were confirmed, the plots were surveyed, admeasured, and shortlisted for design intervention.

2.1.2 Project Conceptualization

Each site was subjected to **reconnaissance surveys** and **detailed site analysis**, covering climate, topography, soil type, existing vegetation, demographic profile, and proximity to water bodies or institutions such as schools or senior citizen centres.

Based on these findings, we developed **site-specific concepts**. For example, if the plot was located near a school, it was designed with interactive and educational green zones; for senior citizen areas, passive recreation spaces were prioritized. The vegetation palette was determined by evaluating **native species**, **invasive growth**, and **ecological resilience**. Concept plans were submitted to the Urban Development Department for approval

2.1.3 Prefeasibility & Feasibility Studies

Preliminary and detailed feasibility assessments were carried out using primary and secondary data sources, including consultations with stakeholders and site users. These studies evaluated the site's behavior under monsoon conditions, connectivity to drainage and electrical networks, and potential for infrastructure integration. Input from relevant municipal departments helped refine the project scope and ensure viability.

2.1.4 Financial analysis and financial structuring of the projects

Upon concept approval, cost estimates were prepared to align with the fixed annual allocations. Design revisions were sometimes necessary to adhere to budget constraints. In some cases, funds were divided across multiple small sites, while in others, a single large site was prioritized. Flexibility in design and financial planning was key, ensuring optimal use of funds without compromising on ecological value or community benefit.

2.1.5 Landscape plan

The landscape planning for each site was informed by multiple contextual and thematic considerations. Since most of the identified plots were marginal, underused, or inconspicuous, the key challenge was to transform these neglected spaces into meaningful, purpose-driven green zones. The goal

was to ensure that users found not only utility but also emotional and ecological value in the final outcomes.

In **Navi Mumbai**, for instance, a large open plot adjoining a water-holding pond had long been a habitat for migratory birds. However, there were no provisions for birdwatching or leisure—only peripheral jogging tracks existed. We proposed a **biodiverse plantation zone** along the pond's edge, transforming the space into a nature-based recreational environment. This allowed visitors to enjoy passive activities such as birdwatching, walking, and seasonal observation, adding both ecological and aesthetic value.

Another case involved a plot adjacent to a **mangrove belt**, which was completely overtaken by ***Leucaena leucocephala*** (*Subabhul*), an invasive species [2]. We conducted awareness sessions with the authorities and stakeholders to explain the ecological risk of allowing such species to dominate. The plan involved removing invasive flora and replacing them with native **mangrove associates**, ensuring habitat restoration. Areas located near mangroves often face threats from misuse and irresponsible human activities, [3]. As the plot was also near a hospital and a children's park, we integrated a **Vitaparcour (fitness trail)** into the tree plantation scheme, promoting health and community wellness.

Throughout the project, a clear **Design SOP (Standard Operating Procedure)** guided our approach. Local materials were prioritized, permeable pathways (such as rammed earth) were used instead of concrete or paver blocks, and ergonomic seating spaces were included. Interpretive signage shared stories and cultural relevance of tree species, aligning with Indian traditions that revere certain trees. Trees like **Kadamba, Banyan, and Ritha**, known for their mythological and medicinal significance, were integrated into **Sanskruti Parks** or **Heritage Trails**, deepening the cultural connect.

Plant selection was critical to the success of these projects. Only two-year-old, fully-grown saplings with a trunk calliper of 2–2.5 inches were used to ensure higher survival rates. The layout incorporated native and symbiont species, supporting a resilient and self-sustaining ecosystem. Gazebos, pergolas, benches, and masonry sit-outs were included where budgets permitted—especially in areas lacking natural shade. Each site was secured with **low-cost fencing** and entrance gates. Where required, security cum admin cabins were constructed.

2.1.6 Site plan/Concept plan and design

Once Master Plans were approved, Good for Construction (GFC) drawings were prepared, including architectural layouts, structural designs, service drawings, and electrical layouts. These ensured seamless coordination during execution.



Figure 1: Pocket forests with Concept Plan



Figure 2: Site showing site execution as per plan

2.1.7 Cost estimation and funding mechanism (PPP Projects).

After preparing Bills of Quantities (BOQs), cost estimates were derived using approved government Schedule of Rates (SORs). Tenders were floated on state E-Tendering platforms, ensuring transparency. Upon contractor appointment, we provided complete technical handholding through to project completion.

2.1.8 Assist Mission Cities in acquiring Technical Sanction from competent authority.

A key responsibility involved assisting Urban Local Bodies (ULBs) in securing Technical Sanction and

Administrative Approval from competent authorities. This enabled smooth financial clearance and tendering, ensuring timely project execution.

2.1.9 Periodic site supervision and any related services which are required for projects.

We conducted regular site inspections, submitted detailed progress reports, and provided project management documentation. The projects were monitored under the **Independent Review and Monitoring Agency (IRMA)** framework, and subject to **Central Government audits**. A 12-month Defect Liability Period was maintained from the date of completion to ensure quality assurance and address any post-completion issues.

2.1.10 Visitor Feedback

Post-completion, voluntary surveys were conducted to gather user feedback, assess the public response, and identify improvements. These responses helped us refine future designs and establish a community-driven approach to urban green space development.

3. Results and Discussions

3.1 Tree Species and their effects on the perception of urban forest

The total number of tree species planted year wise is given in Fig 3.1, Fig 3.2 and Fig 3.3. The total area covered under the three different years is given in Fig 3.4, Fig 3.5 and Fig 3.6.

The maximum tree species planted in the year 2015-2016 were ***Cassia fistula, Mangifera indica, Areca catechu, and indegenous fruit trees.*** The maximum tree species planted in the year 2016-2017 were ***Lagerstroemia flos reginae , Phyllanthus emblica, Millingtonia hortensis, Ficus religiosa, Aegle marmelos, Artocarpus indica and Saraca asoca.*** The maximum trees planted in the year 2017-2019 were ***Bauhinia racemosa, Bauhinia blakeana, Cassia fistula, Cassia siamea, Elaeocarpus ganitrus, Lagerstroemia flos reginae, Mimusops elengi, Areca catechu, Plumeria rubra and Neolamarckia cadamba.***

Over time, it was observed that the majority of species planted in these urban forests were **indigenous trees**, with a rich **varietal diversity** emerging across sites. The thoughtful combination of **fruit-bearing**, **fragrant**, and **seasonal flowering trees** created a dynamic and

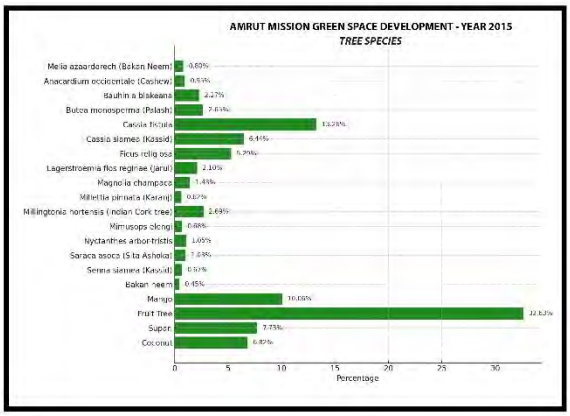


Figure 3: Tree Species under AMRUT 2015-2016

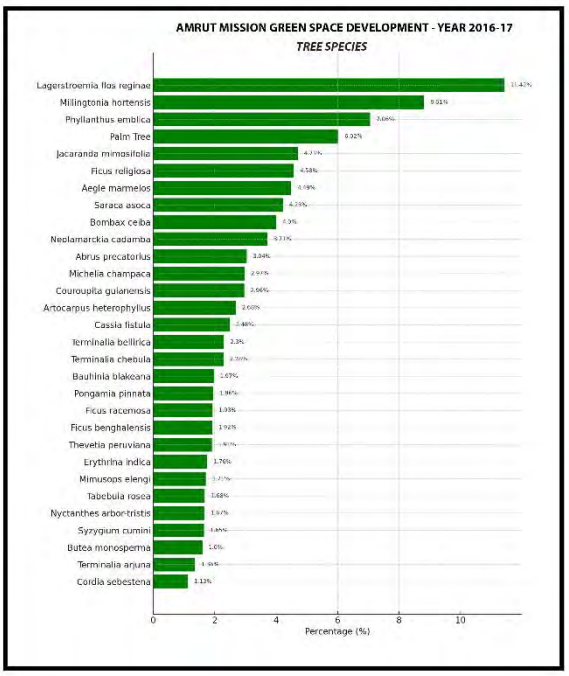


Figure 4: Tree Species under AMRUT 2016-2017

aesthetically pleasing green environment. These carefully curated species introduced seasonal bursts of color, enhancing the visual appeal of the pocket forests and increasing visitor interest and engagement. Notably, the inclusion of fruit trees, a rarity in dense metro areas, proved to be a novel and impactful strategy. It not only contributed to urban biodiversity but also encouraged a stronger sense of community ownership. Residents, especially children and elderly citizens, began observing the changing seasons through blooming cycles and fruiting patterns. In several cases, urban underprivileged populations benefited directly by consuming berries and small fruits, further

motivating them to care for the trees and protect the spaces. This participatory connection between people and nature led to improved maintenance, reduced vandalism, and an increased ecological and emotional value of these urban forests

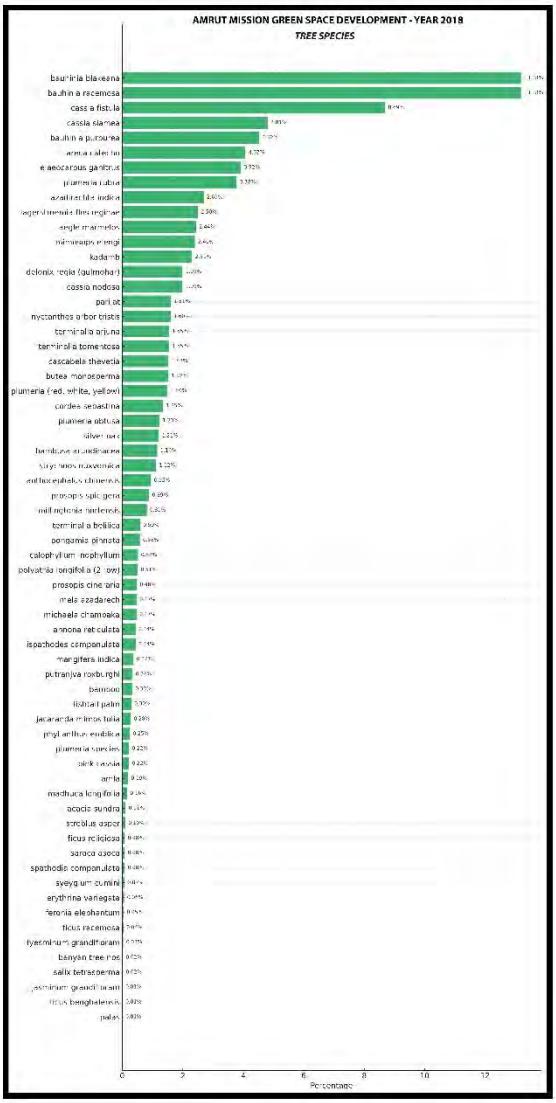


Figure 5: Tree Species under AMRUT 2017-2018

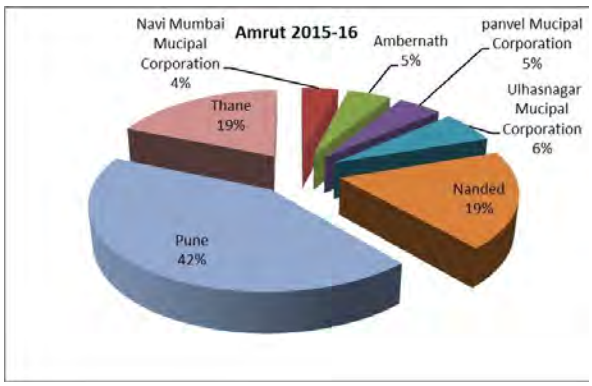


Figure 6: Area spread in cities in 2015-16

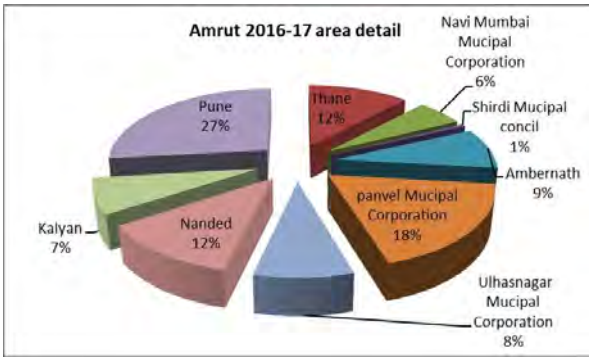


Figure 7: Area spread in cities in 2016-17

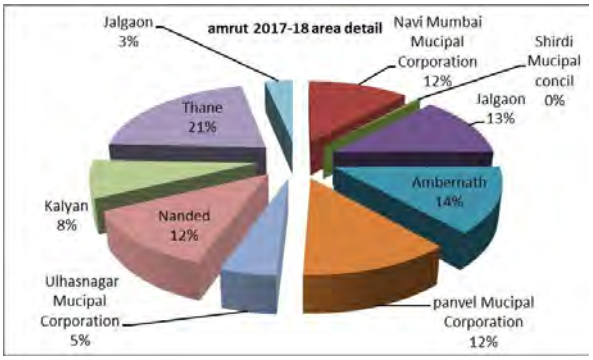


Figure 8: Area spread in cities in 2017-18

3.2 SOP's of Tree plantation and their Survival

During periodic site visits, species survival and establishment were closely monitored. It was observed that while some species adapted and established themselves quickly, others required a longer period to acclimate. However, over a span of 5 to 6 years, nearly all planted species were found to be thriving, and a self-sustaining habitat had begun to evolve. One of the key insights gained was that in conventional planting practices, visual height of saplings was prioritized over girth size, leading to the selection of younger, less stable trees that were mistakenly perceived as mature. This often resulted in higher mortality rates. As part of our design strategy, we consciously avoided the use of tree guards, both to maintain aesthetic and ecological harmony and to reduce unnecessary costs. Instead, emphasis was placed on sourcing well-grown, two-year-old trees with adequate girth, capable of withstanding environmental stress without artificial support. In some cases, minimal staking was provided to assist initial establishment. This approach promoted stronger root systems, natural growth patterns, and overall resilience, contributing to the long-term success of the urban forest plantations.

3.3 Effect on Irrigation water

Over time, irrigation requirements reduced significantly, and today, they are almost negligible, indicating the successful establishment of self-sustaining urban forests with dense canopy cover. These forests, designed with ecological principles and native species selection, have matured into resilient ecosystems requiring minimal external inputs. In recent years, while the Miyawaki method has gained popularity in tropical and subtropical regions, it has been observed that these scientifically planned pocket forests offer superior canopy density, greater spatial openness for human interaction, and enhanced habitat quality for birds, including more nesting opportunities. Unlike the tightly packed Miyawaki groves, these forests maintain ecological balance through strategic tree spacing and symbiotic planting, supporting both biodiversity and public engagement.

3.4 Improvement of soil fertility

Since the SOP's provided little intervention, the weeding, cleaning and removal of fallen leaves was greatly reduced. As a result, the heavy mulch of leaves under trees not only improved soil quality but also harbored soil insects and microbes. It helped in conserving moisture. The infertile flaky soils are today converted into dark soils rich in organic matter.

3.5 Increased visibility of Rare tree species

Many trees long forgotten found a place in these urban forests like *Mimusops elengi, Cassia fistula, Saraca asoca, Artobcarpus indica and Ficus species*. As a result, birds and other fauna nesting in these were suddenly visible. This indicated that the ecosystem was flourishing.

3.6 Visitor Footfall

Visitor footfall in these urban forests has steadily increased, reflecting their growing popularity and relevance in the urban fabric. People of all age groups, from children to senior citizens, are seen enjoying the tranquil and immersive ambience. The emergence of rare insects and bird species has further enhanced the experience, turning these spaces into living classrooms of biodiversity. Opportunities for activities such as Walking Tree Trails, Nature Painting Workshops, and Botanical Excursions have been created, offering both recreational and educational value. These initiatives have proven to be a true **boon for city-dwellers**, reconnecting them with nature and promoting well-being in the heart of urban environments



Figure 9: Improved Soil Fertility in Urban Forests



Figure 10: Visitors enjoying Urban Forests

3.7 Climatic, Ecological & Health benefits

A remarkable transformation has been observed in these urban forests, particularly in terms of microclimate regulation. Temperatures within the forest areas are consistently 2–3°C lower than the surrounding environment, offering a cool and refreshing escape for city dwellers. The presence of numerous birds, butterflies, and pollinators is a clear indicator of a thriving ecosystem that has taken root in what were once neglected, barren wastelands. These areas, previously prone to dumping or undesirable activities, have now become vibrant green havens teeming with life.

An added impact of these urban forests is the appreciation in nearby property values, as residents benefit from enhanced surroundings and improved air quality. The seasonal blooming of native trees adds unexpected bursts of color, drawing in nature enthusiasts and casual visitors alike. The walkable, permeable pathways are now used regularly by locals for recreation, fitness, and relaxation, proving that such ecological interventions not only heal the environment but also elevate the quality of urban life. [4]

4. Conclusions

Thus, it is observed that the total land covered in the three years was **1021613 sqm.** The benefits were much more as compared to the expenditure {Dwyer et al1992}, since the landscape consisted of 80% softscape and only 20% hardscapes. Creating green spaces in cities can provide heat mitigation, ecosystem regeneration, and amenity areas at minimal costs, fostering human-nature interactions.The introduction of permeable pathways create a very natural ethos and allows regenerate a better ecosystem.

This model can be repeated in other cities by municipalities or by public-private participation modules. It is a tested and proven way to establish greener environments with less efforts. It can also generate cleaner jobs through the maintenance. There are several economic benefits [5] of community trees other than beautification such as shading and wind protection, pollution, abatement, storm water management, crime reduction and property value.

In the changing times, with the need of carbon offsets, these projects can be explored as successful carbon sinks. Their carbon offsetting potential can be studied in the future and can lead to better revenue generation which can lead to better habitats in cities.



Figure 11: Murrum Pathways in Pocket forests



Figure 12: Debris collection from wasteland



Figure 13: Preparation of land



Fig 14: Site image before planting pocket forests



Fig 15: Site image after planting pocket forests

Acknowledgments

We would like to acknowledge all the ULB's, the then Principal Secretary UD, Manisha Patankar Mhaiskar and her entire team for believing in us that we could deliver this dream project. We would also like to acknowledge our entire team of architects, horticulturists, structural & MEP Consultants who stood by us throughout our journey. Lastly, I would personally like to thank my parents, Ashok & Shailaja Gokarn who nature-schooled me and my husband, Pankaj Harwansh, who believed that I could dream of creating forests in cities.

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Pocket Parks as Urban Ecosystems: Sustainable Solutions for Biodiversity and Community Empowerment

1. Introduction

Urbanisation across the UK and globally has intensified pressures on space, ecosystems, and human wellbeing. As cities densify, the need for high-performing, multifunctional green infrastructure becomes critical to addressing intersecting challenges related to climate adaptation, biodiversity loss, and social inequality (Wendelboe-Nelson et al., 2024). In this context, pocket parks—small green spaces typically under 0.4 hectares—have emerged as nimble, tactical interventions that deliver disproportionately large ecological and community benefits.

Defined by their modest scale and adaptability, pocket parks are increasingly being recognised not only as aesthetic urban amenities but as key infrastructural nodes. They function as biodiversity stepping stones, mitigate urban heat, manage surface water runoff, and support mental and physical health outcomes (Lefosse et al., 2025). Such spaces are particularly significant in dense or disadvantaged neighbourhoods, where access to quality green space is limited. Their ability to transform derelict, leftover, or underutilised land into vibrant ecosystems has captured the attention of planners and researchers alike.

The Scottish planning context offers fertile ground for exploring the role of pocket parks. The National Planning Framework 4 (NPF4) mandates that development support climate resilience, place-based wellbeing, and inclusive access to nature (Scottish Government, 2023). Pocket parks directly align with these aims, embedding small-scale biodiversity, promoting placemaking, and enabling nature-based solutions (NBS) within fragmented urban fabric. Notable Scottish examples—from Lauriston Castle's sensory pocket garden in Edinburgh to NatureScot-supported meadow patches in Stirling—demonstrate their transformative potential when embedded in local policy and community priorities.

This paper critically examines pocket parks as emergent urban ecosystems. It investigates their ecological performance, social utility, and governance structures through the lens of interdisciplinary design, drawing on Scottish case studies, speculative AI visualisation, and planning frameworks. Through this lens, pocket parks are repositioned as micro-sites of regeneration, resilience, and equity in 21st-century cities. In the wake of the COVID-19 pandemic, access to nearby green space has become a public health imperative, reflected in policies promoting the '15-minute city' and active travel corridors. Pocket parks can be integral to these strategies, offering hyperlocal opportunities for outdoor activity, biodiversity encounters, and passive surveillance. As such, they are increasingly recognised as essential components in post-pandemic recovery and resilience planning. Globally, the rise of nature-

based urbanism has propelled cities like Paris, Singapore, and Seoul to integrate micro-green strategies into resilient urban frameworks. These cities use small-scale parks to test rewilding, support mobility corridors, and restore biodiversity along linear infrastructure. Scotland now has an opportunity to learn from and contribute to this international discourse by embedding ecological micro-infrastructures as systemic planning components.

2. Methodology

This study employed a multi-method qualitative framework, integrating literature review, visual methods, policy analysis, and case study evaluation to examine the potential and performance of pocket parks in Scottish urban environments. Each method was selected to reflect the interdisciplinary nature of landscape architecture and urban planning, especially when addressing biodiversity, wellbeing, and spatial justice.

A critical literature review was conducted via Google Scholar, focusing on publications from 2023 to 2025 that explore tactical urbanism, ecosystem services, urban green infrastructure, and participatory design (Oikonomaki et al., 2024; Lefosse et al., 2025). Planning documents—including the National Planning Framework 4 (NPF4), Open Space Strategies, and Local Development Plans—were analysed to assess institutional commitments to nature-based solutions (Scottish Government, 2023).

Speculative design visuals were produced using Midjourney, an AI-powered generative tool, to explore hypothetical pocket park interventions across various Scottish urban conditions. These image prompts supported critical thinking around spatial constraints, material expression, and ecological potential. While not prescriptive, the visuals helped explore possibilities beyond current built forms and served as participatory engagement tools.

Finally, six Scottish case studies were selected based on spatial scale, type, delivery model, and availability of public documentation. The analysis focused on the ecological characteristics, community involvement, and institutional partnerships that shaped the success and replicability of each intervention. Ethical considerations were incorporated by ensuring visualisations did not promote standardised or overly idealised imagery. Rather, they served to stimulate participatory reflection. Limitations include reliance on secondary sources and the illustrative—not prescriptive—nature of speculative images. Nonetheless, the multimethod approach enabled a holistic view of social, ecological, and governance dimensions. Participatory workshops conducted in similar UK contexts suggest that speculative design imagery can help surface underrepresented voices, particularly those of young people and neurodiverse participants. The method also enables testing of low-cost, scalable ideas for rapid greening, providing fertile ground for iteration before construction. Additional tools included structured community walkabouts, semi-structured interviews with key local stakeholders, and analysis of publicly available open space audits. These methods provided layered insight into usage patterns, barriers to access, and residents' perceptions of microgreen infrastructure. Stakeholder

workshops were also influenced by the Place Standard Tool and themes of access, safety, and sensory comfort.

3. Results

3.1. Ecological Functions

Pocket parks contribute to urban biodiversity by providing stepping stones and habitat refuges in fragmented city landscapes. In Scotland, Stirling's Greener Green Infrastructure (GGI) initiative exemplifies how meadow creation and layered planting in micro-sites foster pollinator diversity and reduce ecological isolation (Lefosse et al., 2025). Such spaces can also function as 'urban oases' with microclimatic cooling benefits, reducing urban heat island effects, enhancing carbon sequestration, and supporting natural drainage (Wendelboe-Nelson et al., 2024).

By integrating native species and multi-strata planting, pocket parks become resilient to climate shifts and can enhance ecological literacy through educational signage, seasonal planting, and citizen science tools. Their ecological value grows cumulatively as cities implement them as distributed ecological nodes across districts. For instance, the Stirling initiative integrated pollinator-friendly wildflower mixes, supported by local school planting programmes. This not only boosted ecological diversity but embedded environmental education in the community. Similarly, Glasgow's Nature in Neighbourhoods project linked fragmented habitats through linear parklets and actively involved youth organisations in maintenance.

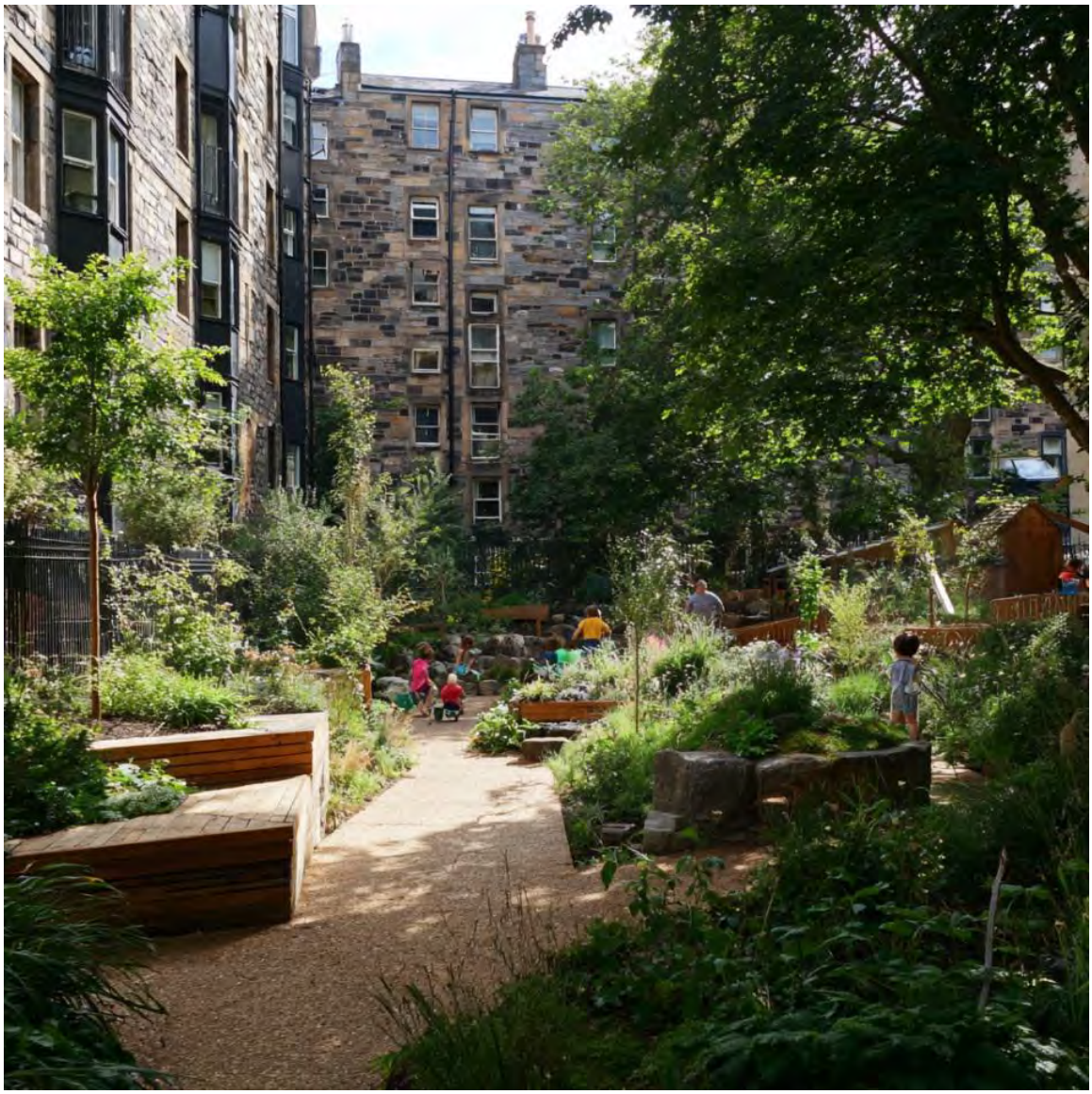


Figure 1 Speculative design of a biodiverse pocket park using native planting and layered habitat zones. Visual by Midjourney AI.

3.2. Social Outcomes

The social performance of pocket parks is strongly correlated with inclusive co-design and sustained community stewardship. In Edinburgh, Lauriston Castle's sensory pocket garden illustrates how spaces designed with neurodiversity and mobility accessibility in mind yield positive wellbeing outcomes (Wendelboe-Nelson et al., 2024). Meanwhile, the 'Pocket Places' scheme in Glasgow and Dundee demonstrates how temporary tactical installations can stimulate local engagement and foster shared ownership (Oikonomaki et al., 2024).



Figure 2 Conceptual design for a sensory garden with biophilic principles. Visual by Midjourney AI.

Table 1. Selected Case Studies of Pocket Parks in Scotland. These case studies collectively show how diverse governance models—from council-led delivery to grassroots co-design—shape spatial outcomes. For example, Leith Links emerged from a series of local charrettes and now features edible planters and community-curated pollinator beds, whereas Saughton Park's revitalisation was part of a city-wide climate resilience strategy with heritage-sensitive upgrades. Across all examples, phased implementation proved key to testing ideas and building support.

Project	Location	Key Features	Lead Organisation	Visuals
Saughton Park	Edinburgh	Climate-resilient planting, hydro-powered lighting	City of Edinburgh Council	Yes
Lauriston Sensory Garden	Edinburgh	Inclusive biophilic design	Friends of Lauriston Castle	Yes
Nature in Neighbourhoods	Glasgow	Ecological corridors	RSPB/Glasgow Council	Yes
Pocket Places	Dundee/Glasgow	Temporary co-design parklets	Sustrans Scotland	Yes
Leith Links	Edinburgh	Community biodiversity parklets	Leith Community Council	Yes
GGI Stirling	Stirling	SuDS, meadows	NatureScot	Yes



Figure 3 Temporary parklet installation concept showcasing tactical urbanism. Visual by Midjourney AI.

3.3. Governance and Policy Integration

Policy support and funding instruments play a key role in institutionalising pocket parks. Scotland's NPF4 and Place Principle encourage multi-agency collaboration, enabling strategic embedding of green interventions in local plans (Scottish Government, 2023). Section 75 planning gain agreements and community asset transfer schemes facilitate land allocation and delivery. However, long-term maintenance models vary significantly, and sustained funding for stewardship is still lacking in many areas.



Figure 4 AI-generated proposal for urban rewilding on derelict land. Visual by Midjourney AI.

4. Discussion

Pocket parks occupy a unique spatial and policy niche in the urban landscape. They demonstrate the power of distributed, small-scale design to catalyse broader ecosystem services and community engagement. The Scottish examples reviewed illustrate how such parks can be both top-down and bottom-up interventions. While their informality invites grassroots innovation, their long-term success requires formal institutional support and inclusion in local frameworks (Oikonomaki et al., 2024).

The concept of landscape justice—ensuring equitable access to green space—resonates with pocket park strategies, particularly in underserved areas. Yet risks remain: ecological

gentrification may follow poorly managed interventions, where improved amenities drive displacement. Anti-displacement tools, such as social rent protection and participatory budgeting, should be explored alongside spatial tools.

Speculative AI-based visualisation emerges as a useful, low-barrier tool to democratise visioning processes. Midjourney renderings created for this study suggest how small, biophilic, or rewilded spaces might be imagined differently—particularly when working with non-design stakeholders. Used in workshops or consultations, they can open new forms of civic imagination and multispecies dialogue. Globally, cities like Melbourne and Toronto are also adopting micro-parks as climate resilience tools. However, Scotland's approach—with its integrated land-use frameworks—offers a replicable model rooted in policy-enabled participation. Future implementations should draw on international lessons while preserving local adaptability. Unlike many global models that rely on large public-private partnerships, the Scottish examples often emerge from blended governance models where community councils, local authorities, and non-profits co-deliver. This offers agility and scalability, though also exposes tensions around accountability and maintenance. Embedding metrics for biodiversity gain, wellbeing improvement, and anti-displacement is essential for future policy refinement. Maintenance remains a critical challenge. Many community-managed sites struggle with capacity over time, requiring hybrid models that blend civic ownership with technical support. Additionally, monitoring of wellbeing impacts, species presence, and community participation should become embedded in project lifecycle assessments. This requires digital tools, governance incentives, and public reporting structures.

5. Conclusion

This paper has argued that pocket parks—despite their size—should be seen as vital infrastructural and ecological assets. When designed and managed through collaborative, place-based processes, they serve not only as nature access points but as instruments of resilience, health, and justice. The Scottish examples demonstrate a maturing practice, but also highlight structural challenges in governance and longevity.

As cities contend with worsening climate risks and mental health crises, pocket parks offer a scalable solution—one that blends spatial acupuncture with participatory planning. Future research could apply longitudinal ecological monitoring, wellbeing metrics, and stewardship tracking to better quantify their performance.

6. Acknowledgements

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EVALUATING THE FUNCTIONAL SYNERGIES OF URBAN ECOLOGICAL SPACE AND PUBLIC SPACE IN HIGH-DENSITY URBAN ENVIRONMENT

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Keywords: ecological benefits, spatial vitality, synergistic development, high-density urban environment

Abstract

The rapid development and uncontrolled expansion of cities have led to ecological degradation and declining vitality in public spaces. In high-density built environments, spatial constraints the optimization of ecological and public spaces, necessitating innovative approaches beyond mere spatial expansion. Traditionally, ecological and public spaces have been regarded as competing entities. However, in urban contexts, these spaces partially overlap in space and share certain functional similarities. Previous studies have shown that certain ecological spaces also serve recreational functions, enhancing public engagement and urban vitality, while the environmental comfort of public spaces influences their attractiveness and residents' livability. Nevertheless, existing research has primarily focused on the multifunctionality of either ecological or public spaces in isolation, lacking a comprehensive assessment of the complex trade-offs and synergies between the two systems. To address this gap, this study systematically analyzes the spatial configuration and evaluates the complex interrelationships between ecological and public spaces from a functional perspective, exploring opportunities for their coordinated and integrated development.

Based on the spatial layout of ecological and public spaces, this study constructs an evaluation index system for ecological benefits and spatial vitality to assess the service efficiency of various spatial patches in Nanjing's main urban area. An unsupervised clustering approach is employed to classify spatial patches, followed by multi-dimensional spatial mapping and statistical distribution analysis to identify dominant spatial patterns, analyze category composition, and reveal intricate spatial synergies. The findings indicate complex yet promising synergies between ecological and public spaces from a service efficiency perspective. Four specific findings collectively support this conclusion: (1) Four distinct ecological benefit types (high ecological benefit, biodiversity and carbon sink-dominated, cooling and habitat quality-dominated, and low ecological benefit) and four public vitality types (high vitality, accessibility-dominated, social media-dominated, and low vitality) coexist within the study area, though their distribution and proportions vary. (2) High-value indicators exhibit diverse combination patterns. Among them, the combination of biodiversity and carbon sink-dominated and social media-dominated is the most frequent, while the high ecological benefit and accessibility-dominated types accounts for the largest total area. (3) The synergy levels assessed from a service efficiency perspective differ from those derived from a single-space perspective. Notably, overlapping ecological and public spaces do not necessarily indicate high synergistic efficiency, underscoring the complexity of their interactions.

This study critically challenges the traditional notion of conflict between ecological and public functions. Instead, it categorizes these spaces based on specific functional indicators, revealing their intricate and dynamic coupling relationships rather than simply classifying them as high or low. By integrating quantitative assessment and spatial analytics, it offers a model for integrated, synergistic development of ecological and public spaces in built-up areas with limited spatial resources, optimizing ecological and public services to enhance spatial efficiency, resilience, and long-term urban sustainability within constrained urban environments.

1. Introduction

Urban ecological spaces include natural ecological spaces within city boundaries as well as ecologically significant green spaces. They serve as key components of the urban ecosystem. The service level of these ecological spaces is directly related to the protection of urban biodiversity and the maintenance of ecological security patterns [1]. Urban public spaces comprise open areas accessible to the general public. They provide essential venues for residents' daily life and social interactions. The development of public spaces directly influences the realization of public vitality and the sustainable growth of cities [2]. In high-density built environments, the limited availability of urban space restricts the development of both ecological and public spaces. This makes it imperative to move beyond traditional spatial expansion models and explore new pathways for systemic optimization.

Within urban built environments, ecological and public spaces share similarities in terms of land use types and hierarchical classification [3]. From a spatial structure perspective, both ecological and public spaces emphasize the connectivity and integrity of their network systems. In terms of land use, there is some overlap between ecological and public spaces, presenting opportunities for multifunctional landscapes and synergistic development. However, due to inherent functional and spatial differences, simply merging or integrating these spaces cannot achieve the desired outcomes and may even compromise their existing functions. Therefore, a coupling approach is needed to realize the coordinated yet differentiated development of ecological and public spaces.

The main challenge in integrating ecological space with public space lies in their fundamentally different functions. Ecological space prioritizes biodiversity conservation, optimizing ecological patterns, enhancing landscape quality, and supporting recreational activities [4]. In contrast, public space mainly serves residents' daily life and social interactions, emphasizing space accessibility, equity, and spatial vitality [5]. Conventional understanding often views human activities as major disturbances to ecological processes. This leads to the perception that human and ecological systems compete spatially and conflict functionally. However, public activities that generate public vitality are not synonymous with all human activities. Recreational and social behaviors in public spaces differ significantly in both intensity and type of interference with ecological processes when compared to other human impacts such as land development, roads, and building construction. In urban ecological environments dominated by semi-natural and artificial natural elements, the vitality generated through recreational and health benefits from green spaces forms a crucial part of urban public vitality [6]. Additionally, the openness of public spaces is essential for the realization of certain ecosystem services.

The functional integration of ecological and public spaces is grounded in their synergistic relationship. Currently, the combined functionality of these two systems has gained significant attention and recognition within academia. This growing interest provides a solid foundation for advancing the development of their coupled system functions. Previous studies have shown that certain ecological spaces also serve recreational functions [7], enhancing public engagement and urban vitality [8], while the environmental comfort of public spaces influences their attractiveness [9] and residents' livability[10]. Current research on the recreational function of ecological spaces mainly focuses on public perception within these areas. However, there is insufficient attention given to the public service provision of ecological space systems. Similarly, the quantification of ecological benefits in urban public spaces often emphasizes small-scale environmental perceptions, lacking a comprehensive evaluation of the overall ecological benefits of the public space system. To date, no study has fully quantified or evaluated the interrelationship between ecological benefits and public vitality in urban environments. Therefore, this study aims to analyze the ecological benefits and public vitality characteristics of individual patches within the coupled system of ecological and public spaces. Based on this analysis, it explores the combined features of these two dominant functions. It uncovers their functional coupling characteristics and the potential for optimizing ecological and public spaces.

The main objective of this study is to clarify the potential for coexistence between ecological benefits and public vitality within ecological and public patches, providing a practical development basis and direction for optimizing the coupling level of system functions. The specific research tasks include: (1) Identifying the number and characteristics of functional service types in urban ecological and public spaces. (2) Investigating the correlation between ecological benefits and public vitality to reveal the service coupling relationship between ecological and public spaces. (3) Comparing the results of spatial coupling and service coupling to deepen the understanding of the system coupling mechanism.

2. Materials and methods

2.1. Study area

The main urban area of Nanjing, Jiangsu Province, China, was selected as the study area, with a total area of about 303 km^2. The layout of existing ecological spaces and public spaces within the study area are shown in the figure1. The ecological spaces cover an area of 59.4 km^2, while the total area of public spaces is 35.0 km^2. Both the ecological spaces and public spaces exhibit diverse scales and types, with varying levels of services.

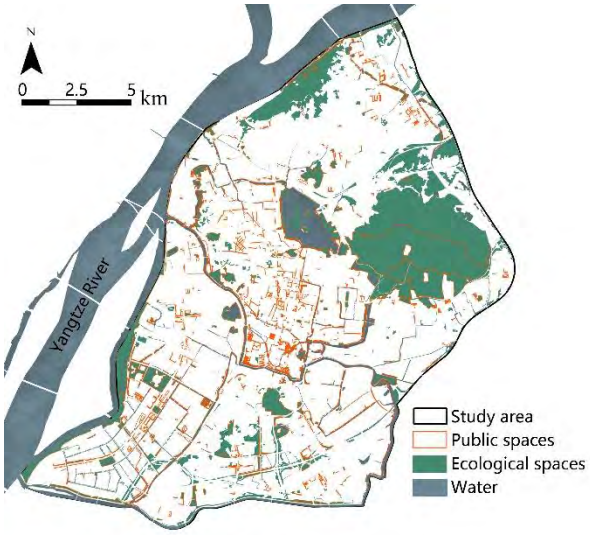


Figure 1. Study area.

2.2. Materials

The data and resources used in this paper are listed in the Table 1. All the data were reprojected and processed in ArcGIS pro. To meet the accuracy requirements for calculating patch-level service metrics, all data were resampled to a spatial resolution of 5 m × 5 m, using the most detailed data from "Jilin-1" as the reference.

Table 1. Description of the data source.

Type of data	Data source	Spatial resolution	Time
Multi-spectral satellite image	Landsat-8, Landsat-9 from EarthExplorer (https://earthexplorer.usgs.gov/)	30m	2020-2024
	Chang Guang "Jilin-1" SP01A satellite (https://www.jl1mall.com/)	5m	2021
Elevation data	ALOS (https://search.asf.alaska.edu/#/)	12.5m	/
Bird occurrence	GBIF (https://doi.org/10.15468/dl.ja42qq)	/	2020-2024
POI data	Baidu Open Platform (https://lbsyun.baidu.com/products/map)	/	2024
Road and Building data	Baidu Open Platform (https://lbsyun.baidu.com/products/map)	/	2024
Mobile phone positioning records	Yidong Company	100m	2024
Social media	Check-in data (crawled from the Sina Weibo and Xiaohongshu)	/	2023
Dianping data	Comments number (crawled from the Dianping website)	/	2023

2.3. Methodology

Based on the current status of patch spatial coupling, this study evaluates the levels of ecological benefits and public vitality to identify the coupling characteristics of each patch within the existing system. The specific steps are as follows: (1) Constructing datasets for ecological and public spaces to define the spatial boundaries of each patch. (2) Establishing a comprehensive evaluation system from the perspectives of ecological benefits and spatial vitality to evaluate the functional service benefit characteristics of each patch and deriving service types through clustering. (3) Analyzing the combinations, spatial distribution, and quantitative characteristics of ecological benefits and public vitality types within patches to clarify the current service coupling level of each patch.

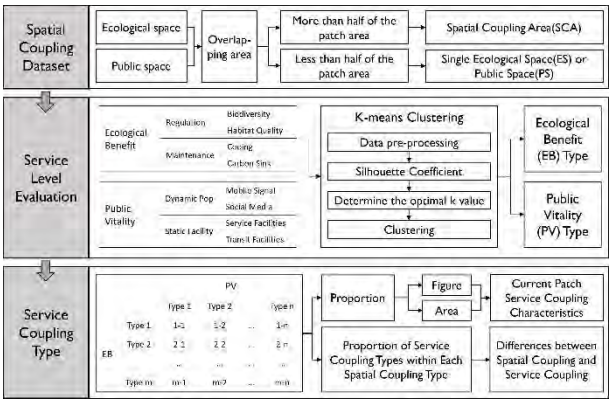


Figure 2. Methodology route.

2.3.1. Spatial coupling dataset

The patches in the coupling system of ecological and public spaces consist of three types: single ecological space patches, single public space patches, and spatial coupling patches.

The identification of ecological spatial patches is based on land use data derived from the analysis of multispectral remote sensing data using ENVI 5.6 software. The identification of urban public spaces relies on land use and morphological analysis, integrating multi-source planning data with high-resolution satellite images to determine the current distribution of public spaces.

The identification of spatially coupled areas is based on the distribution patterns of ecological and public spaces. If the overlapping area between ecological and public spaces exceeds half of the patch area, the entire patch is classified as a spatial coupling area(SCA). Otherwise, it is classified as either a single ecological space(ES) or public space(PS).

2.3.2. Service level evaluation

2.3.2.1. Ecological benefits

According to the China Ecosystem Assessment and Ecological Security Database (CEAESD), the primary ecological functions of Nanjing include biodiversity and urban ecological landscape. Besides, the study area has frequent hot weather in summer, and the urban heat island effect is a serious problem. Therefore, this study quantified biodiversity, habitat quality, cooling, and carbon sink to evaluate the ecological benefits of patches in the dataset. Details of these factors are presented in Table 2.

Table 2. Evaluation factors for ecological benefits.

EB	Calculation factors
Regulation: Biodiversity	Bird diversity Vegetation diversity
Regulation: Habitat Quality	Habitat quality module of the InVEST model
Maintenance: Cooling	Surface Temperature in Summer
Maintenance: Carbon Sink	Cumulative annual non-primary production

2.3.2.2. Public vitality

The evaluation system for public vitality incorporates both dynamic data, which reflects actual population and interest distribution, as well as static facility data that supports residents' public life. Dynamic data consists of mobile phone signaling data, representing population distribution, and social media data, capturing public attention and interests. This dynamic data is evaluated by calculating the composite density and its stability indicators. Static data consists of various service facilities that support public vitality, as well as public transportation facilities that influence patch accessibility. These static facilities are evaluated using density and diversity indicators. Details of these factors are presented in Table 3.

Table 3. Evaluation factors for public vitality.

PV	Calculation factors
Dynamic Pop: Mobile Signal	Mobile Signal
Dynamic Pop: Social Media	Xiaohongshu Weibo Dianping
Static Facility: Service Facilities	Tourist attractions Sports and Leisure Living Services Education and Culture Public Facilities Shopping
Static Facility: Transit Facilities	Bus Stations Metro Stations

2.3.3. Service type clustering

Using unsupervised clustering, the evaluation factors are grouped to identify ecological benefit (EB) and public vitality (PV) types. Firstly, PCA is applied to reduce the dimensionality of multiple calculation indicators, resulting in factor scores for EB and PV. To address data skewness, the Yeo-Johnson transformation is applied, followed by Z-score standardization to eliminate dimensional differences among indicators. Next, the K-means method is applied separately to the dimensionally reduced ecological benefit and public vitality indicators to identify distinct density-based types of ecological and public functional services. The K-means method effectively handles cluster-shaped data and helps determine the types of functional service relationships within the system. Throughout this process, the silhouette coefficient is used to determine the optimal number of clusters. Considering the need to differentiate service functions as much as possible in this study, more clusters are used as long as the silhouette coefficient does not show a significant decline.

2.3.4. Service coupling type

Based on the evaluation of ecological benefits and public vitality types, the coexistence possibilities of various EB and PV types within each patch under the two service orientations are analyzed. The number and area proportions of different coupling types are evaluated to identify the dominant service coupling types in the study area.
Additionally, comparing the proportions of service coupling types across different spatial coupling types (SCA, PS, and ES) reveals the differences between spatial and service coupling types.

3. Results

3.1. Ecological benefits and public vitality types

The silhouette coefficient was calculated to determine the optimal number of ecological benefit clusters. Considering both the silhouette values and the need for classification of ecological service types, 4 were selected as the most appropriate number. Figure 3 illustrates the clustering results of ecological benefits. The median radar plots shows that there are four clustering types of ecological benefits including high ecological benefits (EB1), biodiversity and carbon sink-dominated (EB2), cooling and habitat quality-dominated (EB3) and low ecological benefits (EB4). There are significant differences in area among the four types. The area of EB1 is notably larger than that of the others. Moreover, EB4 patches are distributed in the central part of the study area, while EB2 and EB3 are predominantly located along the edges.

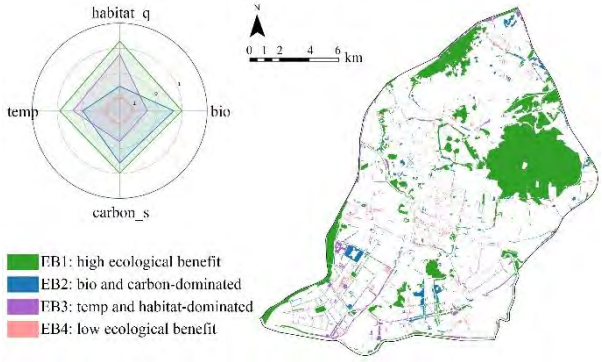


Figure 3. Types and spatial distribution of ecological benefits.

Similarly, the silhouette coefficient was used to determine the optimal number of clusters for public vitality. Based on both the calculation results and analytical requirements, 4 was selected as the best k value. The results of k-means clustering are shown in Figure 4. The types of public vitality include high public vitality (PV1), accessibility-dominated (PV2), social media-dominated (PV3), and low public vitality (PV4). Among them, PV1 type is mainly concentrated in the central area of the study area, PV4 type usually locates in the periphery, and PV2 and PV3 exhibit certain spatial clustering characteristics.

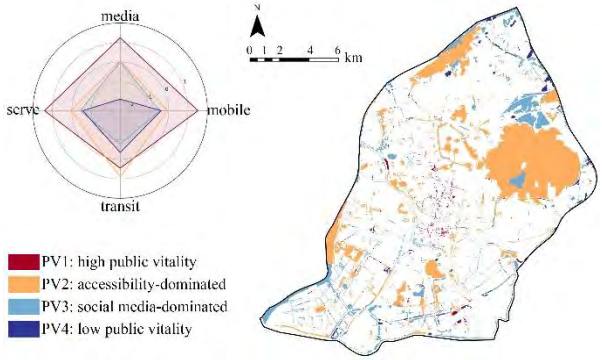


Figure 4. Types and spatial distribution of public vitality.

3.2. Service coupling types

Figure 5 shows the heatmap of the combined counts of ecological benefit and public vitality clustering results. EB4-PV1 and EB2-PV3 account for the largest proportions, while EB1-PV1, despite having the highest service synergy, appears in very limited quantities. Meanwhile, patches with moderate public vitality levels (PV2 and PV3) exhibit significantly higher quantities. In contrast, the quantities across different EB types show no marked differences.

In terms of area, EB1-PV2 patches with high ecological benefits and moderate public vitality account for a very large proportion. Their total area exceeds the combined area of all other types. When considering their proportion in terms of quantity, individual patches of this type tend to have very large areas. This is a typical characteristic of the large-scale ecological spaces in the study area. It also suggests that large ecological spaces in the study area demonstrate relatively high service synergy, offering substantial ecological benefits while maintaining a certain level of public vitality. Moreover, the EB1-PV3 patches cover a relatively large area, likely corresponding to some large ecological patches with relatively low accessibility. In contrast, the total area differences among other types are not significant.

Comparing patch numbers and areas, it is evident that average patch sizes vary significantly across different types. To improve service coupling levels, attention should be paid not only to the number of optimized patches but also to their size. Incorporating patch scale into the optimization framework can enhance efficiency.

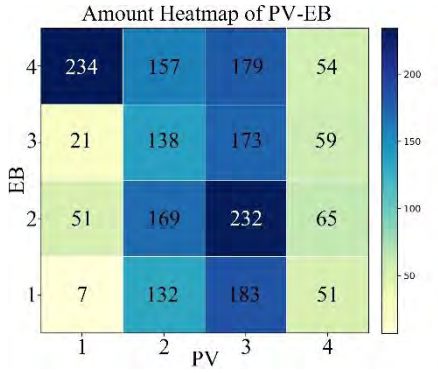


Figure 5. Amount heatmap of EB-PV types.

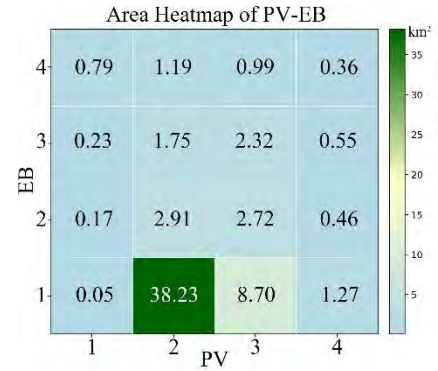


Figure 6. Area heatmap of EB-PV types.

3.3. Ecological benefits types

A comparison of quantity and area proportions across different ecological benefit types reveals that public vitality is generally low in high ecological benefit areas (EB1). In contrast, other ecological benefit types exhibit similar proportions of patches across different levels of public vitality. This indicates that patches with medium to low ecological benefits have the potential to moderately increase their public vitality without compromising their existing ecological functions.

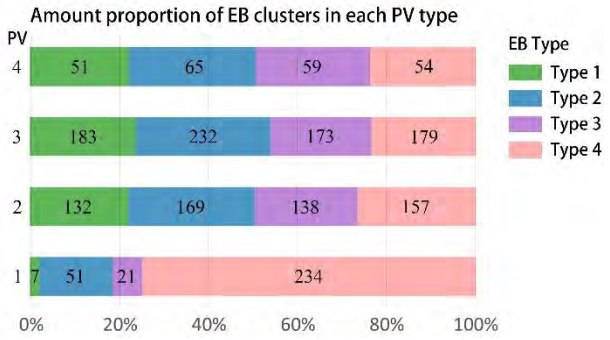


Figure 7. Amount proportion of EB clusters in each PV type.

When comparing the proportion of ES types within each public vitality type, the greatest disparity is observed in the ES1 proportions. Patches with high ecological benefits (ES1) are significantly more prevalent in the lowest public vitality group (PV4) than in other PV types. Additionally, ES2 patches tend to exhibit higher public vitality than ES3 patches of the same ecological benefit level. This suggests a stronger synergy between biodiversity, carbon sequestration functions, and public vitality in ES2 patches. Therefore, future efforts to optimize ecological benefits in patches with high public vitality should prioritize enhancing biodiversity and carbon sequestration. In contrast, the proportion of ES4 patches with extremely low ecological benefits does not vary significantly across different PV types. This indicates that improving ecological benefits in low-EB patches is not expected to influence their current public vitality levels.

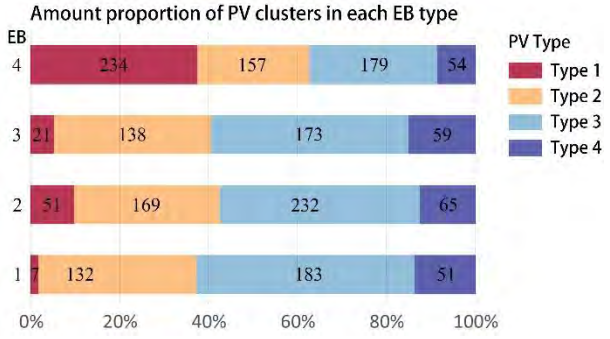


Figure 8. Amount proportion of PV clusters in each EB type.

3.4. Comparation of EB-PV types in LCA, PS and ES

Comparing the distribution characteristics of service benefit types among SCA, PS, and ES patches, the service coupling level in SCA patches is significantly higher than in PS patches. This indicates a consistency between spatial coupling and service coupling within the study area. However, some SCA patches still exhibit relatively low service coupling levels, suggesting there is room for further improvement.

The service coupling characteristics of SCA patches share certain similarities with those of ES patches. Therefore, moderately increasing human activities within existing ES patches to enhance public vitality is unlikely to significantly affect their ecological benefits. PS patches generally demonstrate very low ecological benefits, although a few exhibit relatively high ecological benefits. This implies that there is potential to improve the ecological benefits of PS patches. In addition, further research is needed to identify specific enhancement pathways.

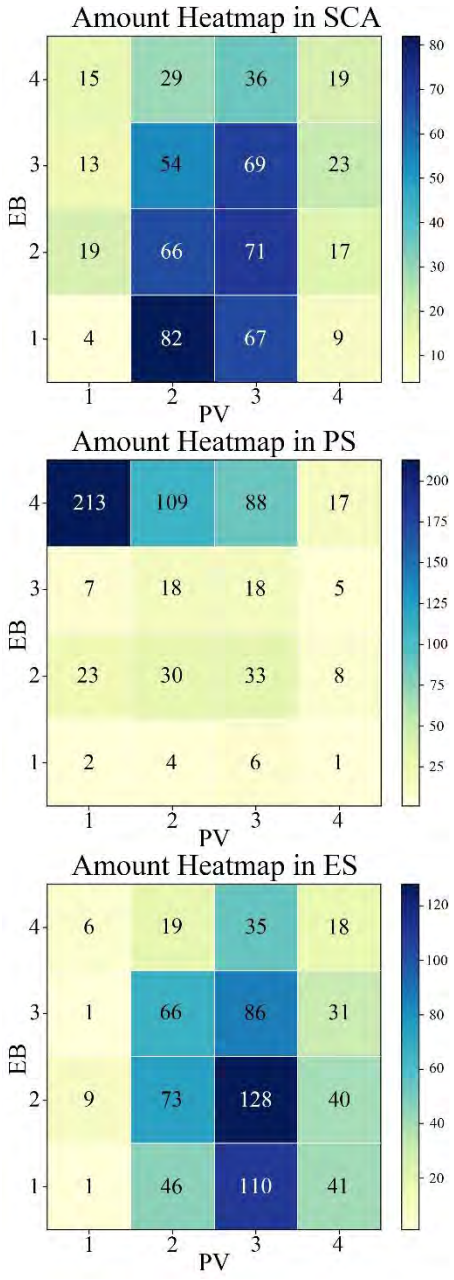


Figure 9. Amount heatmap of EB-PV types of SCA, PS and ES.

4. Discussions

This study aims to analyze the functional coupling between ecological and public space patches within the built environment. Using functional evaluation and clustering methods, it explores the various trade-offs and synergies among the functions of

each patch. The results reveal significant differences in functional coupling between patches, indicating that ecological benefits and spatial vitality are not simply in trade-off but can exhibit multiple possible synergistic relationships.

Considering individual service functions, varying levels of synergy exist among the factors influencing ecological benefits and public vitality. Within ecological benefits, the synergy between biodiversity and carbon sequestration is more obvious. Additionally, habitat quality and cooling benefits also demonstrate significant synergy. In terms of public vitality, accessibility, mainly represented by public transportation, functions as a relatively independent indicator. Meanwhile, other factors such as mobile signaling, social media, and public service facilities display clear synergistic relationships. These findings are based on clustering analysis of diverse ecological benefit and public vitality indicators. They also address the limitations of traditional service benefit evaluations that rely on single numeric representations. The results highlight the diverse characteristics and development potential of comprehensive ecological benefit and public vitality indicators. They also provide a more accurate data foundation for evaluating the service levels within coupled ecological and public space systems.

The combined characteristics of ecological benefits and public vitality function types in Nanjing's main urban area indicate that a small number of patches exhibit a very high level of synergy between two systems. These high-performing patches provide concrete references for optimizing the integration of ecological and public space functions. However, they account for only 0.37% of all patches. Therefore, the coupling level between ecological and public space services still requires significant enhancement. Meanwhile, the evaluation results show that combinations with moderate service levels in both systems have an obvious advantage. This suggests that a certain degree of synergy between ecological benefits and public vitality can be achieved without substantial input. Synergistic benefits can be realized within a specific range with relatively low input. In addition, there are patches in the study area with either low service levels in both systems or a combination of median and low values that require optimization. To improve the overall system service level, targeted optimization measures addressing ecological benefits and public vitality should be implemented based on a thorough understanding of each patch's development needs and potential.

The integration of urban ecological space and public space should be approached from two key perspectives: spatial layout and functional service. Spatial coupling provides a spatial foundation that underpins functional service integration. Meanwhile, functional service coupling provides tangible mechanisms through which spatial configurations can be effectively realized. The comparison of service coupling levels across different types of spatial coupling intuitively highlights the distinctions between spatial coupling and functional coupling. The findings indicate that spatial configuration significantly impacts the combination patterns of functional services. Spatially coupled patches show clear advantages in the levels of functional service coupling. Moreover, the differences among the three types are distinct. The functional service combination ratio of single public space patches differs substantially from that of the other two types. In contrast, single ecological space patches share similar functional coupling characteristics with SCA patches.

5. Conclusions

Based on the collection, processing, and analysis of multi-source digital data, this study investigates the types and spatial distribution of ecological benefits and public vitality within the urban-scale ecological and public space systems. Using categorical type characteristics to replace single service-level values provides a more accurate reflection of the service level features of each patch. This approach lays the foundation for discussing the combination patterns among various functional benefit indicators, and provides data support for the future development of coupled systems. The results clarify the current levels of service coupling between ecological and public spaces in the study area and identify patch types with higher potential for ecological benefit and public vitality coupling. This provides a quantitative data basis for optimizing system functional coupling. Furthermore, by comparing spatial and functional coupling evaluations, this study examines both the consistencies and differences between spatial layout and functional service coupling. This comparison facilitates the integration of patch quantity and layout optimization with internal functional benefit improvements in system coupling optimization. Future research may further investigate the driving factors behind different coupling characteristics. This will support the planning and design practices of urban ecological and public spaces, promoting the coordinated evolution and sustainable development of urban social and ecological systems.

Acknowledgments

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HEATWAVE VULNERABILITY OF URBAN TREES IN WUHAN: A STUDY TOWARDS CLIMATE-RESILIENT URBAN FOREST DEVELOPMENT

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Keywords: urban trees, heatwave vulnerability, adaptability, heat risks, climate-resilient urban forest

Abstract

[Background and Objectives] As a major metropolitan center in Central China, Wuhan faces intensifying challenges from summer heatwaves. The unprecedented extreme dry heatwave of 2022 resulted in widespread growth inhibition and mortality among urban trees across the city. Understanding the heatwave vulnerability characteristics of urban trees and their underlying mechanisms is crucial for enhancing urban forests' climate resilience in the face of escalating heatwave threats associated with global warming.

[Methods and Analysis] This study quantitatively evaluated the heatwave vulnerability of common tree species in Wuhan through two dimensions: climate risk and adaptive capacity. Species-specific heatwave risk was quantitatively assessed using species distribution models and climate niche analysis. Heatwave adaptability was measured through comprehensive evaluation of trees' morphological and physiological responses to extreme heat stress. We also explored how heterogeneous urban microhabitats – characterized by typical mosaic of high-density buildings, hardscapes, and green spaces – influence trees' heatwave adaptability.

[Results and Implications] Our findings revealed that in the baseline period since the 1980s, most studied species have faced high level of heatwave risk featured with low suitability in MTWM (Maximum Temperature of Warmest Month). *Cedrus deodara*, *Prunus* × *yedoensis*, *Acer palmatum*, *Metasequoia glyptostroboides*, and *Ginkgo biloba* exhibited particularly prominent risks, with projections indicating risk escalation in near and far future scenarios. Among these species, temperate-origin ones such as *P. yedoensis*, *G. biloba*, and *M. glyptostroboides* demonstrated the weakest heat adaptability during the heatwave event, manifesting in severe crown damage and transpiration disorders, thus rendering them especially vulnerable. Moreover, the heatwave adaptability of intraspecific individuals was significantly influenced by surrounding

microhabitat factors, particularly building enclosure degree, canopy coverage, and impervious surface proportion. These findings provide strategic guidance for enhancing the heatwave adaptability of urban forest through evidence-based species selection and habitat optimization, which will contribute to the development of climate-resilient urban landscapes and sustainable maintenance of ecosystem services.

Urban forests serve as critical infrastructure for climate regulation, air quality improvement, and biodiversity conservation in metropolitan areas. However, escalating climate change poses unprecedented challenges to urban tree populations, with extreme heat events becoming increasingly frequent and intense. As a major metropolitan center in Central China, Wuhan confronts mounting pressures from intensifying summer heat extremes, exemplified by the unprecedented heatwave of 2022 that caused extensive tree dysfunction and mortality, resulting in dramatic decline of ecosystem services in urban forest. Given the projected increase in heatwave frequency and intensity with the irreversible global warming trend, developing a comprehensive understanding of species-specific thermal response and vulnerability has become critical for sustaining urban forest ecosystems under escalating thermal stress [1].

This study aims to systematically evaluate the heatwave vulnerability of prevalent tree species in Wuhan's urban forests through a two-dimensional analytical framework encompassing exposure risk and adaptive capacity. Specific objectives include: (1) quantifying species-specific heat risks using climate niche analysis; (2) assessing adaptive capacity through morphological and physiological response evaluation; (3) revealing interspecific variations in heatwave vulnerability by integrating risk and adaptability metrics; (4) investigating the influence of urban microhabitats on tree heatwave adaptability; (5) providing evidence-based recommendations for climate-resilient urban forest development.

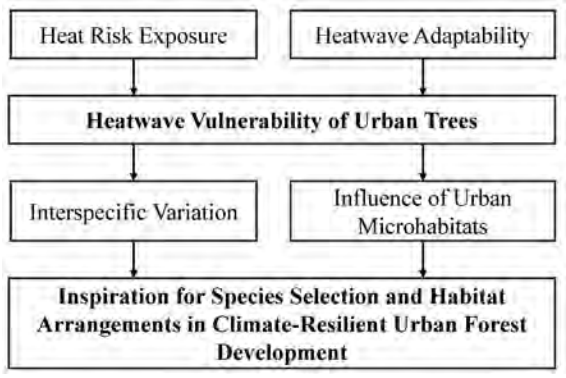


Figure 1. Research Framework

1 Materials and Methods

1.1 Study area and species selection.

The study was conducted in Wuhan (30°35'N, 114°17'E), a major metropolitan center in Central China characterized by a subtropical monsoon climate. Seven common urban tree species were selected representing different functional groups and origins: five deciduous species (*Koelreuteria bipinnata*, *Platanus acerifolia*, *Prunus* × *yedoensis*, *Metasequoia glyptostroboides*, *Ginkgo biloba*) and two evergreen species (*Magnolia grandiflora*, *Camphora officinarum*).

1.2 Assessment of heatwave adaptability based on morphological and physiological responses.

Visual tree assessment was conducted using a standardized 1-10 scoring methodology to quantitatively evaluate crown damage severity following the extreme heatwave event of 2022. Inverse scores indicated morphological heatwave adaptability, with lower damage scores representing higher adaptability.

Transpirational parameters including leaf stomatal conductance (Gs, mmol m^{-2} s^{-1}) and transpiration rate (Tr, mmol m^{-2} s^{-1}) were measured to elucidate the physiological mechanisms underlying species-specific morphological responses to heatwave threats. Measurements were conducted using portable photosynthesis systems under standardized conditions.

1.3 Quantitative evaluation of heat risks.

Maximum temperature of the warmest month (MTWM, °C) was employed as the critical bioclimatic parameter for heat risk evaluation across three temporal periods: baseline (1981-2022), near future (2023-2050), and distant future (2051-2100). Risk quantification was based on the absolute deviation between species-specific climate niche optima and local thermal conditions. Species-specific climate niches were derived from climate datasets of species occurrence records, and future climate conditions were simulated via

General Circulation Models (GCMs) under multiple emission scenarios.

1.4 Heatwave vulnerability assessment combining adaptability and risk metrics.

A two-dimensional analytical framework was employed encompassing exposure risk and adaptive capacity assessment. Vulnerability was quantified using the disparity between heat risk and adaptability. The vulnerability evaluation integrated climate risk assessment with adaptive capacity metrics to reveal interspecific variations in comprehensive heatwave vulnerability.

1.5 Analysis on the influence of urban microhabitats.

Microhabitat characteristics were quantified at the 50-100 m scale around individual trees, including: Degree of Building Enclosure (DegBE, %), Percentage of Canopy Coverage (PerCC, %), and Percentage of Impervious Surface Area (PerIS, %). These parameters were derived from high-resolution satellite imagery and field surveys. Pearson correlation analysis was conducted to explore the relationships between the microhabitat characteristics and trees' heatwave vulnerability for a specific species.

2 Results

2.1 Species-Specific Heatwave Adaptability

Significant interspecific variation in crown damage was observed among the assessed species, as shown in Figure 2a, allowing classification into three groups. Species in Group 1, including *M. grandiflora*, exhibited minimal crown damage with mean scores below 3, demonstrating superior heat resilience. Group 2 comprised *K. bipinnata*, *P. acerifolia*, and *C. officinarum*, which showed moderate crown deterioration (scores 4~5). Most notably, Group 3 species - *M. glyptostroboides*, *G. biloba*, and *P.* × *yedoensis* – displayed severe crown damage (scores 5~7), significantly exceeding the damage observed in *M. grandiflora* ($p < 0.05$), which demonstrated the weakest adaptability to the heatwave event. This interspecific variation correlated strongly with species phylogeographic origins, as species with genera originating from North Temperate region exhibited significantly greater crown damage compared to those with tropical evolutionary origins ($p < 0.05$). [2]

Besides, transpirational parameters including leaf stomatal conductance (Gs) and transpiration rate (Tr) were measured to elucidate the physiological mechanisms underlying species-specific morphological responses to heatwave threats. Pronounced interspecific differences were observed, with *G. biloba* and *C. officinarum* exhibiting significantly lower Gs and Tr compared to other studied species ($p < 0.05$), while *M. grandiflora* demonstrated the highest values ($p < 0.05$), as shown in Figure 2b and 2c. For species exhibiting moderate-to-low crown damage, a significant positive correlation emerged between crown damage severity and the physiological parameters ($p < 0.05$), suggesting that these species could employ reduced transpiration as an adaptive strategy to mitigate heat-induced morphological impairment. In contrast, species showing severe crown damage, such as *G. biloba* and *M. glyptostroboides*, displayed significant negative correlations with Gs and Tr, indicating physiological impairment under extreme heat conditions—specifically, compromised regulatory mechanisms governing stomatal function a nd transpirational cooling capacity. [2]

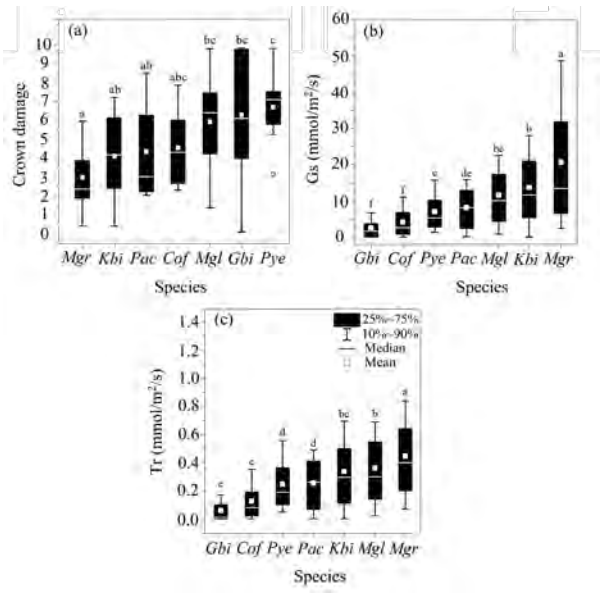


Figure 2. Variations in crown damage and physiological indicators among different tree species. (a) Crown damage; (b) stomatal conductance (Gs); (c) transpiration rate (Tr). Species Abbreviation: *Mgr - Magnolia grandiflora*, *Kbi - Koelreuteria bipinnata*, *Pac - Platanus acerifolia*, *Cof - Camphora officinarum*, *Mgl – Metasequoia glyptostroboides*, *Gbi - Ginkgo biloba*, *Pye - Prunus* × *yedoensis*. Letters above the boxes indicate the significance of interspecific differences. Species that do not share any common letters exhibit a statistically significant difference in crown damage ($p < 0.05$).

2.2 Species-Specific Heat Risks

The evaluated heat risks varied among species, with *C. officinarum*, *P.* × *yedoensis*, *G. biloba*, *M. glyptostroboides* and *P. acerifolia* demonstrating significantly higher risk values than other species ($p < 0.05$), as shown in Figure 3. This interspecific differentiation correlated significantly with species functional traits. Specifically, a negative correlation was observed between the risk values and leaf dry matter content (LDMC) of studied species ($p < 0.05$), highlighting the protective function of dense leaf tissues against hydrothermal stress. Furthermore, our temporal analysis projects progressive risk intensification from baseline to near future and distant future periods, indicating that the threats of high temperature to the studied species will continue to escalate throughout the 21st century.

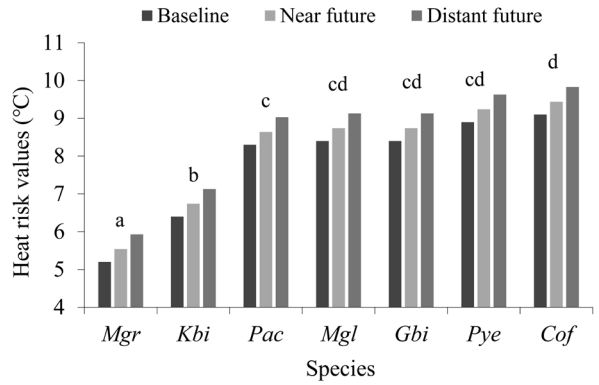


Figure 3. The heat risk values of different tree species across various temporal periods. Letters above the bars indicate the significance of interspecific differences. Species that do not share any common letters exhibit a statistically significant difference in crown damage ($p < 0.05$).

2.3 Interspecific Variation In Heatwave Vulnerability.

Vulnerability was quantified using the disparity between heat risk and adaptability, which categorized species into three groups, as shown in Figure 4. Group 1, species with high vulnerability (0.629~0.949) characterized by higher risk and lower adaptability, comprised *P.* × *yedoensis*, *G. biloba*, and *M. glyptostroboides*. Group 2, species with low vulnerability (-1~-0.371) characterized by lower risk and higher adaptability, included *M. grandiflora* and *K. bipinnata*. For species in above groups, the risk values negatively correlated with their adaptability. In comparison, the species in Group 3, including *C. officinarum* and *P. acerifolia*, presented a distinct vulnerability pattern characterized by both higher risk and higher adaptability, resulting in medium vulnerability (0.142~0.433).

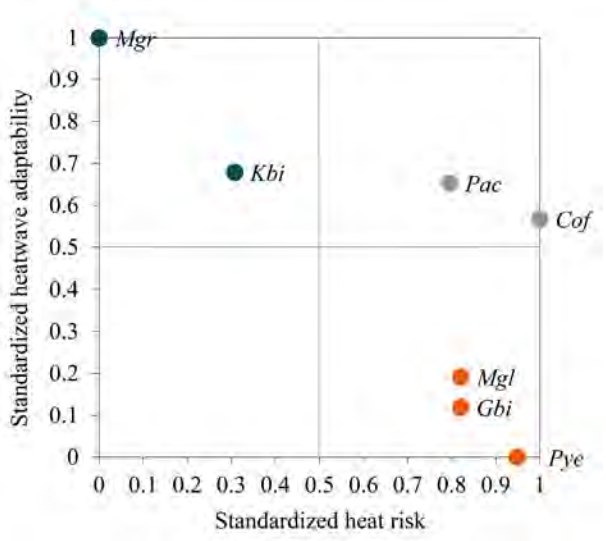


Figure 4. The two-dimensional matrix for heatwave vulnerability.

2.4 Microhabitat influence on Heatwave Vulnerability

As the critical determinant of heatwave vulnerability, the heatwave adaptability of a specific tree species was found to be significantly modulated by the structural characteristics of urban's underlying surface particularly at the 50-100m microhabitat scale. The Degree of Building Enclosure (DegBE) and the Percentage of Canopy Coverage (PerCC) exhibited significant negative correlations with the crown damage severity across multiple species, whereas the Percentage of Impervious Surface Area (PerIS) showed a positive correlation with observed damage. These relationships indicate that microhabitats characterized by higher building enclosure and increased vegetation coverage substantially enhance the adaptability of urban trees to heatwave stress. [2]

We further elucidated the regulatory pathways through which these structural factors regulate tree adaptability via microclimate modification. Specifically, PerCC enhances trees' acclimatization by reducing ambient temperatures and increasing humidity, DegBE mitigates heat stress by attenuating convective heat transport through reduced wind velocity and lowering air temperatures. In contrast, PerIS amplifies thermal stress through increased surface temperatures, reduced humidity, and elevated wind speeds that exacerbate convective heat transfer.

3 Discussion

3.1 Physiological Mechanisms of Heat Adaptation

The contrasting physiological responses between resilient and vulnerable species reveal distinct adaptive strategies. Resilient species like *M. grandiflora* maintain high transpiration rates during heat stress, facilitating effective thermoregulation through evapotranspiration cooling. Conversely, vulnerable species exhibit compromised stomatal regulation under extreme heat, leading to both morphological damage and physiological dysfunction. These findings are consistent with previous studies demonstrating that tree species exhibit varied physiological responses to extreme heat events [3], with transpirational capacity serving as a critical determinant of thermal tolerance.

3.2 Interspecific Variation in Heatwave Vulnerability

The observed interspecific variation in heatwave vulnerability strongly correlates with species phylogeographic origins. Temperate-origin species (*P. × yedoensis*, *G. biloba*, *M. glyptostroboides*) exhibited the highest vulnerability, reflecting their evolutionary adaptation to cooler climates and limited physiological mechanisms for extreme heat tolerance. These findings align with biogeographic theory suggesting that species' thermal tolerance reflects their evolutionary climate history. This pattern aligns with global observations of climate-induced tree mortality, where temperate species show greater vulnerability to heat stress compared to their tropical counterparts [4-5].

3.3 Microhabitat Effects on Heatwave Vulnerability

The significant influence of urban microhabitat factors provides practical pathways for enhancing tree resilience. Building enclosure creates wind shadows that reduce convective heat transfer, while canopy coverage provides shade and evapotranspiration cooling. These findings suggest that strategic spatial arrangement can mitigate vulnerability even for climatically unsuitable species. Similar microclimate modulation effects have been documented in other urban contexts, where building configurations and vegetation coverage significantly influence tree performance [6].

3.4 Implications for Climate-Resilient Urban Forest Development

Our findings provide valuable insights for tree species selection and management towards developing more climate-resilient urban forests. Low-vulnerability species (*M. grandiflora* and *K. bipinnata*) merit prioritization in heatwave-prone urban contexts due to their demonstrated thermal tolerance. For highly vulnerable taxa (*P. × yedoensis*, *G. biloba*, and *M. glyptostroboides*), implementation of targeted management protocols is imperative, including enhanced irrigation infrastructure, strategic shade provision, and placement in cooler urban microclimate to mitigate morphological and physiological damage under thermal stress.

Regarding the "temporally safe" species with moderate vulnerability (*P. acerifolia* and *C. officinarum*), their performance in urban environments warrants continuous monitoring, particularly given that projected escalation of heatwave intensity and frequency may increase their exposure risk, potentially compromising their current resilience and elevating their vulnerability over time. These species-specific management approaches should be incorporated into urban forestry frameworks that effectively balance immediate climate adaptation imperatives with long-term ecosystem service sustainability and functional resilience.

4 Conclusion

This study reveals significant interspecific variation in heatwave vulnerability among urban tree species in Wuhan, with temperate-origin species (*P. × yedoensis*, *G. biloba*, *M. glyptostroboides*) demonstrating highest vulnerability due to compromised physiological responses under extreme heat. Urban microhabitat characteristics significantly modulate species adaptability, providing opportunities for vulnerability mitigation through strategic spatial design. The findings provide actionable guidance for climate-resilient urban forest development by prioritizing heat-tolerant species in exposed locations, implementing protective microhabitat design for vulnerable species, and establishing monitoring protocols for climate adaptation.

Acknowledgments

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RIVERS AS LIVING ENTITIES AND LANDSCAPE PRACTICE

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Keywords: River, Design speculation, First Nations, Urban ecology, Law

Abstract
The way rivers are conceived is changing. Rivers are increasingly being understood as culturally, and spiritually significant, especially where Indigenous knowledge systems intersect with contemporary urban planning and environmental governance. In Australia, the Birrarung (Yarra River) in Melbourne has become a focal point for such a transformation. Once designated as Melbourne Drain Number One, the Birrarung is now, through legal innovation, speculative design, and urban revitalisation, being reimagined as a living entity—an approach that challenges conventional paradigms of governance, planning, and design.
The presentation will explore the implications of leading with the idea of the river as a living entity. It draws on three interconnected case studies: the Yarra River Protection (Wilip-gin Birrarung murron) Act 2017, the speculative design exhibition Reimagining Birrarung: Design Concepts for 2070, and the Greenline Project, a major urban revitalization initiative. Together, these case studies illustrate how legal, cultural, and design frameworks can converge to foster more inclusive, sustainable, and reconciliatory approaches to urban river landscapes.

1. Legal and Cultural Foundations: The Yarra River Protection Act

The Yarra River Protection (Wilip-gin Birrarung murron) Act 2017 represents a landmark moment in Australian law. It is the first piece of legislation in the country to recognize a river as a "living and integrated natural entity" and one of the first pieces of legalisation in Australia in Indigenous language. This recognition is not merely symbolic; it reflects a fundamental shift in how First Nations and rivers are conceptualised within Australian governance frameworks. The Act was developed in close consultation with the Wurundjeri Woi-wurrung people, the Traditional Owners (custodians) of the Birrarung, and embeds their cultural values and custodianship into the legal fabric of river management (Clark & Jones, 2019)

Importantly, the Act introduces the concept of "one living entity" to describe the river, its tributaries, and the surrounding land, an idea that aligns closely with Indigenous worldviews that emphasise interconnectedness and reciprocity. It acknowledges that the Birrarung is more than the “river”, it is its waters, its banks, its land, the sky above and the land beneath, its fauna and flora.

This legal recognition of the river as a living entity resonates with global movements toward granting legal personhood to natural features, such as the Whanganui River in Aotearoa New Zealand and the Ganges and Yamuna rivers in India. However, the Birrarung Act stops short of full legal personhood. Legal personhood allows the river to act as an individual with the capacity to have legal rights and obligations. Instead, the Birrarung Act creates a hybrid model in

which the Birrarung is legislatively recognised but not given legal status itself, and the Act does not control the water itself. This approach has its limits, but it seeks to blends Indigenous epistemologies with Western legal structures, offering a pragmatic yet culture-altering approach to environmental governance (O'Donnell & Talbot-Jones, 2018).

The Act and the subsequent planning strategies provide a number of key shifts in cultural and land management thinking. Culturally, it seeks to shift the city's population from seeing the Birrarung as a just a river, recognising the Birrarung as a central cultural and environmental entity in the city's identity. It demands that future planning of the river must acknowledge and include the Traditional Owners, that the river corridor is an integrated entity, and that all acts should provide a net gain in environmental health. These requirements underscore the deep interdependence between ecological and human well-being—a principle that is increasingly recognized in sustainability science but has long been central to Indigenous knowledge systems.

The Act also requires the creation of a 50-year community vision as a means of emboldening community participation and voice in all future planning and project decisions.

The Act established the Birrarung Council, an independent statutory body that includes Traditional Owner representatives alongside experts in planning, water management, landscape architecture and community engagement. The Council's role is to provide strategic advice and ensure that the river's health and cultural significance are prioritized in planning decisions.

The late Aunty Margaret, a respected Wurundjeri Elder and Birrarung Counicl member, powerfully stated, "The River needs its lands". These words have become the underpinning statement that continues to drive the Council's, and other organisations', work to explore the concept of the 'Great Birrarung Parkland', through which all Birrarung land and water will be recognised as one connected cultural landscape from its source to the sea. (Birrarung Council Annual Report to Parliament 2022).

2. Speculative Futures: Reimagining Birrarung 2070

While legislation provides a foundational framework, envisioning the future of the river requires ither imaginative and participatory approaches. The Reimagining Birrarung: Design Concepts for 2070 exhibition exemplifies how speculative design can serve as a tool for advocacy, education, and long-term planning. Curated as a public exhibition and digital platform, the project invited landscape architects to propose visionary concepts for the Birrarung's future. (Reimagining Birrarung Design Concepts for 2070. National Gallery of Victoria 2024)

The design brief was to respond to three key things. Firstly: if the river could speak – what would it say? This shifts our design process from how we can best use the river, to working with the river, to finally doing what the river needs and wants.
Secondly, to explore the idea of the Great Birrarung Parkland, and what that might be and look like in the future, being guided by the 50 Year Community Vision (Yarra_River_50-Year_Community_Vision_2018 / Wilip-gin Birrarung murron)

And thirdly, to look to how we can increase the ecological quality of the river itself, and move from merely reducing damage and minimising impact, to fundamentally increasing net environmental benefit.

The speculative designs created revolved around themes of ecological regeneration, public access, and cultural recognition. Each design provocation explored what it might mean to treat the river not as a boundary or resource, but as a living entity with agency and rights. Examples of this include new forms of land division, in which political boundaries are formed through the rivers geography and

speculating on new future forms of land management and rehabilitation using new technology and citizen management models.

Proposals ranged from rewilding urban riverbanks and restoring wetlands to rethinking of our urban infrastructure that typically aligns itself with rivers, i.e. roads and powerlines.

One of the most compelling aspects of the exhibition was its emphasis on temporal depth. By projecting fifty years into the future, the designs encouraged long-term thinking and challenged the short-termism that often characterizes urban development. This temporal framing also allowed for the integration of climate adaptation strategies, such as flood resilience, habitat restoration, and carbon sequestration.

Design becomes a mediating practice, translating abstract values into tangible interventions. By visualising alternative futures, the project made complex ecological and cultural ideas accessible to a broader public, thereby fostering a sense of collective ownership and responsibility.

The speculative nature of the exhibition also created space for critical reflection. It asked difficult questions: What does it mean to co-design with the natural landscape and First Nations community? How can we reconcile competing land uses with the needs of a living river? What governance structures are required to support such a vision? In doing so, it positioned design not merely as a technical exercise but as a form of cultural and political engagement.

3. Urban Implementation: The Greenline Project (City of Melbourne, 2022)

The Greenline Project represents the materialization of many of the ideas explored in the previous two case studies. It is a 4-kilometre urban revitalization initiative along the Birrarung in the centre of Melbourne (the central business district), aiming to transform the north bank riverfront into a connected, vibrant, and ecologically resilient public space that reflects the values of the Birrarung as a living entity (City of Melbourne, 2022).

At its core, the Greenline Project is a response to decades of fragmented planning and underutilised riverfront spaces. It seeks to stitch together a series of promenades, parks, and cultural sites into a cohesive landscape that prioritizes ecological health, public access, and cultural storytelling. The master plan integrates Traditional Owner knowledge and aspirations, ensuring that Wurundjeri Woi-wurrung values are embedded in both the design process and the built environment (City of Melbourne, 2022). A cultural narrative is being developed with the Traditional Owners and the City of Melbourne, which will form the cultural heartbeat of the project, identifying which stories are told, how and where they are told physically and ensuring "truth telling" is a key part of the design. We are only at the start of this journey and seeing how this might manifest.

Ecological repair is a central pillar of the Greenline project. This includes the restoration of riparian vegetation, the creation of habitat corridors, and the implementation of water-sensitive urban design (WSUD) principles. These interventions not only enhance biodiversity but also improve water quality and climate resilience. Importantly, they are framed not as technical fixes but as acts of care and reciprocity toward the river.

The Greenline Project also emphasises cultural recognition. Interpretive signage, public art, and ceremonial spaces are being developed in collaboration with Traditional Owners to tell the stories of the Birrarung and its people. This approach moves beyond tokenistic inclusion to genuine co-design, where Indigenous voices shape both the narrative and the form of the landscape (City of Melbourne, 2022).

Community engagement has also been integral to the project's development. Through

workshops, consultations, and participatory design processes, the project has sought to build a shared vision for the riverfront. This inclusive approach reflects a broader shift in urban planning toward collaborative governance and community driven outcomes.

Discussion: Toward a New Paradigm of River Governance and Design

Taken together, these three case studies illustrate a paradigm shift in how urban rivers are understood and managed in Melbourne and Australia and contribute to the broader global discussion. By leading with the idea of the river as a living entity, they challenge anthropocentric and extractive models of development and instead promote relational, regenerative, and reconciliatory approaches.

The overall cultural story of the Birrarung is to shift the political and cultural agenda from just seeing rivers as resources and recreational and open space entities, to a place that is central to our sense of ourselves and the city. Melbourne as a community is not yet reconciled with its natural landscape nor its First Nations. This is becoming more important as the state of Victoria, of which Melbourne is the capital, is undertaking "Treaty" with its First Nations people.

From a governance perspective, this shift requires new institutional arrangements that recognise Indigenous sovereignty, support cross-sector collaboration, and prioritize ecological integrity. The Birrarung Council is a promising model in this regard, offering a platform for diverse voices to shape river management.

From a planning perspective, it calls for long-term, adaptive strategies that are grounded in both scientific and indigenous knowledge. The *Reimagining Birrarung* exhibition demonstrates how speculative design can facilitate such strategies by making future scenarios visible and debatable.

From a design perspective, it demands a rethinking of aesthetics, functionality, and authorship. Projects like the Greenline show how design can be a tool for the healing of landscapes, communities, and relationships with Country.

Crucially, this paradigm shift is not merely technical or procedural; it is ethical and epistemological. It requires us to ask: What kind of relationships do we want to have with the natural world? Whose knowledge counts? What does justice look like in the context of environmental change?

And more specifically it provides a position for landscape architectural design to embrace and to be part of the solutions.

All three of these projects recognise that, if we want to listen to the river, and bring back nature and repair the native landscape, then we must respond to the lack of representation of the precolonial landscape in the Melbourne area. Part of that response has been to develop ways of graphically representing the Birrarung and her lands over time. So far this has taken the form of an animation of the river over 20,000 years and the illustration of the landscape pre1800s. This has allowed the broader community in particular to grasp for the first time what the landscape looked like. These images have now been published in multiple reports and media articles and books (Buckrich, 2024).

Conclusion

The Birrarung offers a powerful case study in how rivers can be reimagined as living entities through the integration of Indigenous knowledge, legal innovation, speculative design and urban revitalisation. This approach not only enhances ecological and cultural outcomes but also fosters a deeper sense of connection and responsibility among urban populations.

As cities around the world grapple with the triple challenges of climate change, biodiversity decline and social inequality, the lessons from the Birrarung are both timely and transformative. They remind us that rivers are not just physical features but living systems that sustain life, carry memory, and

embody the possibility of a more just and sustainable future, a regenerative future.

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METHODOLOGICAL APPROACH FOR ASSESSING REWILDING POTENTIAL OF PARK THE REWILDING AREAS IN QINGDAO, CHINA

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Abstract

During the phase of horizontal urban expansion, a large number of urban and surrounding green spaces were developed in a disorderly manner, threatening biological habitats, sharply reducing urban population diversity, and causing the gradual disappearance of wild urban landscapes from public view. Urban rewilding areas play an irreplaceable role in protecting biodiversity, maintaining urban ecological processes, and reconnecting people with nature. However, there remained a research gap in the selection and evaluation methods for small- and medium-scale urban rewilding areas. Therefore, using Taipingshan Park in Qingdao as a case study, this paper proposed a framework for identifying urban rewilding areas based on the wilderness mapping principle and GIS spatial analysis methods, and constructed a methodology for evaluating the rewilding potential of these areas using multi-source data, including naturalness and community vitality. Seven indicators, including biophysical naturalness and appearance naturalness, were selected to build a wildness characteristic model for Taipingshan Park. The park's wildness was classified into core wildland areas, buffer zones, and peripheral areas using a fuzzy membership function, and 12 sample points were selected for investigation. Additionally, an evaluation framework for the rewilding potential of parks in Qingdao City was developed, consisting of six dimensions and 22 indicators, with the weights of the indicators determined. The results showed that human disturbance, regeneration seedling conversion capacity, and diameter class structure were the key factors affecting rewilding potential. The rewilding potential scores of the 12 quadrats in Taipingshan Park ranged from 5.42 to 7.45, with an average score of 6.309 and a comprehensive evaluation grade of III. This method provided a targeted strategy for the protection of rewilding areas in Qingdao's parks and offered new ideas for the protection and design of wild landscapes in urban parks in the future.

1. Introduction

During the process of urbanization, the rapid expansion of economic activities and the continuous concentration of population led to the unregulated development of vast areas of urban and peri-urban green spaces. As a result, land that once supported natural succession and ecological processes largely disappeared. Urban green spaces underwent a process of "dewilding," which gave rise to several ecological issues, including the homogenization of urban landscapes, the loss of wildlife habitats, and the excessive consumption of natural resources[1]. Against this backdrop, urban rewilding gradually emerged as a cutting-edge and increasingly prominent topic in the field of ecological conservation and restoration. Urban rewilding emphasized the integration of the sustainable principle of "nature-led and low human intervention" into small- and medium-scale landscape planning and design. It relied on the intrinsic forces of nature to restore degraded

habitats, maintain ecosystem stability, and re-establish urban wild landscapes [2].

The implementation of urban rewilding was effectively integrated with nature-based solutions and green infrastructure. For instance, rewilding sites were connected with other green elements such as rain gardens, bioretention ponds, and rooftop gardens, forming an ecological network that combined "points, lines, and surfaces." This approach optimized the urban blue-green infrastructure, facilitated species movement among ecological nodes, and fostered mutually beneficial interactions among habitats[3].

A notable example was the inner garden of Meiji Jingu Shrine in Japan, which served as an "eternal forest" within the urban context. The site was managed using a nature-oriented approach, incorporating a mix of broad-leaved and coniferous species and establishing a multi-layered forest structure composed of high, medium, and low vegetation strata. This design promoted the successional transition from planted forests to natural forests, showcasing the dynamic coexistence of coniferous and broadleaf species.In Germany, cities such as Hannover and Dessau adopted rewilding strategies for abandoned buildings, courtyards, and underutilized urban spaces. With minimal human intervention, native vegetation was allowed to colonize these areas naturally, forming spontaneous habitats within the urban matrix[4]. These rewilded patches created refuges for small fauna—including butterflies, bees, birds, and hedgehogs—enhancing urban biodiversity and providing residents with increased opportunities to engage with wild nature[5].

After decades of development, the connotation of the concept of rewilding had undergone significant transformation and expansion. The focus of rewilding research gradually shifted from ecological restoration to the management and utilization of spontaneous vegetation. Through various approaches and strategies, rewilding effectively promoted the naturalization of urban flora, thereby contributing to the creation of urban wild landscapes with distinct regional characteristics. However, studies on the conceptual foundations of urban rewilding remained limited, and research on the driving mechanisms of urban rewilding and the potential for rewilding urban plant communities was still insufficient.

2. Methods and materials

2.1 Study area

Qingdao was located in the north temperate zone (35°35'–37°09'N, 119°30'–121°00'E), covering an area of 11,282 km². The city was surrounded by mountains on three sides and bordered the Yellow Sea to the east. It supported a rich diversity of plant life, comprising 1,569 species and varieties across 790 genera and 218 families. Among them were 824 species of woody plants, 701 species of herbaceous plants, and 44 species of ferns.



Figure 1. Study area.

2.2 Data sources

The data utilized in this study included land use types, elevation data (DEM and terrain relief), vector data of roads and buildings, normalized difference vegetation index (NDVI), points of interest (POI), species characteristics, community attributes, regeneration seedling traits, and coefficients of natural composition.

2.3 Framework for rewilding area identification was constructed

Based on the concept of a continuous wilderness map and the characteristics of wild landscapes in Qingdao's parks, this study selected eight indicators—biophysical naturalness, visual naturalness, distance from roads, topographic undulation, surface runoff, vegetation coverage, and scenic spot density—to assess park wildness. Each indicator was positively correlated with wildness, meaning that higher values indicated a higher degree of wilderness quality. A weighted linear summation model was then employed to integrate and overlay the wildness indicators, resulting in a comprehensive wildness evaluation of the study parks. Finally, the fuzzy affiliation method was applied to reclassify the wildness levels into three categories: core wilderness areas, wilderness buffer zones, and peripheral areas (Fig 2.).

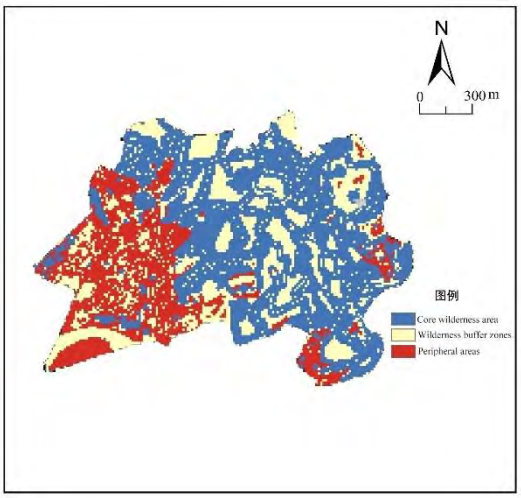


Figure 2. Wilderness zoning of Taiping Mountain.

2.4 Evaluation index system for rewilding potential was constructed

In this study, a preliminary framework for evaluating rewilding potential was developed, encompassing three key dimensions: naturalness, community vitality, and disturbance. To determine the relative importance of each indicator within the evaluation system, the analytic hierarchy process (AHP) was employed. This involved the construction of a pairwise comparison judgment matrix, followed by a consistency test to ensure logical coherence, and the subsequent calculation of index weights. The resulting weighted index system provided a quantitative basis for assessing the rewilding potential of plant communities within designated rewilding zones of the park.

3. Results

3.1 Identification results of rewilding areas in Taipingshan Park

Table 5.24 demonstrated that the weights of the criterion-level indicators followed the order: community vitality > community structure > degree of disturbance > community species composition > community adaptability > site conditions. Community vitality exhibited the highest weight (0.342), followed by community structure (0.207), identifying both as key indicators in evaluating the rewilding potential of plant communities. These results suggested that the regenerative capacity and structural stability of plant communities were the primary determinants of rewilding potential.

At the indicator level, human disturbance had the highest comprehensive weight (0.132), indicating that anthropogenic activities exerted a direct and substantial influence on species growth and development within the community. This made it the most critical factor limiting rewilding potential.

Furthermore, the regenerative capacity of seedlings and the diameter class structure of the community played significant roles. The quantity and quality of understory regeneration seedlings were directly linked to the future successional trajectory of the community and were thus decisive for long-term development. The diameter class distribution of trees reflected the age structure of the community and indirectly indicated its regenerative potential and ecological stability.

3.2 Evaluation system of rewilding potential in rewilding area of Taipingshan Park

3.2.1 Indicator weights are determined

As shown in Table 1, the weights of the criterion-level indicators were ranked in the following order: community vitality > community structure > degree of disturbance > community species composition > community adaptability > site conditions. Among these, the regenerative capacity and stability of plant communities emerged as the primary determinants for evaluating their rewilding potential. At the index level, anthropogenic disturbance exerted a direct and significant influence on the growth and developmental processes of species within the community, and was identified as the most critical factor constraining the rewilding potential of plant communities. Furthermore, the quantity and quality of understory regeneration seedlings were closely linked to the future successional trajectories of plant communities and played a decisive role in shaping their long-term ecological development.

Table 1. The total weight of the evaluation factors for the re wildification potential of plant communities in the park's wildness area.

Criterion layer B	Weight	Indicator layer C	Weight	Comprehensive weighting
Species composition of community B1	0.124	Species richness S C1	0.472	0.058
		Simpson diversity C2	0.165	0.020
		Shannon-Weiner diversity C3	0.255	0.032
		Pielou uniformity C4	0.108	0.013
Community structure	0.207	Diameter class structure C5	0.466	0.096

B2		Shrub coverageC6	0.277	0.057
		Canopy density C7	0.161	0.033
		Plant community hierarchy C8	0.096	0.020
Site conditions B3	0.053	Litter thickness C9	0.400	0.021
		Soil conditions C10	0.400	0.021
		Slope aspect C11	0.200	0.011
Community viability B4	0.342	Update the seedling species C12	0.102	0.035
		Update the seedling density C13	0.249	0.085
		Update the quality of seedlings C14	0.160	0.055
		Community healthC15	0.043	0.015
		Updated seedling conversion capacity C16	0.379	0.130
		Natural composition factor C17	0.065	0.022
Community adaptability B5	0.077	Ratio of the number of species of evergreen deciduous trees C18	0.250	0.019
		The ratio of the number of evergreen deciduous trees C19	0.250	0.019
		Rustic nature C20	0.500	0.038
Degree of interference B6	0.198	Human interference C21	0.667	0.132
		Natural factors C22	0.333	0.066

3.3 Analysis of the evaluation results of rewilding potential in the rewilding area of Taipingshan Park

Using the rewilding area of Taipingshan Park as a case study, the rewilding potential of 12 individual quadrats was independently evaluated. Based on these results, the overall rewilding potential of the designated rewilding zone within the park was subsequently analyzed. This approach enabled a localized assessment of spatial heterogeneity in rewilding capacity and provided a representative basis for understanding community-level ecological restoration dynamics within urban park settings.

Table 2. Index A of the potential for re wildification of plant communities in the wilded area of Taiping Mountain Park.

	C1	C2	C3	C4	C5	C6	C7	C9	C10	C11
1	15	2.10	0.86	0.95	Multimodal	54%	63%	1	0.5	0.71
2	14	2.14	0.84	0.81	Inverse-J	88%	83%	1	0.17	0.19
3	18	2.38	0.88	0.84	Multimodal	67%	68%	3	0.33	0.03
4	23	2.20	0.81	0.70	L	78%	73%	2.8	0	0
5	23	2.50	0.88	0.82	L	79%	70%	1	0.33	0.17
6	18	2.45	0.88	0.88	Inverse-J	83%	84%	3	0.2	0.16
7	20	2.32	0.85	0.76	Modral	85%	73%	3.3	0	0
8	23	2.26	0.86	0.76	Modral	92%	61%	5.4	0	0
9	22	1.94	0.79	0.71	Inverse-J	73%	80%	4.7	0.25	0.01
10	15	2.53	0.88	0.80	Inverse-J	70%	81%	5.8	0.37	0.06
11	21	2.30	0.85	0.81	Inverse-J	76%	80%	6.2	0.4	0.33
12	19	2.34	0.85	0.82	L	84%	78%	3	0.3	0.15

Table 3. Index B of the potential for re wildification of plant communities in the wilded area of Taiping Mountain Park.

	C17	C16（%）							
		C12	C13	I II	II III	III IV	seedling	I II	II III
1	5.92	4	0.88	100	100	88	33	100	0
2	4.10	4	1.6	7.39	100	48.5	75	100	1.9
3	3.09	2	0.5	100	89.2	100	100	100	42
4	3.82	9	1.4	100	65.7	4.4	100	100	21
5	3.61	5	2.0	100	91.4	38.1	100	100	12.
6	4.79	4	1.0	100	52.1	17.6	5.60	65.42	3.6
7	3.00	6	0.6	100	51.0	100	13.8	100	0
8	2.42	5	0.4	100	75.6	17.8	6.4	100	0
9	2.90	11	1.2	100	60.7	100	100	100	0
10	3.23	8	0.4	100	42.8	91.6	100	100	7.8
11	4.10	7	1.3	100	31.4	100	42.2	100	11
12	5.28	8	0.8	100	65.4	67.2	100	100	6.8

(1) Species composition of the community

a. Diversity Index Analysis

As shown in Table 2, the diversity indices of the tree and herbaceous layers in Taipingshan Park were relatively high. This was mainly due to minimal human disturbance, as most rewilding areas remained unmanaged, retaining the original natural landscape. The plant communities were dominated by native or naturalized species. Although the herbaceous layer lacked cultivated or naturally regenerated root flowers, it contained stress-tolerant taxa such as legumes and Asteraceae, which contributed to the observed species richness.

In contrast, the shrub layer showed low diversity and was primarily composed of Wild Rose and juvenile rose seedlings (20–60 cm in height), with few well-developed individuals. Most shrubs occurred as isolated plants or monocultures. This pattern reflected long-term natural succession, during which early-successional species such as bush clover and milkweed gradually developed into small trees exceeding 2 meters in height.

b. Uniformity index analysis

The herbaceous layer in the rewilding area of Taipingshan Park exhibited greater species evenness than the arbor layer. This pattern was attributed to the park's extensive management regime, which allowed the herbaceous community to develop with higher species richness and a more balanced composition, approaching a natural state of ecological equilibrium.

(2) Community structure

Based on the distribution of tree diameters in the sample plots, the diameter class structure of the plant community in the rewilding area of Taipingshan Park was predominantly characterized by inverse-J and L-shaped patterns, indicating a mature and stable community structure. Notably, plots 9 to 12 exhibited a high proportion of dominant species, further reflecting advanced successional stages. In contrast, plots 7 and 8 displayed a unimodal distribution, while trees in plots 1 and 3 had diameters mostly concentrated between 5 and 15 cm. These plots contained a mix of young and senescent individuals but lacked reproductively mature trees capable of producing viable seedlings, resulting in limited natural regeneration.

(3) Site conditions

The original landform, stable native plant communities, extensive management, and minimal human disturbance in the rewilding area of Taipingshan Park created favorable conditions for seedling regeneration. The soil was fertile and loosely compacted, the canopy moderately dense, and light availability sufficient for understory growth, collectively providing optimal conditions for plant development. However, steep slopes and the presence of large surface rocks in some plots led to significant soil erosion, which adversely affected the normal growth and reproductive processes of vegetation.

(4) Community viability

As shown in Table 3, the plant community in the rewilded area of Taipingshan Park exhibited high vitality and strong regenerative capacity, which facilitated positive successional development. In quadrat 3, the slope approached 90°, resulting in intense competition among herbaceous species and limited seed germination. Consequently, regeneration was restricted to two species—hackberry (*Celtis sinensis*) and Acacia (*Robinia pseudoacacia*)—with seedling heights primarily ranging from 55 to 100 cm.

In contrast, quadrats 9 to 12 supported more diverse regeneration, both in terms of species richness and vertical stratification. However, the low tree density in quadrat 10 led to a limited number of regenerated seedlings. From the perspective of natural composition coefficients, quadrats 3, 7, 8, and 9 remained in the early stages of succession. These plots were predominantly colonized by pioneer species such as hackberry and Acaci**.** Although members of the Pinaceae and Quercus genera were present, their ecological importance remained low.

The dominant tree species in the rewilding area of Taipingshan Park were primarily Black Pine (*Pinus thunbergii*), Acacia, and various Quercus species. Although these species were present throughout the area, their distribution was not extensive and was largely concentrated along mountain trails due to artificial planting. Pioneer species exhibited strong germination tendencies, which limited the establishment of later-successional seedlings such as Black Pine, *Quercus serrata* and *Quercus variabilis.* Most of these seedlings ranged in height from 55 to 95 cm, with few newly germinated individuals observed. Despite the community's strong regenerative capacity, the absence of appropriate human intervention risked reversing the natural successional trajectory and potentially hindering long-term ecosystem stability.

(5) Community adaptability

The dominant species in the rewilding area of Taipingshan Park included Black Pine, hackberry, Acacia, and Nutgall Tree (*Pinus thunbergii*). The plant community was primarily composed of native tree species, with mixed coniferous–broadleaf forests accounting for 58.33% of the total. These communities exhibited strong ecological adaptability to the local habitat conditions of Taipingshan Park.

(6) Degree of interference

Artificial irrigation was observed in the southwestern corner of quadrat 1 in the rewilding area of Taipingshan Park. The remaining 11 quadrats received no maintenance or management and experienced minimal human disturbance. Only quadrat 7 showed signs of trampling; however, the pedestrian flow was low and did not significantly affect the normal growth and development of the plant community.

As shown in Table 5.27, the rewilding potential scores of the 12 quadrats in Taipingshan Park ranged from 5.423 to 7.453, with an average of 6.309, corresponding to a comprehensive evaluation grade of III. Among these, seven quadrats scored above the average and five below. Overall, the park demonstrated relatively high

rewilding potential, characterized by favorable biodiversity and low levels of human disturbance. The park exhibited a rewilding potential classified as Level III. The designated rewilding area experienced minimal anthropogenic and natural disturbances, supported a relatively stable plant community with strong regenerative capacity, and maintained moderate canopy density, which ensured adequate light availability for understory vegetation. The soil was fertile, and the overall habitat conditions were favorable for plant growth and seedling regeneration.

These quadrats required no large-scale human intervention. Following the principle of "preserving native vegetation and respecting existing habitat conditions," unrestricted public access was limited. Management practices included controlling the density of regeneration seedlings, removing aggressive invasive species, and conserving the wild landscape character. Over time, these areas were expected to serve as species sources for the broader Taiping Mountain region.

Among the sample plots, Plot 9 exhibited the highest rewilding potential score (7.453), characterized by strong community vitality and low disturbance levels. Dominant tree species included *Quercus serrata* and *Quercus acutissima*, along with their natural seedlings. The canopy also featured large trees such as hackberry, Acacia and Water Elm (*Zelkova serrata*), complemented by smaller tree species including Chinese pistache (*Pistacia chinensis*), Nutgall Tree and *Pyrus betulifolia.*

In contrast, Plots 1 and 8 exhibited the lowest rewilding potential scores, at 5.736 and 5.428 respectively, corresponding to Level II. These quadrats were subject to anthropogenic disturbances such as trampling, and featured rugged terrain with severe soil erosion. Habitat conditions were generally unfavorable for plant growth, leading to a fragmented herbaceous layer and low diversity in tree and shrub strata. The communities were in early successional stages, with limited stability and sparse regeneration in both species richness and density.

Given these site conditions, targeted human interventions were recommended, including sowing native herbaceous species (e.g., *Oplismenus undulatifolius, Setaria viridis*) and transplanting trees of varying age classes. These actions would promote community development, enhance seed germination and growth, increase community vitality, and improve structural and species diversity. Additionally, the site topography allowed for the design of a multifunctional micro-space to accommodate public activities, enabling visitors to rest or observe successional dynamics at close range.

4. Discussion

This study introduced two key innovations in the evaluation of rewilding potential in urban parks. First, grounded in the principles of wilderness mapping, a set of wilderness feature analysis models tailored to small- and medium-scale urban contexts was developed using ArcGIS. Second, an evaluation system for assessing park rewilding potential was established, incorporating indicators related to naturalness, community vitality, and the degree of anthropogenic disturbance. This framework provided methodological support for the quantitative assessment of plant community rewilding potential.

Despite these contributions, the study had certain limitations. On the one hand, the influence of different park typologies and internal landscape configurations on rewilding potential was not thoroughly examined, which constrained the model's applicability and generalizability. On the other hand, the current indicator system could be further refined. Incorporating more diverse ecological and social indicators in future research would enhance both the model's robustness and its scientific relevance.

5. Conclusion

(1) Based on the principles of wilderness mapping, seven indicators were selected to assess the wildness of Taipingshan Park: biophysical naturalness, visual naturalness, distance from roads, topographic undulation, vegetation coverage, surface runoff, and scenic spot density. A fuzzy membership function was employed to classify the park's landscape into distinct wildness zones. This approach enabled a quantitative and spatially explicit partitioning of wilderness gradients, providing a scientific foundation for subsequent rewilding potential evaluations and landscape planning.

(2) An evaluation index framework for assessing the rewilding potential of plant communities within the rewilding zones of Qingdao's urban parks was developed. This framework encompassed six dimensions and comprised a total of 22 evaluation indicators. The relative importance of these

indicators was ranked in the following order: community vitality > disturbance > community structure > community species composition > community adaptability > site conditions. Among these, the regeneration capacity and age structure of the tree layer were identified as key endogenous drivers of rewilding potential, reflecting the intrinsic resilience and renewal capacity of plant communities. In contrast, anthropogenic disturbance emerged as the most critical exogenous factor constraining the rewilding process, exerting significant influence on community stability and successional trajectories.

(3) The rewilding potential scores of the 12 quadrats in Taipingshan Park ranged from 5.423 to 7.453, with a mean value of 6.309, corresponding to a comprehensive evaluation grade of Level III. Among these quadrats, seven exhibited scores above the average, while five fell below it. Overall, Taipingshan Park demonstrated a relatively high rewilding potential, characterized by favorable biodiversity conditions and a low level of anthropogenic disturbance.

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EXPLAINABLE MACHINE LEARNING-DRIVEN TRIPARTITE SYNERGY IN HISTORIC URBAN C STREETS: SYSTEMIC ANALYSIS OF "SPACE-ENVIRONMENT-PERCEPTION" IN TIANJIN'S CORE URBAN AREA

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Keywords: machine learning, Space-Environment-Perception, Urban fabric, Vegetation combination

Abstract
Under the backdrop of rapid urbanization and intensifying environmental pressures, historic urban blocks face dual challenges of preserving cultural identity and enhancing environmental resilience. As a typical high-density heritage city in northern China, Tianjin has frequently recorded regional-high air pollutant indices in recent years, where the conflict between cultural preservation and air quality has become a core contradiction in urban renewal. Within this context, the study constructs an integrated machine learning framework combining visual perception analysis, air pollutant assessment, and vegetation structure analysis. Selecting Tianjin's main urban area as a case study, it first employs DeepLabV3+ deep learning for spatial analysis to quantify vegetation structures; second, applies VGGNet to decode and quantify six-dimensional visual perceptions, analyzing spatial distribution characteristics of pedestrians' perceptions (safety, vibrancy, aesthetics, etc.), revealing significant disparities in environmental perception quality; finally, establishes an explainable machine learning model (XGBoost-SHAP-PDP) framework to excavate tripartite relationships among nine spatial-environmental indicators (including built spatial forms, urban street greening general structures - USGGS, air pollutants) and six perceptual dimensions, providing mechanistic discussions for optimizing heritage-compatible environments in Tianjin's historic blocks. Through multi-source urban data and explainable AI technology, it uncovers dynamic complex correlation mechanisms among site spaces, streetscape perceptions, and street environments within culturally sensitive contexts.

1 Introduction

In China, the comprehensive environmental indicators of blocks have become an important basis for evaluating the quality of high-quality human settlement spaces. Street visual perception is currently a key indicator for assessing the visual quality of the built environment. Streetview image (SVI), as an emerging data source, provides street spatial image data for large-scale urban measurement that closely aligns with the real human perspective {1}. In previous studies, linear regression analysis was performed using computer vision technology to analyze visual perception and street greening structure (USGGS), proving an association between street greening and perception {2}. Chenling Wu et al. summarized that the spatial scale, urban units, elements, etc., of built-up areas and green spaces are important indicators affecting the quality of the built environment {3}.

However, the content of urban environmental quality is systematic and complex. Due to factors such as tourism development, the increase in vehicles has exacerbated the deterioration of air environmental problems in urban blocks. As Thunis indicated, the urban environment, especially air quality, has become more fragile than before due to unsustainable transport modes and spatial configurations {4}. As a typical high-density heritage city in northern China, Tianjin has often registered air pollutant indices at relatively high regional levels in recent years, particularly with significant NO_2 emissions. NO_2 air pollution is becoming a major threat to urban human health {5}. As a nationally important historical city, the conflict between cultural preservation and air quality has become a core contradiction in Tianjin's urban renewal.

Consequently, we propose a primary research question: In historic urban blocks, which spatial environmental elements promote the most livable synergistic development between the physical environment and the visual environment? Some theories from the field of urban microclimate are adopted to link urban form with urban air pollution {6}. Therefore, high-density urban historic blocks are selected as the object of this study because air pollution is more concentrated in this urban environment compared to others. The article discusses the influencing mechanisms by quantifying the multivariate relationships between urban spatial environmental elements, including air pollution and greening structure, and perception. Finally, it is hoped that from this research, a comprehensive framework for environmental quality in high-density historic blocks, along with impact mechanisms and optimization strategies, can be derived through optimizing block morphology.

2.information on materials and methods

2.1 Study Area

Tianjin is a megacity in northern China with typical climatic characteristics of northern cities. The six central districts of Tianjin have earlier urban construction dates and higher population density {7}, possessing rich historical and cultural resources such as the Five Great Avenues, Binjiangdao Commercial Street, and the Italian Style Street. These areas exhibit high demand for improving pedestrian visual perception levels and can represent urban regions with abundant cultural tourism and commercial resources while requiring visual environment optimization. With accelerated urbanization and industrialization, air pollution is becoming one of Tianjin's most severe environmental issues {7}. Therefore, this study selects the six central districts of Tianjin as the research area (Figure 1), comprising six administrative districts—Hexi District, Nankai District, Heping District, Hedong District, Hebei District, and Hongqiao District.

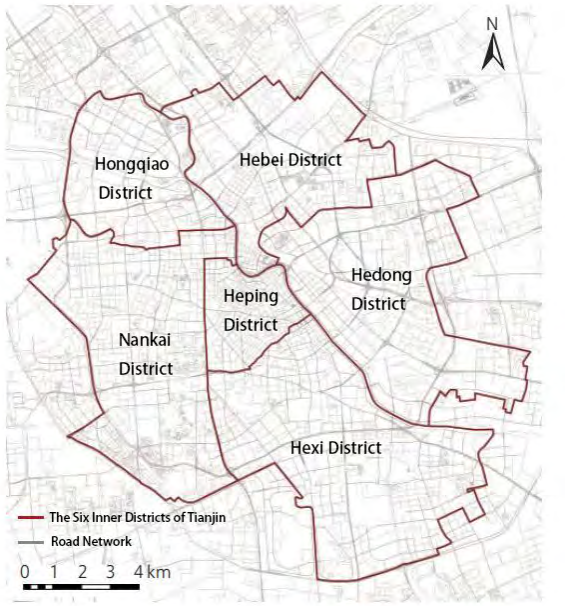


Figure 1. Scope of the six central districts of Tianjin.

2.2 Street View Image Collection Processing and Site Spatial Environmental Element Screening

Research data primarily includes urban road network data, urban panoramic street view images, urban fine-grained data, and Cityscapes and SSGS datasets for DeepLabV3+ neural network model training. Urban panoramic street view images were obtained from panoramic static images provided by the BSV (Baidu Street Map) open platform. The advantages of this data lie in its fast update frequency, extensive coverage range and area, and stronger reliability compared to TSV (Tencent Street Map) data. Today, BSV panoramic street view images have been widely applied in various studies related to urban street spaces {8}. The article categorizes spatial forms and site environments of blocks in Tianjin's six central districts into three major types with nine items: vegetation greening structure elements, air pollutants, and building and spatial elements. Table 1 (Table 1) provides definitions for each indicator, detailing their relevance in representing block environmental characteristics. Since the article primarily focuses on analyzing block site environmental conditions, we selected data on the usage of general urban street greening structure (USGGS) in Tianjin and composite data of multiple air pollutants within the region (including gaseous

pollutants like COx, NOx, and particulate pollutants such as PM2.5). Additionally, buildings, green spaces, water, and other facilities (e.g., transportation facilities such as streets and parking spaces) are main elements of the built environment {9}. Therefore, we incorporated elements related to block building and spatial forms (e.g., building continuity), which are effective for assessing local spatial pollution conditions and composite vegetation functions. These indicators also provide more comprehensive quantitative representations of height variations and surface ratios, thereby enabling the selection of parameters suitable for further integration into block performance evaluation.

Table 1. Block Spatial Forms and Site Environmental Elements in the Six Central Districts of Tianjin.

Classification	Feature Type	Unit	Definition
Greening Structure Element	Single tree	Unit	Single tree vegetation structure
	Tree-Shrub-Grass	Unit	Combined vegetation structure of trees, shrubs, and herbaceous plants
	Tree-Shrub	Unit	Combined vegetation structure of trees and shrubs
Air Pollution Elements	Including gaseous pollutants (COx, Nox, etc.) and particulate pollutants (PM2.5, etc.)	unitless	Fitted data of gaseous pollutants and particulate pollutants
Building and Spatial Elements	Building Continuity	unitless	Degree of continuity of street buildings
	Building Density	%	Proportion of total building coverage area in each grid
	Sky View Factor	%	Proportion of sky element surface area in each grid
	Road Proportion	%	Proportion of all road surface area in each grid
	Sidewalk Proportion	%	Proportion of sidewalk surface area in each grid

2.3 Quantification of USGGS Based on Deep Learning Computer Vision

In terms of model selection, a semantic segmentation network based on the DeepLabV3+ neural network architecture was chosen. This architecture was open-sourced by Chen et al. in 2018 {10}. The DeepLabV3+ neural network model stands out among numerous models due to its high precision and segmentation speed, primarily owing to its design tailored for urban scene analysis, enabling accurate identification of landscape features in urban streetscapes. The model utilizes DeepLabV3 as an encoder and generates multi-dimensional feature extraction expressions through Atrous convolution, effectively performing upsampling. DeepLabV3+ also enhances the delineation of boundary details through a cascaded decoder mechanism, improving the model's accuracy and processing speed. The comprehensive application

of these technologies significantly enhances the model's performance in urban scene segmentation {10}.

By training the DeepLabV3+ neural network model using the SSGS dataset and Cityscape dataset, it becomes capable of accurately identifying trees, shrubs, and groundcover plants in urban street spaces based on features, and calculating their proportions within the entire panoramic streetscape image. The results are then imported into Matlab, where rule-based clustering is used to classify USGGS {2}. Based on the classification results from the DeepLabV3+ neural network model, clustering rules were established to differentiate and cluster Tianjin's USGGS into 5 categories, screening three predominant greening structure cluster labels: Tree, Tree-Shrub-Grass structure, and Tree-Shrub structure. The clustering rules are shown in Table 2 (Table 2).

Table 2. Clustering Rules

Greening Structure	Clustering Rules
Single tree	Shrub value = 0, groundcover plant value = 0, tree value ≠ 0
Tree-Shrub-Grass	Tree value ≠ 0, shrub value ≠ 0, groundcover value ≠ 0
Tree-Shrub	Tree value ≠ 0, shrub value ≠ 0, groundcover value = 0

2.4 Calculation of Pedestrian Visual Perception Characteristics at Sites

Following semantic segmentation, this study employs the VGGNet model to analyze urban perception. VGGNet, originating from the Visual Geometry Group at the University of Oxford {12}, was selected for its structured design and outstanding performance across diverse datasets. We constructed a deep learning network based on the VGG16 architecture, widely used for image classification tasks. Utilizing MIT Place Pulse data, we preprocessed and classified paired perceptual comparison results for six perception indicators. These results served as inputs to train the network to predict winners in paired comparison tasks. The cross-entropy loss function and backpropagation were used to update the gradients of the VGG16Net neural network for binary classification perception training. The trained neural network can distinguish perceptual intensity between multiple pairs of streetscape images, thereby simulating residents' perceptual evaluation of two streetscape images. In the training and validation sets, prediction accuracies for different perceptions were as follows: safety, liveliness, beauty, wealth, depression, and boredom – six perceptual states {2}.

2.5 Constructing Regression Models Using XGBoost+SHAP

We use the XGBoost algorithm combined with SHAP (SHapley Additive exPlanations) values for regression analysis. XGBoost is a gradient boosting algorithm that predicts outcomes by building an ensemble of decision trees. It minimizes the loss function (typically mean squared error for regression tasks) and incorporates regularization terms to prevent overfitting. The objective function is:

$$L(\theta) = \sum_{i=1}^{n} \lambda(y_i, f(x_i)) + \Omega(f)$$

When λ(y_i,f(x_i)) is the loss function,y_i is the true value,f(x_i) is the predicted value, and Ω(f) is the regularization term. XGBoost can handle complex and nonlinear relationships, making it suitable for analyzing urban data with multiple influencing factors. Then, use the SHAP value to explain the results of the XGBoost model. SHAP utilizes the Shapley value in cooperative game theory to fairly allocate the contribution of each feature to the model's prediction. The calculation method of the Shap-ley value j of the feature is:

$$\phi_j = \sum_{S \subseteq N \setminus \{j\}} \frac{|S|!\,(|N| - |S| - 1)!}{|N|!} [f(S \cup \{j\}) - f(S)]$$

Where N is the set of all features, S is a subset of features excluding j and $f(S)$ is the model's prediction using only the features in subset S. By applying SHAPLY to interpret the model results, it becomes possible to understand how different block spatial forms and site environmental factors—such as generalized greening structure {12}, gaseous pollutant distribution, and building spatial elements—influence the outcomes of each perception cluster.

Through the regression and analysis methods employing XGBoost combined with SHAP interpretation, a comprehensive analysis of site spatial environmental factors affecting urban block perception can be achieved, enabling an in-depth understanding of the spatial forms and environmental drivers behind visual perception

characteristics. This approach not only facilitates accurate predictions for spatial design but also enhances the interpretability of multi-dimensional urban street environmental factors, making it an ideal analyzable and operable method in contemporary urban built environment renewal.

3 results

3.1Street Spatial Environmental Factors Influencing Visual Perception Dimensions

Figure 2 reveals dominant elements' nonlinear contributions to visual perception through XGBoost-SHAP modeling (|SHAP| values indicate influence magnitude, signs indicate direction). The SHAP method shows building continuity (X5) is the core positive driver of safety perception (Y1, SHAP +0.8), while sky view factor (X7) is its key negative constraint (SHAP -0.3). Pollutant concentration (X4) exhibits perceptual dimension heterogeneity: positively driving boredom (Y3, SHAP +0.15) and depression (Y6, SHAP +0.05) but negatively suppressing liveliness (Y2, SHAP -0.15) and beauty (Y4, SHAP -0.15). Among greening elements, Tree-Shrub-Grass combination (X2) significantly suppresses boredom (Y3, SHAP -0.10), while Tree-Shrub (X3) simultaneously enhances wealth perception (Y5, SHAP +0.10) and exacerbates depression (Y6, SHAP -0.15). Road proportion (X8) shows weak influence across all dimensions (|SHAP|<0.05).

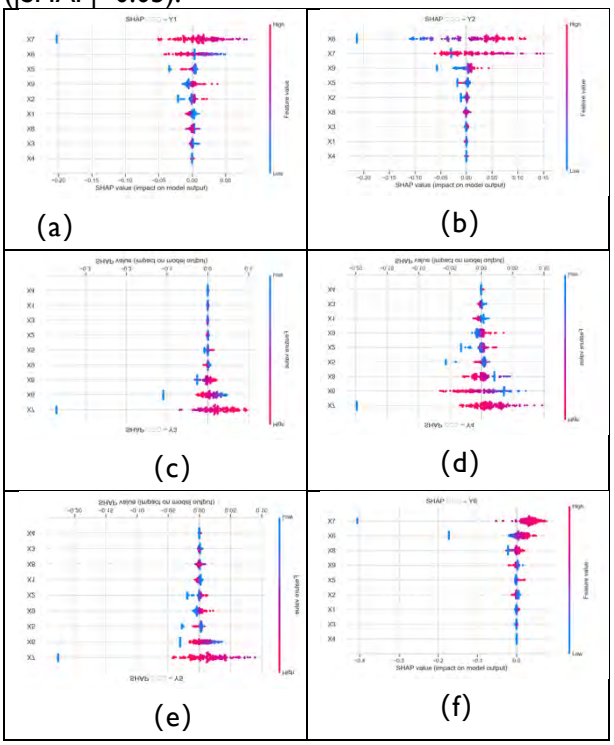
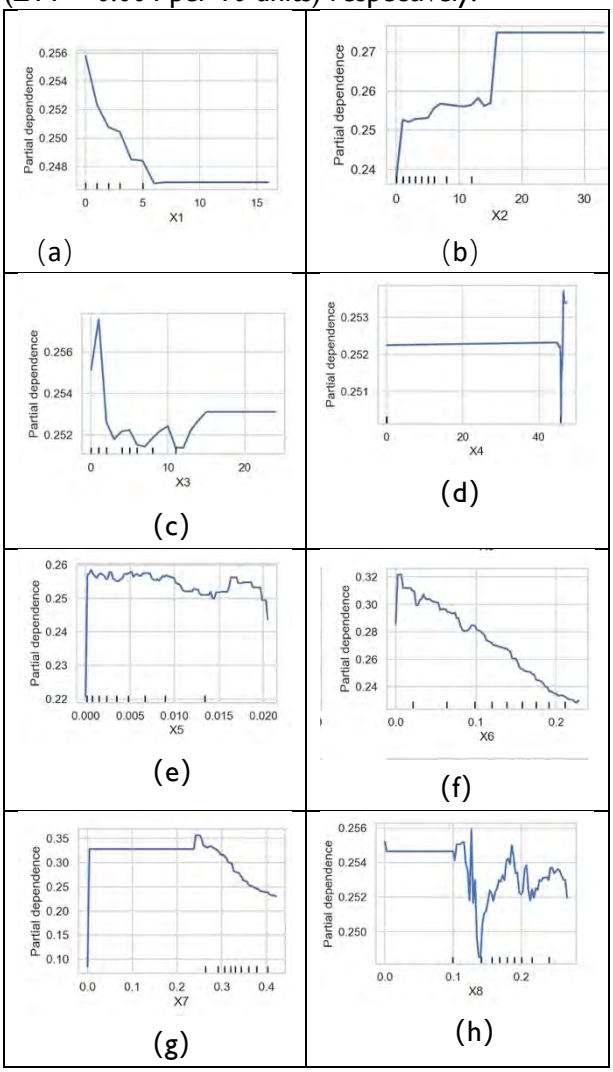


Figure 2. SHAP feature importance for six-dimensional visual perception: (a) Y1 safety, (b) Y2 liveliness, (c) Y3 boredom, (d) Y4 beauty, (e) Y5 wealth, (f) Y6 depression

3.2Element Response Mechanisms for Comprehensive Perception

Partial dependence analysis in Figure 3 indicates building continuity (X5) triggers abrupt growth in comprehensive perception (Y1, Δ+0.04) within the 0-0.005 range. Tree-Shrub-Grass combination (X2) promotes 0.03 Y1 growth in 0-15 unit range (marginal benefit decays 60% thereafter). Pollution factor (X4) causes no significant fluctuation globally (Δ<0.001), while sky view factor (X7) shows global negative response (Y1↓0.06 per 0.1 unit increase). Building density (X6) accelerates Y1 reduction beyond 0.1 threshold (slope -0.4). Single-tree (X1) and Tree-Shrub (X3) exhibit threshold response (10-15 units ΔY1=+0.008) and weak linear growth (ΔY1=+0.004 per 10 units) respectively.



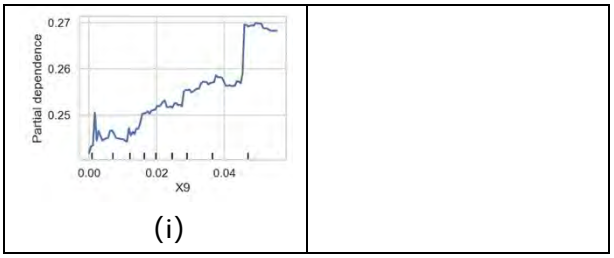


Figure 3. Partial dependence curves for comprehensive perception (Y1): (a) X1 s-t tree, (b) X2 t-b-g Tree-Shrub-Grass, (c) X3 t-b Tree-Shrub, (d) X4 w-r pollution, (e) X6 building density, (f) X5 building continuity, (g) X7 sky view factor, (h) X8 road proportion, (i) X9 sidewalk proportion

3.3Decision Path Analysis of Perception Dimensions

Figure 4 confirms safety perception (Y1) relies on high building continuity-low sky view coupling mechanism (output jumps to 1.2 when X5=1 and X7=0). Liveliness perception (Y2) is governed by antagonistic effects: sky openness (X7=0.357 contributes +0.023) vs. pollution suppression (X4=0.185 offsets +0.008). Pollution consistently negatively affects beauty perception (Y4) (X4=0.414 reduces 0.04) but positively drives boredom (Y3) (X4=0.352 increases 0.02). Tree-Shrub (X3) imposes >9.01 lower-bound constraint on wealth perception (Y5) (X3=9.01 contributes +0.011). Tree-Shrub-Grass combination (X2>0.1) reduces pollution's negative contribution to beauty by 50%.

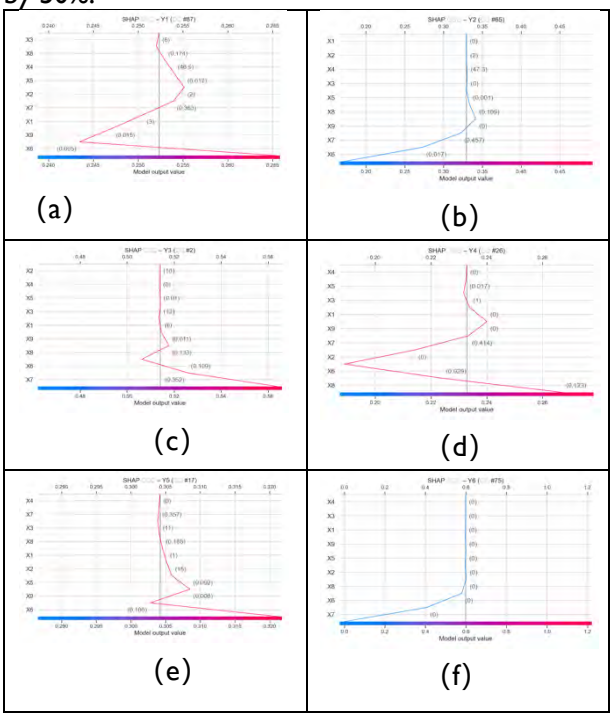


Figure 4. Decision paths for typical samples: (a) Y1 safety, (b) Y2 liveliness, (c) Y3 boredom, (d) Y4 beauty, (e) Y5 wealth, (f) Y6 depression

4 discussion and conclusion

4.1 Perception Shaping Mechanism of Environmental Elements

Research indicates that building interface integrity is the core physical carrier of safety perception, where minor improvements can significantly enhance environmental psychological comfort (dominant SHAP value contribution). When street interfaces are fractured, safety perception sharply weakens; whereas initial enhancements to continuous interfaces can trigger perceptual leaps, validating the scientific basis of "micro-renewal" in historic district conservation. Sky exposure exhibits a double-edged effect: moderate openness enhances spatial vitality, but excessive exposure weakens safety perception and amplifies pollution anxiety, explaining the optimal spatial scale differences between commercial blocks and residential areas.

The efficacy of greening structures depends critically on vegetation composition complexity: composite Tree-Shrub-Grass vegetation effectively alleviates monotony through layered landscapes, but ultra-high-density planting backfires by obscuring social spaces; refined tree arrangements enhance environmental quality perception, yet their maintenance demands may transform into negative emotional sources in low-management-intensity areas, highlighting that vegetation configuration must align with spatial functional positioning.

4.2 Latent Regulatory Role of Pollution Elements

Pollutants exhibit "invisibility" in comprehensive perception due to their dimensional counteractions: in commercial streets, visual pollution suppresses aesthetic experiences, while in arterial roads, it unexpectedly enhances safety perception by reinforcing enclosed interfaces. This paradoxical effect is particularly pronounced in open blocks—identical pollution levels reduce pleasure in vibrant spaces yet intensify environmental monotony in static spaces.

Pollution's suppression of vegetation benefits forms a critical risk chain: in highly polluted environments, the landscape enhancement from composite vegetation significantly attenuates. Here, improving building interface integrity can effectively buffer pollution losses, especially by reducing pollution exposure through interface shielding, thereby providing supporting space for vegetation functions.

This "building-vegetation" synergy holds particular value for streets in highly polluted industrial districts.

4.3 Synergistic Mechanism of "Perception-Pollution-Vegetation"

This study reveals cascading responses within the ternary system:

Vegetation's anti-pollution efficacy: In high-pollution streets, broad-canopy composite vegetation alleviates aesthetic losses through dual pathways—physical dust interception and visual shielding; medium-pollution areas require controlled tree density to balance quality enhancement and maintenance burdens.

Building's regulatory value: Continuous interfaces generate multiplier benefits in open streets by optimizing microclimates (reducing sky exposure risks) and expanding vegetation growth space.

This mechanism prioritizes street renewal: first repair critical interface breakpoints to activate system resilience, then configure vegetation structures according to pollution levels (enhance composite vegetation in high-pollution zones, prioritize refined trees in low-pollution zones), ultimately forming spatially adaptive perception optimization pathways.

4.4 disscussion

Through machine learning and SHAP methods, this study decodes the nonlinear correlation mechanism of "space-environment-perception" in historic urban blocks, extracting synergistic rules for heritage-friendly street spaces: Building interface integrity, as a carrier of cultural memory, can simultaneously enhance safety perception and ecological resilience through micro-renewal; composite vegetation structures (Tree-Shrub-Grass combination) within critical density ranges both buffer pollution's erosion of beauty and preserve historic spatial textures; pollution control must follow the "zoning-differentiated efficacy" principle—prioritizing aesthetic restoration in commercial streets while leveraging interface enclosure to convert safety gains in traffic corridors. The study reveals weight-balance ratios between vegetation configuration and pollution exposure, establishing a site environmental adaptation pathway "constrained by heritage essence conservation and mediated by vegetation dynamic regulation". Ultimately, historic blocks are reconstructed into living systems where cultural memory coexists with ecological functions. This synergistic paradigm demonstrates that explainable machine learning-based spatial analysis can transform cultural landscapes into load-bearing environmentally adaptive ecosystems while preserving historical authenticity. By decoding nonlinear relationships among historic urban spaces, vegetation dynamics, and pedestrian environmental experiences, the study provides transferable strategies for "spatial gene repair – microclimate regulation – perception experience optimization" in heritage cities.

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URBAN INFORMAL GREEN SPACES: HOW TO APPLY ECOLOGICAL PRINCIPLES TO NATURE-BASED-SOLUTIONS

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Keywords: informal green spaces, Nature-based Solutions, urban industrial wastelands, plant succession, urban biodiversity

Abstract

Informal Green Spaces (IGS) are part of urban green infrastructure and could play an important role in urban biodiversity conservation. These informal spaces not only provide habitats for diverse species but also enhance the health and resilience of urban ecosystems by strengthening ecological connectivity, improving microclimates, and facilitating ecological succession. Nature-Based Solutions (NBS) strategies in IGS include preserving spontaneous vegetation, creating new wildlife habitats, implementing phytoremediation, and designing and navigating the desired succession phases, thus making the dynamic character of urban ecosystems visible. IGS can also serve as demonstration and educational platforms for biodiversity conservation, raising public awareness and engagement in ecological protection while driving urban sustainable development. Industrial wastelands, as a critical type of IGS, exhibit distinct spontaneous plant communities that demonstrate different succession stages and their future opportunities for ecological design. Studying these dynamics reveals the patterns of vegetation structure changes, providing essential insights for guiding ecological restoration, biodiversity conservation, and landscape reconstruction of such sites. Harbin, one of the earliest industrial cities in China, contains numerous industrial wastelands that require remediation. This study employs the space-for-time substitution method to analyze the composition and stability of existing plant communities in urban industrial wastelands in Harbin with different abandoned durations (3 years, 6 years, 9 years, 12 years, and 20 years). This is pioneering research trying to understand the successional mechanism of how nature works in postindustrial landscapes and what we can learn from it. We performed field surveys and analysis including the species richness, Shannon-Wiener index, Simpson index and Godron stability index of the vegetation. By decoding the dynamic patterns of spontaneous plant communities at different succession stages, we translated ecological succession patterns into actionable landscape language. Firstly, by establishing plant communities at different successional stages within the site, ecological data like Shannon-Wiener index change curves were translated into interactive landscape installations(e.g., data-visualized pathways and succession clock landmarks). This made invisible ecological processes into spatially perceptible public experiences. Secondly, we utilized the replacement patterns of dominant species to create dynamic seasonal landscapes(such as the golden autumn withering of pioneer herbs alternating with the evergreen foliage of climax trees) to interpret natural rebirth in the background of industrial ruins. Thirdly, we repurposed industrial structures (e.g., pipelines) as three-dimensional succession substrates for climbing plants (like Parthenocissus quinquefolia), and transformed abandoned infrastructure into dynamic landscape archives that record natural encroachment processes through the gradual wrapping of steel texture by vines and the biodegradation of corroded structures. This NBS design paradigm based on plant succession achieves the transformation of urban informal green spaces into green infrastructure that combines biodiversity and functional stability. At the same time, this research is

contributing to understanding possible nature-based solutions which are used in European countries (such as“go wild”, “go spontaneous”) in the Chinese context.

Introduction

Rapid urbanization, while driving socio-economic development, has intensified ecological challenges such as habitat fragmentation, urban heat island effects, and biodiversity loss. As a critical component of urban green infrastructure, Informal Green Spaces (IGS) demonstrate significant potential for urban biodiversity conservation: They not only provide habitats for diverse species but also enhance the health and resilience of urban ecosystems by strengthening ecological connectivity, improving microclimates, and facilitating natural succession[1]. Furthermore, IGS can serve as demonstration and education platforms for biodiversity protection, raising public awareness and engagement in ecological conservation while advancing urban sustainability[2]. Within this context, industrial wastelands—as a quintessential form of IGS—leverage natural succession processes to not only remediate contaminated soils but also preserve unique ecological heritage values[3]. Nature-Based Solutions (NBS), with their core principles of low-intervention yet high adaptability, emerge as a pivotal pathway to activate the ecological functions of such spaces. By guiding rather than suppressing natural processes, NBS achieves synergistic outcomes across economic, social, and ecological dimensions[4].

The Harbin, a quintessential old industrial base city in China, hosts numerous industrial wastelands awaiting remediation, providing an ideal research sample for studying IGS ecological succession and NBS applications. Therefore, this study employs the Space-for-Time Substitution method to analyze the composition and stability of existing plant communities across industrial wastelands with varying abandonment durations (3/6/9/12/20 years) in Harbin. It further explores translating these successional patterns—such as species replacement of dominant plants and stability dynamics—into tangible NBS implementation pathways, thereby driving the transformation of IGS from "grey ruins" to "green infrastructure". This work not only offers a scientific template for revitalizing wastelands in northern industrial cities, but also provides empirical evidence for evaluating the applicability of European "go wild" in China’s high-disturbance urban contexts. Ultimately, it advances the integration of IGS into urban green infrastructure networks, achieving synergistic development across ecological restoration, cultural preservation, and public education.

Materials and methods

1. Site selection and survey methodology

Harbin, located in northeast China, historically served as a hub of the Chinese Eastern Railway and an international transportation nexus connecting Eurasia (Fig. 1). As a former industrial powerhouse, the city experienced widespread factory closures and relocations following national economic restructuring in the 1990s, resulting in extensive industrial wastelands. This study adopted the space-for-time substitution approach to examine vegetation characteristics across natural recovery stages spanning 3–20 years. Sampling sites included abandoned areas with durations of 3 (R3), 6 (R6), 8 (R8), 9 (R9), 12 (R12), 13 (R13), and 20 (R20) years. Field surveys were conducted from May to July 2021, documenting species composition, plant height (cm), coverage (%).

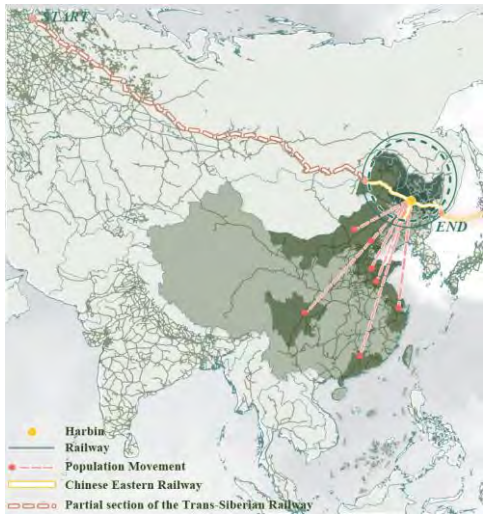


Figure 1. Study site

2. Data statistics and analysis

The Species Importance Value (IV) was calculated to evaluate species dominance. Spontaneous plants were classified into five categories based on IV thresholds: accidental species: IV<1%, companion species: 1%≤IV<5%, dominant species: IV≥5%,

prominent dominant species: IV≥10%. The IV formula is:

IV = (Relative Coverage + Relative Frequency + Relative Height) / 3 (1)

The Shannon-Wiener index (H), Simpson index (D), species richness index (P), Pielou evenness index (E), and Whittaker β diversity index (β_W) collectively reflect the composition and structure of plant communities. Thus, these diversity indices were adopted to analyze changes in plant species diversity across different successional stages. The calculation formulas for each index are as follows:

$$H = -\sum_{i=1}^{S}(P_i \ln P_i) \quad (2)$$

In the formulas, *Pi* represents the proportional abundance of species *i* relative to the total dominance, calculated as:

$$P_i = \frac{IV_i}{IV_0} \quad (3)$$

In the formula, IV_i denotes the simplified dominance measure of species *i*, while IV_0 represents the sum of simplified dominance values for all species within the community.

$$D = 1 - \sum_{i=1}^{S}(P_i)^2 \quad (4)$$

$$P = S \quad (5)$$

$$E = {}^{H}/_{\ln S} \quad (6)$$

$$\beta_W = {}^{S}/_{\alpha} - 1 \quad (7)$$

In the formula, *S* = Total number of species, Pi= Proportional abundance of species *i* (i.e., the ratio of its simplified dominance to the total dominance), α = Mean species richness per sample plot.

This study utilized a modified Godron stability assessment method to evaluate plant community stability across successional stages. Scatter plots were constructed with the cumulative percentage of the reciprocal of species numbers on the x-axis and the cumulative percentage of species relative frequency on the y-axis. The data points were fitted using a cubic polynomial equation [Eq. (8)] to generate a fitted curve. This curve was intersected with the line y=100-x [Eq. (9)], where the intersection point (x, y) served as the stability reference point. The Euclidean distance between this coordinate and (20, 80) was calculated, with greater distances denoting lower plant community stability and smaller distances indicating higher stability[5].

$$y = ax^3 + bx^2 + cx + d \quad (8)$$

$$y = 100 - x \quad (9)$$

Results

1. Dynamic characteristics of vegetation communities

The spontaneous vegetation in the sampled wastelands exhibited a coexistence pattern of prominent dominant species (single species IV > 10%), dominant species, companion species, and accidental species. Only the R3 and R12 stages featured prominent dominant species, with significant differences in importance values (IV) between prominent dominant and dominant species. *Chenopodium album* and *Ulmus pumila* were common across all stages. At R3 stage, *Ulmus pumila* (17.33%) served as the prominent dominant, while *Artemisia argyi* (8.61%) and *Artemisia sieversiana* (5.91%) were dominants. R6 was dominated by *Phragmites australis* (7.58%), *Salix spp.* (6.07%), and *Artemisia argyi* (5.65%). At R9, dominants included *Artemisia scoparia* (7.29%), *Chenopodium album* (7.04%), and *Artemisia argyi* (6.00%). R12 featured prominent dominants *Ulmus pumila* (12.72%) and *Chenopodium album* (10.49%), with *Galium aparine* (7.71%) as dominant. R20 was dominated by *Ulmus pumila* (7.23%), *Erigeron canadensis* (6.81%), and *Chenopodium album* (5.19%). Thus, early succession (R3) formed a *Ulmus pumila* + *Artemisia argyi* + *Artemisia sieversiana* community; mid-succession (R6-R9) transitioned to *Phragmites australis* + *Salix spp.* + *Artemisia argyi* and *Artemisia scoparia* + *Chenopodium album* + *Artemisia argyi* communities; late succession (R12-R20) evolved into *Ulmus pumila* + *Chenopodium album*+*Galium aparine* and *Ulmus pumila* + *Erigeron canadensis* + *Chenopodium album* communities.

2. Comparative analysis of plant community diversity indices

Significant differences were observed in species richness, Shannon-Wiener index, Simpson index, Whittaker β-diversity index, and Pielou evenness index across successional stages of the industrial wastelands. Species richness and Simpson index exhibited parallel fluctuating trends, both peaking at R6 and reaching minima at R12 as abandonment duration increased. The Shannon-Wiener index fluctuated nonlinearly over time, peaking at R6 and R9 while bottoming at R12. Pielou evenness index gradually decreased with prolonged recovery duration. Whittaker β-diversity index demonstrated fluctuating but overall increasing trends, with the highest value at R20 and the lowest at R6.

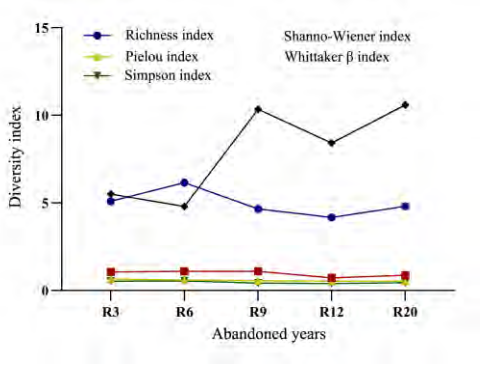


Figure 2. Comparative analysis of plant community diversity indices

3. Evolution trends of plant community stability

The Euclidean distances between the intersection points of the Godron stability fitted curves and the line y=100-x and the theoretical stable point (20,80) were calculated as follows across recovery durations: 17.94 (R3), 24.23 (R6), 14.51 (R9), 11.66 (R12), and 9.98 (R20) (Table 1). Plant community stability progressively increased with prolonged recovery time, where R20 exhibited the highest stability (9.98) and R6 the lowest (24.23).

Table 1. Godron stability of plant communities across abandonment durations

Abandoned ages	Moving point	Euclidean distance
R3	(32.68,67.32)	17.94
R6	(2.87,97.13)	24.23
R9	(30.26,69.74)	14.51
R12	(28.24,71.76)	11.66
R20	(27.06,72.94)	9.98

Discussion

1. Application of ecological principles in NBS

1.1 Data-visualized landscapes and dynamic seasonal landscape

Diversity Index Spiral Pathway Elevation Design. The mean diversity indices from five abandonment-duration sites were translated into elevation parameters to generate a spiral ascending pathway. Pathway surfaces were laser-etched with species inventories corresponding to each stage, enabling the public to perceive biodiversity evolution through spatial movement.

（2）"Ecological Clock" Landmark Installation. Laser-cut concentric rings of weathered steel were constructed, with ring widths representing Godron stability thresholds. Inter-ring LED strips shifted hues seasonally, symbolizing successional progression through chromatic change.

（3）Dominant Species Successional Design. Leveraging phenological traits of pioneer herbs and climax trees , a juxtaposed layout was created where "decay zones" alternated with "rebirth zones" (metaphor for climax communities). This formed a visually narrative field of natural regeneration (Fig. 3).

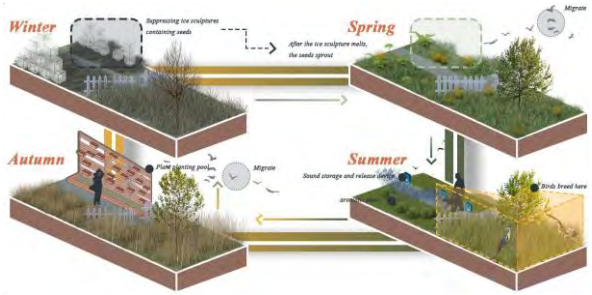


Figure 3. Dynamic seasonal landscape

1.2 Industrial relic revitalization

The abandoned pipeline structure underwent segmented multifunctional transformation to create layered ecological and cultural spaces (Fig. 4). The upper section was converted into an open-air spontaneous plant habitat after debris removal and structural reinforcement, where native soil and microclimatic conditions enable wildflowers and grasses to proliferate freely, forming a distinctive aerial green landscape that demonstrates nature's regenerative capacity. The middle section integrates observation platforms and seating installations, transforming into resting and viewing spaces for close-range observation of plant colonization patterns, panoramic viewing of the regenerated landscape, and on-site ecological interpretation of plant adaptation and successional processes. The lower section's textured surface serves as an ideal substrate for pre-selected native climbing plants (e.g., Parthenocissus quinquefolia), whose progressive coverage provides a tangible representation of successional stages, enabling the public to visually track ecosystem dynamics through the vines' envelopment of the structure—transforming industrial relics into a living didactic apparatus where spatial experience translates ecological principles into intuitive knowledge.



Figure 4. Repurposed pipeline structure

1.3 Industrial memory activation

Olfactory installations crafted from signature materials of distinct industrial sectors (e.g., the molten-metal scent of steel mills, cotton-and-dye aromas of textile factories, or raw-material-and-bakery notes of food processing plants) extract, preserve, and reconstitute characteristic odors through modern techniques (Fig. 5). Positioned within curated exhibition spaces, these installations immerse visitors in familiar yet alien scents that instantly evoke memories of historical industrial operations. More than commemorative artifacts, they forge transgenerational emotional conduits—enabling younger generations to physically experience the narrative of urban industrialization through multisensory engagement, thereby strengthening cultural identity rooted in the city's productive heritage.

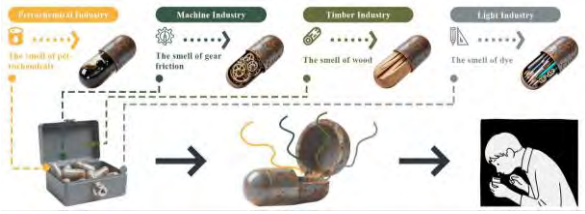


Figure 5. Olfactory installation for industrial memory activation

2 Unique value of industrial wastelands as IGS

2.1 Ecological Significance

Industrial wastelands, as a special type of Informal Green Spaces (IGS), possess value far beyond the ecological service functions of traditional green spaces. The heterogeneous habitats of industrial wastelands (e.g., pipeline gaps, microtopography of slag piles) provide unique habitats for numerous organisms. Due to reduced human disturbance, such areas often become important sanctuaries for urban biodiversity[6]. For example, some abandoned factory sites undergo natural vegetation recovery over time, attracting diverse species like birds and insects to inhabit and reproduce. In urban ecosystems where many native species face habitat loss, industrial wastelands partially fill this gap, serving as refuges for urban biodiversity, playing a critical role in maintaining urban ecological balance[7].

2.2 Cultural Significance

From a cultural-ecological narrative perspective, industrial wastelands carry rich historical and cultural significance. These sites witness the rise and fall of urban industrial development. Preserved industrial structures and equipment serve as physical carriers of industrial civilization. Taking an abandoned steel mill as an example, towering blast furnaces and intricate pipelines recount the glory days of steel production. They are not merely industrial relics but vital components of urban cultural memory. Through their preservation and adaptive reuse, unique industrial stories can be unearthed, passing down the city's historical context while strengthening residents' cultural identity and sense of belonging.

2.3 science Education Platforms

As distinctive IGS, industrial wastelands function not only as biodiversity refuges but also as natural platforms for ecological education. Equipped with interpretive signage, nature observation trails, and science exhibition halls, these once-forgotten industrial sites integrate industrial heritage with biodiversity knowledge into living ecological classrooms. The coexistence of preserved industrial facilities and regenerated natural vegetation forms unique "industrial-ecological" symbiotic landscapes. This visualizes ecological succession and restoration processes, allowing the public to witness firsthand the transformation of derelict spaces into vibrant ecosystems.

Conclusion

This study, using industrial wastelands in Harbin as a research sample, revealed the ecological succession patterns of these sites as Informal Green Spaces (IGS) through the Space-for-Time Substitution method, confirming the critical role of Nature-Based Solutions (NBS) in activating their ecological functions. Results demonstrate that with increasing abandonment duration, plant communities transitioned from pioneer-dominated stages (e.g., *Ulmus pumila* + *Artemisia argyi*) to climax

communities (e.g., *Ulmus pumila* + *Chenopodium album*), with community stability (Godron distance decreasing from 17.94 to 9.98) and biodiversity indices showing fluctuating upward trends. Species richness and Simpson index peaked at the R6 stage. Based on these findings, the study established NBS implementation pathways—including data-visualized landscapes, industrial relic revitalization, and industrial memory activation—translating abstract ecological processes into tangible spatial narratives. This integration achieved synergistic outcomes in ecological restoration, cultural preservation, and public education. The research not only provides a scientific template of "succession principles to design translation" for revitalizing wastelands in cold-climate industrial cities but also validates the adaptability of European "go wild" in China's high-disturbance urban contexts. It offers empirical support for incorporating IGS into urban green infrastructure networks. Future studies could deepen mechanistic research on IGS in urban ecological resilience through long-term monitoring and cross-city comparative analyses.

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BIODIVERSITY HOTSPOT DESIGN AND MULTI-SCALE ECOLOGICAL NETWORK RECONSTRUCTION BASED ON OPTIMIZATION ALGORITHMS

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Keywords: Biodiversity Hotspots, Optimization Algorithms, Urban Rewilding, Micro-habitat Networks, Artificial Intelligence

Abstract

Facing the urgent needs of urban ecological restoration, this study proposes a lightweight AI-driven rewilding practice framework, focusing on biodiversity hotspot design and small microhabitat network optimization. The research identifies four major challenges: spatial heterogeneity processing, connectivity quantification, multi-objective optimization conflicts, and computational complexity constraints. We systematically review algorithmic solutions including systematic conservation planning algorithms, machine learning methods, graph theory optimization approaches, and multi-objective optimization techniques. The study constructs a comprehensive optimization framework encompassing hotspot identification-network construction integration, multi-scale integration strategies, and adaptive management algorithms. This framework combines MARXAN algorithm capabilities with graph theory network optimization, employing improved simulated annealing methods to simultaneously optimize hotspot configurations and connection structures. The approach utilizes systematic conservation planning, MaxEnt species distribution modeling, and circuit theory to address coupling problems across different scales, while implementing dynamic network adjustment through adaptive management components. The framework provides significant implications for urban ecosystem construction, where "living systems" face similar optimization challenges. The proposed strategies effectively handle multi-scale ecological requirements from building microenvironments to urban regional scales, while machine learning integration offers pathways for intelligent urban ecosystem management. The result provides a new way for small and medium-sized design teams to rewild urban green spaces, and provides a low-cost implementation example for IFLA's "Guiding cities x Biodiversity" issue.

Text

1. Introduction

1.1 Research Background

The dramatic increase in human activities has become the primary driving force behind global

biodiversity decline. During urbanization processes, massive population growth, land use changes, and extensive pollution discharge have occurred. These anthropogenic disturbances have led to large-scale reduction and fragmentation of natural habitats. Such drastic changes not only threaten species survival but also severely compromise the structural integrity and connectivity of ecological networks, reducing ecosystem resilience and self-restoration capacity[1].

1.2 Biodiversity Hotspots

Biodiversity hotspots were first defined by Norman Myers in the 1980s, carrying dual implications of importance and urgency: these regions are Earth's most species-rich areas that face severe threats[2]. These areas contain at least 1,500 endemic vascular plant species while retaining no more than 30% of their original vegetation cover. Traditional protected area approaches often treat biodiversity hotspots as independent units, overlooking ecological and functional relationships. Modern conservation paradigms emphasize the transition from "conservation islands" to "conservation networks," connecting hotspot regions through ecological corridors and buffer zones to amplify conservation effectiveness.

1.3 Ecological Network Construction

The complexity of multi-scale ecological processes has become a significant challenge in ecological network construction. Different species exhibit substantial variations in life history traits, migration patterns, and habitat requirements. Traditional ecological network construction methods primarily rely on expert experience and simple spatial overlay analysis, lacking the capability to handle complex multi-objective optimization problems. Advances in artificial intelligence and optimization algorithms have provided new technical pathways for ecological network construction. Finding optimal solutions for multi-objective optimization under complex constraints has become a major advantage of algorithm-based ecological network construction techniques, opening new possibilities for biodiversity hotspot conservation.

1.4 Research Framework

This study aims to address core issues in biodiversity hotspot conservation and multi-scale ecological network reconstruction, systematically review the application progress of relevant optimization algorithms[3], and construct a comprehensive conservation planning framework based on optimization algorithms.

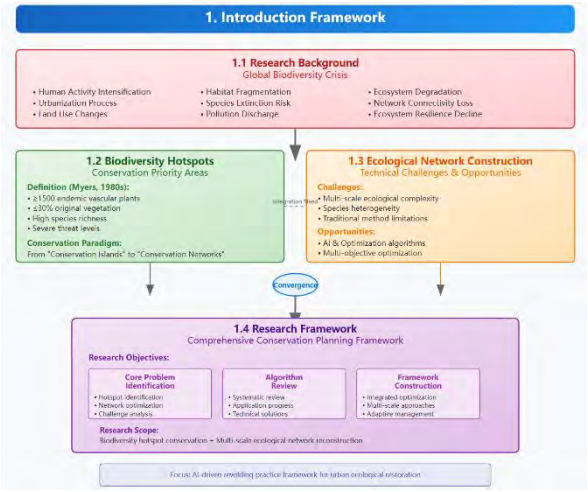


Figure 1. Research Framework.

2. Core Problem

2.1 Biodiversity Hotspot Identification

Spatial heterogeneity analysis represents the primary technical challenge in biodiversity hotspot identification. Biodiversity distribution in natural environments is extremely uneven, with factors from micro-topography to macro-climatic gradients influencing species spatial distribution patterns. Traditional analytical methods typically assume spatial homogeneity, failing to capture this complexity. Balancing habitat requirements of multiple species presents another challenge, as different species communities have vastly different habitat requirements. Avoiding overemphasis on certain indicator species while neglecting other important groups during hotspot identification currently lacks unified solutions. Data incompleteness and spatiotemporal dynamics further complicate identification, as species distributions continuously shift with environmental changes, requiring dynamic adaptation capabilities.

2.2 Ecological Network Optimization

One core difficulty lies in accurate connectivity quantification. Ecological connectivity encompasses structural connectivity (physical connections between habitat patches) and functional connectivity (species migration and gene flow capacity) [4]. The latter is influenced by species biological characteristics, landscape resistance, and behavioral responses, making precise modeling challenging. Scale dependency issues similarly constrain optimization effectiveness, as local-scale requirements focus on habitat quality while regional scales require long-distance migration corridor design. The limited nature of conservation resources makes cost-benefit trade-offs critical, requiring balance between land acquisition costs,

management expenses, and expected conservation benefits.

2.3 Hotspot-based Ecological Network Construction Challenges

Hotspot-based ecological network construction presents multiple technical challenges. Connectivity design is the primary issue, as identified hotspots are typically spatially separated, requiring understanding of functional complementarity and spatial configuration relationships. Hotspot hierarchy classification is equally complex, with high-level hotspots serving hub functions while secondary hotspots act as stepping stones. Function-structure matching presents another challenge, as breeding ground hotspots should be positioned at network cores while transitional habitats serve as connecting nodes. However, coordinating hotspot ecological functions with network topological positions lacks theoretical guidance. Boundary delineation involves scientific determination of hotspot spatial extents, affecting overall network operability.

2.4 Research Framework

Ecological network design involves multiple conflicting objectives. Direct contradictions exist between conservation effectiveness and economic costs. Ecologically valuable regions typically have expensive land prices, while cheap land often has limited ecological value.

Connectivity and protected area compactness are also difficult to reconcile. Enhancing connectivity requires more linear corridors, but this disperses protected area layout and reduces management efficiency. Temporal scale conflicts similarly exist. Currently optimal solutions may not adapt to future environmental changes, requiring trade-offs between short-term benefits and long-term adaptability[5]. Different species conservation requirements frequently conflict. Finding network configurations that simultaneously satisfy all target species is extremely difficult. These conflicts make the optimization process complex.

2.5 Computational Complexity Challenges

Large-scale ecological network optimization involves numerous decision variables, typically reaching tens of thousands to hundreds of thousands. Such problems belong to the NP-hard category[6]. Traditional algorithms experience computation time that grows exponentially with problem scale. Multi-objective optimization further complicates the situation, with Pareto frontier identification requiring enormous computational resources. Real-time data updates impose higher requirements on algorithm response speeds.

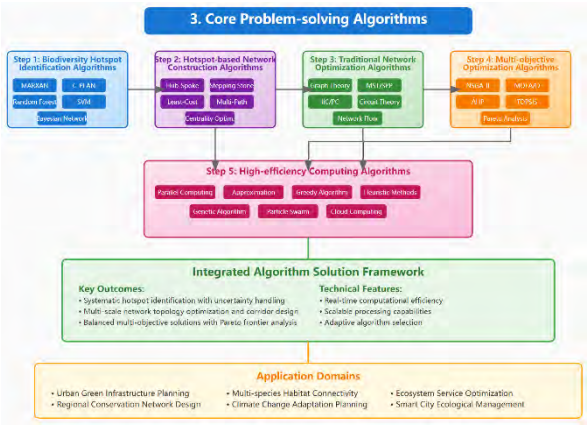


Figure 2. Core Problem Framework.

3. Methods

3.1 Biodiversity Hotspot Identification Algorithms

Systematic conservation planning algorithms provide mathematical optimization foundations for hotspot identification. The MARXAN algorithm employs simulated annealing methods to minimize conservation costs while meeting conservation target constraints. C-PLAN uses heuristic search strategies to rapidly identify conservation combinations. These algorithms address the subjectivity issues of traditional expert judgment but still face computational efficiency bottlenecks when processing large-scale data[7].

The introduction of machine learning methods has enhanced identification intelligence levels. Random forest algorithms effectively handle nonlinear relationships among high-dimensional environmental variables. Support vector machines perform excellently under small sample conditions. Deep learning models such as convolutional neural networks can automatically extract ecological feature patterns from remote sensing imagery.

Uncertainty handling algorithms quantify uncertainties in the identification process through various methods. Bayesian networks integrate multi-source heterogeneous data, Monte Carlo simulation evaluates identification result robustness. Ensemble learning methods reduce single algorithm bias risks through multi-model fusion.

3.2 Hotspot-based Ecological Network Construction Algorithms

Hotspot connectivity algorithms address network topology optimization between hotspot regions. The Hub-Spoke Model designates ecologically important hotspots as network hubs, with others

achieving integration through radial connections. This structure ensures coverage while minimizing costs but risks central node overload. The Stepping Stone Algorithm utilizes secondary hotspots as ecological stepping stones for long-distance migrating species, finding optimal paths through dynamic programming. Multi-hub Network Design constructs multi-center topologies, distributing loads and improving redundancy[8].

Inter-hotspot corridor design algorithms handle spatial optimization of connection pathways. Least-Cost Corridor employs Dijkstra algorithms to identify minimum resistance paths, considering topography, land use, and anthropogenic disturbances. The formula is as follows:

$$C_{total} = \sum_{k=1}^{K} w_k \cdot R_k(x, y)$$

Where C_{total} is total resistance cost at location (x, y), w_k is weight factor for resistance component k, $R_k(x, y)$ is resistance value of component k at location (x, y), K is number of resistance components (topography, land use, etc.).

Multiple Pathway Optimization designs redundant connections through genetic algorithms, ensuring basic connectivity when corridors are damaged. Pinch Point Analysis uses circuit theory to identify network bottlenecks.

Hotspot network hierarchical algorithms establish tiered management systems. Hierarchical Clustering performs clustering based on ecological importance, spatial location, and functional characteristics. The Core-Buffer-Corridor Model divides hotspots into protected areas, buffer zones, and corridors through multi-layer optimization. Network Centrality Optimization quantifies hotspot importance using node centrality metrics.

3.3 Traditional Ecological Network Optimization Algorithms

Graph theory algorithms provide mathematical foundations for ecological network analysis. Minimum spanning tree algorithms achieve full network connectivity with minimal connecting edges, with Kruskal and Prim algorithms demonstrating high computational efficiency in large-scale networks. Shortest path algorithms such as Floyd-Warshall and Johnson algorithms calculate optimal connection paths between any two points in networks, supporting species migration pathway planning.

Network flow algorithms evaluate network capacity and bottlenecks through maximum flow minimum cut theorems. Ford-Fulkerson and Dinic algorithms play important roles in handling capacity-constrained connectivity optimization.

Connectivity modeling algorithms specifically handle functional connectivity assessment of ecological networks. Graph connectivity indices, Integral Index of Connectivity (IIC), and Probability of Connectivity (PC) quantify overall network connectivity levels. The calculation formula for the Probability of Connectivity (PC) is:

$$PC = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} a_i \cdot a_j \cdot p_{ij}^*}{A_L^2}$$

Where p_{ij}^* is maximum probability of dispersal between patches i and j, a_i and a_j are areas of habitat patches them. A_L is total landscape area.

Circuit theory models treat landscapes as resistance networks, identifying critical connection paths and blocking points through current density analysis. Network topology optimization algorithms analyze ecological network structural characteristics using complex network theory[9], with small-world and scale-free network models providing theoretical guidance for network design.

3.4 Multi-objective Optimization Algorithms

Multi-objective conflicts in ecological network design require specialized optimization algorithms. The NSGA-II algorithm can simultaneously optimize conservation benefits, economic costs, and connectivity indicators in ecological network planning, generating Pareto frontiers through non-dominated sorting to provide decision-makers with different trade-off options. MOEA/D decomposes complex multi-objective problems in ecological networks into sub-problems, improving solution efficiency through neighborhood collaboration, particularly suitable for handling conflicts between species conservation requirements and land use costs.

Multi-criteria decision analysis methods play important roles in determining ecological network objective weights. Analytic Hierarchy Process (AHP) helps experts establish hierarchical structures of conservation objectives, quantifying relative importance among biodiversity conservation, connectivity maintenance, and cost control. TOPSIS methods rank alternative network configurations based on relative proximity to ideal conservation solutions. Multi-attribute value functions transform multiple objectives including

ecological benefits, economic costs, and management feasibility into single evaluation indicators, simplifying network optimization decision processes.

3.5 Efficient Computing Algorithms

The computational complexity of large-scale ecological network optimization problems has driven development of efficient algorithms. Ecological networks typically involve thousands of habitat patches and potential connections, which traditional algorithms struggle to handle. Parallel computing techniques significantly improve computational efficiency of large-scale ecological corridor design by decomposing network topology optimization tasks.

Approximation algorithms find wide application in ecological network optimization[10]. Greedy algorithms provide rapid approximate solutions for hotspot selection and corridor design, while local search algorithms improve conservation effectiveness by adjusting network nodes and connections. Heuristic methods such as genetic algorithms and particle swarm optimization are particularly suitable for handling complex constraint conditions in ecological networks, including species migration distance limitations and habitat area thresholds. Cloud computing platforms support real-time optimization and dynamic adjustment of ecological networks, adapting to environmental changes and conservation requirement updates.

4. Results

4.1 Integrated Hotspot Identification-Network Construction Optimization

Traditional separation of hotspot identification and network construction has obvious defects, which integrated optimization addresses through joint decision mechanisms. This framework combines MARXAN algorithm functions with graph theory optimization, employing improved simulated annealing to simultaneously adjust hotspot configurations and connection structures. Objective functions contain hotspot conservation benefits, connectivity indicators, and total costs.

Conservation investment allocation employs dynamic programming to handle resource constraints. The algorithm calculates comprehensive importance scores based on species richness, rarity, and connectivity contributions, determining investment priorities. When biodiversity data updates, the algorithm automatically re-evaluates importance and adjusts allocation.

Iterative optimization integrates multiple techniques. Initial stages use greedy algorithms for hotspot candidate generation, then genetic algorithms optimize network topology. Each iteration calculates IIC and PC indicators, triggering supplementation mechanisms when connectivity declines. Tabu search avoids repeated evaluation, improving convergence speed.

4.2 Multi-scale Integration Strategies

Multi-scale optimization requires handling differences in hotspot identification and connectivity requirements across spatial scales. The framework employs hierarchical strategies to address scale coupling problems. Global scales use systematic conservation planning to identify internationally important hotspots, employing minimum spanning tree algorithms for transboundary backbone networks. Circuit theory models calculate large-scale connectivity resistance considering migratory species requirements.

Landscape-scale optimization combines MaxEnt species distribution models with circuit theory. The algorithm predicts suitable habitat distributions, then uses least-cost path algorithms for corridor design between local hotspots. Multi-species connectivity is achieved through weighted overlay of species resistance surfaces based on conservation priorities.

Cross-scale integration employs spatial decomposition and aggregation algorithms. Large-scale connectivity requirements decompose to small-scale grids through interpolation, while local requirements transmit upward through aggregation functions. Constraint propagation techniques ensure parameter consistency across scales.

4.3 Adaptive Management Algorithms

Adaptive management integrates remote sensing monitoring and machine learning for dynamic network adjustment. Hotspot quality monitoring employs time series analysis of NDVI and land use data, with random forest algorithms identifying degradation signals. When quality indicators fall below thresholds, algorithms automatically initiate reconstruction programs.

Network expansion strategies use incremental optimization for new hotspot integration. The algorithm evaluates connectivity potential, employing Dijkstra algorithms for shortest connection paths and cost-benefit analysis for optimal schemes. For degradation situations, network flow theory identifies alternative paths and reallocates functions.

Real-time monitoring calculates graph theory indicators including average path length, clustering

coefficients, and network efficiency. When connectivity significantly declines, systems trigger local optimization. Machine learning analyzes historical data, identifying environmental patterns and predicting vulnerabilities for proactive management support.

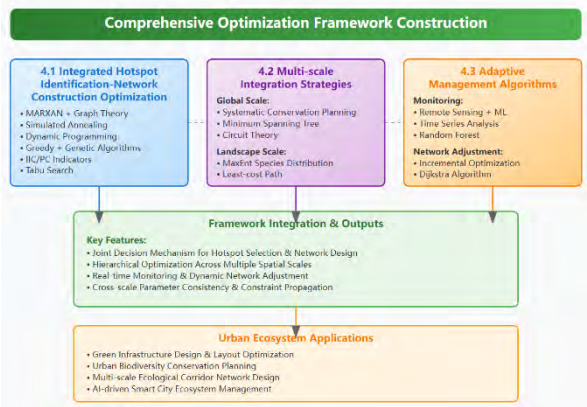


Figure 3. Comprehensive Optimization Framework Construction.

5. Conclusions

This study systematically identified core technical challenges in biodiversity hotspot design and multi-scale ecological network reconstruction, including key issues such as spatial heterogeneity processing, connectivity quantification, multi-objective conflicts, and computational complexity. Through reviewing systematic conservation planning algorithms, machine learning methods, graph theory optimization, and multi-objective algorithms, we constructed a lightweight AI-driven rewilding practice framework, achieving a technical breakthrough from isolated protection to networked protection approaches.

This framework holds significant importance for urban ecological restoration and rewilding initiatives. Cities, as complex human-natural coupled systems, require strategic rewilding of their "living systems" (green spaces, water bodies, soil networks) through optimized microhabitat network design. The proposed hierarchical optimization strategies enable small and medium-sized design teams to effectively handle multi-scale ecological requirements from building microenvironments to urban regional levels, with algorithms like MARXAN capable of guiding cost-effective layout of urban green infrastructure for rewilding projects. Particularly, the integrated application of machine learning and remote sensing monitoring provides accessible technical pathways for intelligent management of urban ecosystem restoration, offering practical tools for rewilding urban green spaces while aligning with IFLA's "Guiding cities x Biodiversity" objectives and current trends in AI-enhanced environmental management.

6. Discussion

This study still has certain limitations. The theoretical framework's applicability boundaries for different scale problems require further refinement, and specific implementation details of cross-scale integration strategies need deepening. Additionally, the representation of socioeconomic factors and public participation mechanisms in the optimization framework needs further improvement. Future optimization directions should focus on algorithm efficiency enhancement and quantification. The combination of deep learning and reinforcement learning provides new approaches for adaptive optimization of ecological networks. However, algorithm interpretability and transparency are crucial for decision support, especially when involving public policy formulation. Model validation and effectiveness evaluation require support from long-term field monitoring data.

Acknowledgments

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RESTORATION OF SAMCHEONGDONGCHEON STREAM IN HISTORIC DOWNTOWN SEOUL, SOUTH KOREA

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Keywords: Stream-related urban design, Climate adaptation, Landscape as urban-heritage, Cheonggyecheon tributary restoration, Samcheongdongcheon Stream

Abstract

The restoration of Samcheongdongcheon Stream, the first tributary of Cheonggyecheon in Seoul's historic downtown, represents a critical opportunity to reconcile cultural heritage with ecological recovery and urban resilience. Historically flowing between major palaces and government offices during the Joseon Dynasty, the stream underwent significant transformation through modern urbanization—its middle and lower reaches now exist as buried sewer systems and roads. Despite a partial restoration in 2009, existing approaches reflect the limitations of the Cheonggyecheon restoration model, particularly regarding ecological continuity and cultural integrity. This study aims to propose a resilient and multifunctional restoration direction for Samcheongdongcheon Stream, addressing historical and urban dynamics alongside climate adaptation needs.

The research encompasses a spatial analysis of the entire former watercourse and watershed, alongside content analysis derived from literature on urban waterway restoration. Nine major issues were identified—ranging from transportation, heritage conservation, and waterside spaces, to urban water management and ecosystem restoration. From these, three overarching planning frameworks were developed: (1) restoration and utilization of urban heritage, (2) waterfront planning, and (3) creation of an integrated urban water system. A diachronic analysis of the stream's evolution—geographical, socio-cultural, and functional—was undertaken through historical records, maps, and field surveys, framing Samcheongdongcheon Stream as a historic urban landscape layered with multiple transformations.

Restoration directions are proposed along three axes. First, restoration and utilization of urban heritage emphasizes differentiated strategies for upper, middle, and lower stream sections, considering road reduction feasibility and the presence of buried cultural assets. Second, waterfront planning highlights the potential for public open spaces along key hydrological nodes, proposing urban design guidelines for integrated public access and identity reinforcement. Third, creation of integrated urban water system seeks to balance water supply and stormwater management, incorporating fresh water sources, subway-station-extracted groundwater, and stored stormwater to ensure ecological continuity and flood resilience. These strategies advocate for permeable and impermeable streambed configurations to address both vertical and longitudinal water connectivity.

Ultimately, this study positions Samcheongdongcheon Stream's restoration not as a singular ecological or nostalgic project but as a strategic reimagination of urban coexistence with water. The proposed approach surpasses the Cheonggyecheon precedent by integrating geomorphic memory, contemporary urban systems, and adaptive infrastructure. It asserts the importance of critical restoration as a dynamic process that responds to evolving urban demands while preserving and regenerating the layered values of a historic watercourse.

1. Introduction: Historical City and Disappeared Waterways

The streams within Seoul's historic downtown, consisting of Cheonggyecheon and its 24 tributaries, represent a natural and cultural heritage that has been managed for various purposes since the Joseon Dynasty. Through the process of modernization, most of these streams were covered and repurposed as roads and sewer systems, until the restoration of Cheonggyecheon in 2005, which established it as a major open space in the historic city center. However, from the perspectives of historical and cultural restoration, river ecological recovery, and surrounding urban development, several limitations have become apparent \cite{Rep2014}.

Consequently, in 2012, Seoul declared a renewed restoration initiative for Cheonggyecheon and selected "Reviving Tributaries" as one of its long-term projects. Among these tributaries, Samcheongdongcheon—being the first tributary of Cheonggyecheon—retains its upstream section uncovered, preserving its source. It exhibits diverse historical and cultural values along its course and features an extensive length where road reduction is feasible, thus holding high potential for restoration \cite{Red2022}. However, research on restoration strategies remains very limited.

Furthermore, the first phase of the Samcheongdongcheon restoration project, partially implemented in the downstream section in 2009, created a pond-like water channel above the buried old stone embankments and sewer pipes, reflecting the inherent limitations of the Cheonggyecheon restoration approach. Considering that urban stream restoration can enhance the social and ecological resilience of surrounding areas \cite{Thesis2018}, the restoration method for Samcheongdongcheon should effectively address the key issues of historical and cultural restoration, ecological recovery, and urban development—thereby strengthening the city's resilience in the face of climate change.

Therefore, the aim of this study is to propose a restoration direction for the vanished waterway of Samcheongdongcheon in Seoul's historic city center—one that transcends the limitations of the Cheonggyecheon restoration model and can respond resiliently to climate change.

2. Research Subject, Methodology, and Flow

The spatial subject of analysis is the former watercourse and watershed of Samcheongdongcheon, from its source to its confluence with Cheonggyecheon. This includes the uncovered upstream section characterized by the source and Samcheong Park, as well as the middle and lower reaches, which currently exist as roads and sewer systems.

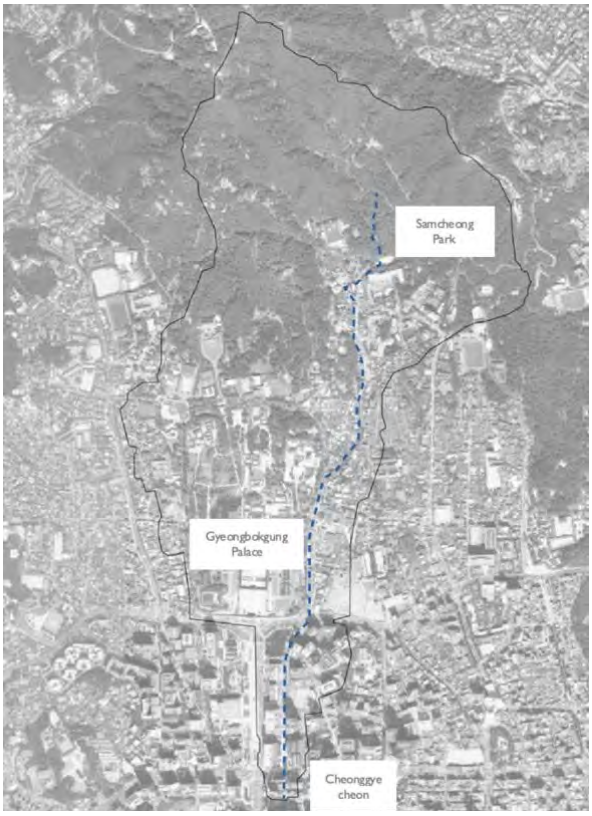


Figure 1. Spatial Scope of the Study



Figure 2. Samcheongdongcheon near Geonchunmun, 19th century
Source: Cheonggyecheon Citizens' Committee, Seoul Metropolitan Government, & The Seoul Institute. (2014). *Cheonggyecheon – Restoration of historicity and natural ecology*. Seoul: River Management Division, Seoul Metropolitan Government, p. 42.



Figure 3. Samcheong-ro near Geonchunmun, 2022

The content analysis primarily involved identifying key issues related to the restoration of former waterways within the historic city by reviewing previous studies on both urban old waterway restoration and the Cheonggyecheon restoration project. From this review, nine major issues were derived.

These nine issues include: changes in transportation, heritage restoration, landscape and cultural restoration, creation of waterside spaces, urban planning and design with waterfronts, mitigation of urban stream drying, water supply, aquatic ecosystem restoration, and drainage system adjustments. Subsequently, the meanings, concepts, and types of each issue were analyzed to derive planning elements. Based on this, a framework for the restoration of former waterways within the historic city was established, comprising three main categories: topographical restoration and heritage utilization, waterfront planning, and integrated urban water system creation.

Finally, to propose a restoration direction for Samcheongdongcheon, the study divided time periods based on points of significant formal change to the stream and examined the geographical and socio-cultural characteristics, as well as the principal meanings of the waterway during each period, in order to develop a diachronic understanding of the site. This approach reflects the recognition that former waterways like Samcheongdongcheon represent "historic urban landscapes" with tangible and intangible changes accumulated over time \cite{Rep2005}. To this end, historical maps, old photographs, and relevant literature were reviewed, and four site visits were conducted between November 2021 and October 2022. Based on this understanding, the study presents the premises, scope, and specific directions for the restoration of Samcheongdongcheon, illustrated with diagrams.

3. Framework for Restoring Former Waterways in the Historic City Based on Nine Issues

3.1. Review of the Nine Issues Selected from Previous Studies

The nine issues identified through prior research on restoring old waterways in historic cities are discussed as follows.

First, changes in transportation, including road reduction, changes in automobile traffic, and expanded pedestrian conditions, show that road reduction is inevitable for restoring former waterways. However, this can be mitigated by traffic demand management using new information and communication technologies \cite{Red2017}, and the commercialization of autonomous vehicles, which could alleviate traffic congestion \cite{Red2018}, contributing to spatial reorganization toward pedestrian-centered urban environments.

Second, the issue of preserving the original form of buried cultural heritage involves active preservation and utilization of cultural assets such as stone embankments to restore the terrain of old waterways. An integrated restoration approach—considering the current condition of cultural properties and the urban spatial context—is meaningful, as it enhances the contemporary utility of heritage \cite{Thesis2014}, \cite{Thesis2019}.

Third, in terms of landscape and cultural restoration, with a focus on the original form of historic urban landscapes, place identity, and restoration of activities, an integrated perspective that accepts landscape as a dynamic and evolving entity is necessary \cite{Thesis2020}. Since place identity is reinforced when people perceive and use these landscapes \cite{Red2011}, \cite{Red2012}, encouraging various activities related to the waterways is important.

Fourth, regarding creation of waterside spaces, this can be understood as a geographical concept defined by the union of aquatic and terrestrial areas—recognized as expansive spaces where various uses such as ports and recreation occur \cite{Thesis2009}. Given the demands for climate change adaptation, green growth, and improvement of quality of life in contemporary urban areas, waterfronts hold high value and potential. They should not be regarded merely as passive management zones, but as expansive areas including floodplains, levees, and adjacent land within approximately 0.5–1 km, requiring active utilization in urban planning \cite{Rep2010}.

Fifth, a review of urban planning issues related to waterfront spaces shows that guidelines at the planning level—such as setbacks, restrictions on the use and scale of surrounding buildings, and incentives—must ensure openness, accessibility, and activity in public spaces. These guidelines should be linked to surrounding open spaces and cultural content to establish wide-area pedestrian networks, expand commercial functions, and build integrated management systems for adjacent buildings \cite{Red2014}.

Sixth, concerning mitigation of urban stream drying within urban water circulation and management systems, the increase in impervious surfaces significantly increases surface runoff and flood frequency \cite{Rep2010}. River maintenance projects focused on flow and flood control have led to the construction of concrete embankments and channel rectification \cite{Rep2011}. Excessive collection of surface water (such as stormwater) and overexploitation of groundwater are direct causes of stream drying. Integrated water management systems that emphasize infiltration, storage, and utilization of stormwater—such as water-sensitive urban design and sponge cities—can alleviate these issues. Thus, restoration of old waterways should be integrated with such systems.

Seventh, regarding the supply of water, as seen in Cheonggyecheon, pumping water from the Han River ensures a stable and sufficient supply. However, drawbacks include high initial investment, operational costs (e.g., electricity), and partial restoration of the watercourse, which disrupts longitudinal connectivity and leads to water waste and increased flood risks due to diversion of fresh water from the source \cite{Red2012}. Therefore, adopting a supply method that utilizes fresh water from the source and stormwater as primary sources is necessary to enhance longitudinal and vertical connectivity.

Eighth, in relation to aquatic ecosystem restoration, longitudinally and vertically connected streams restore the dynamic and self-regenerating characteristics of waterways, contributing to sustainability efforts such as flood control and biodiversity enhancement \cite{Thesis2009}.

Finally, the issue of drainage system adjustments involves separating stormwater and fresh water from sewage to supply restored waterways. The location and scale of newly installed sewers should vary depending on the urban spatial context adjacent to the watercourse. However, this may partially conflict with the restoration of stone embankments or recovery of longitudinal and vertical connectivity. Therefore, such interactions need to be adjusted segment by segment.

3.2. Derivation of Planning Elements Based on Each Issue

In this process, some detailed contents are linked to multiple planning elements, and some planning elements relate to multiple detailed contents across different issues, reflecting interrelations or conflicts among them.

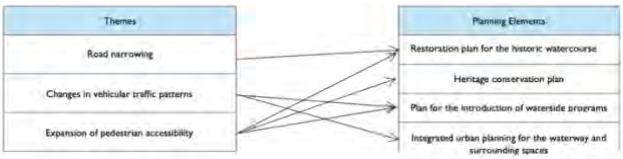


Figure 4. Planning elements reflecting the issue of changes in transportation

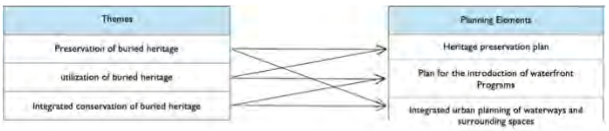


Figure 5. Planning elements reflecting the issue of heritage restoration

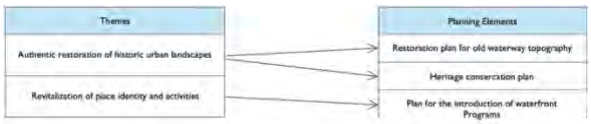


Figure 6. Planning elements reflecting the issue of landscape and cultural restoration

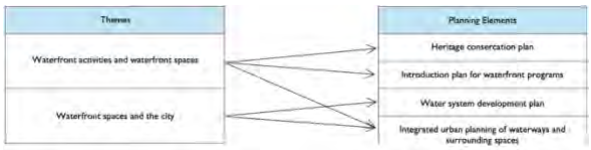


Figure 7. Planning elements reflecting the issue of creation of waterside spaces

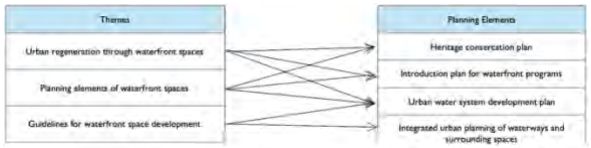


Figure 8. Planning elements reflecting the issue of urban planning and design with waterfronts



Figure 9. Planning elements reflecting the issue of mitigation of stream drying

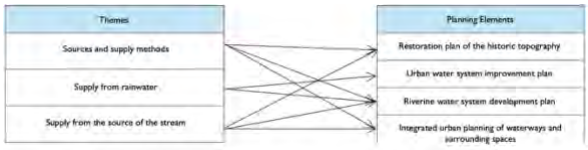


Figure 10. Planning elements reflecting the issue of water supply

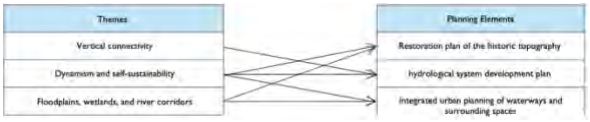


Figure 11. Planning elements reflecting the issue of aquatic ecosystem restoration

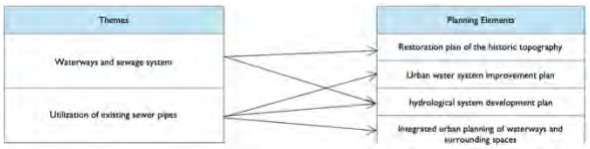


Figure 12. Planning elements reflecting the issue of drainage system adjustment

3.3. Framework for Restoring Former Waterways in the Historic City

Finally, the six planning elements were consolidated into three broader categories: restoration and utilization of urban heritage, waterfront planning, and integrated urban water system creation.

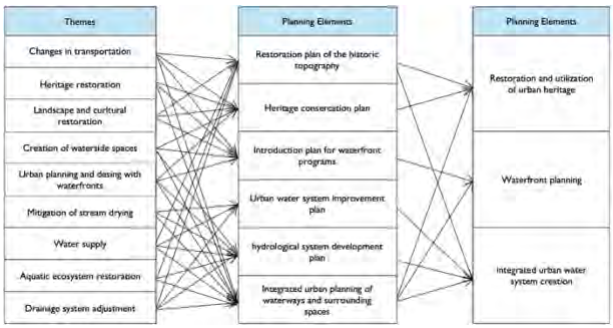


Figure 13. Framework for Restoring Former Waterways in the Historic City

4. Patterns of Change in Samcheongcheon Stream as a Historic Urban Landscape

Samcheongcheon Stream is not simply a vanished stream but rather a *palimpsest*—a landscape inscribed with traces of continuous historical, cultural, and urban transformations. To propose an adaptive and meaningful restoration, it is necessary to understand the geographical characteristics, socio-cultural features, and significance of the waterway at key phases marked by distinct formal changes: the Joseon Dynasty period, the modern era (before and after the covering of the watercourse), and the contemporary period. These are summarized in the following table:

4.1. Changes in the Geographical Characteristics

During the Joseon Dynasty, Samcheongcheon Stream flowed between Gyeongbokgung and Changdeokgung Palaces, surrounded by many major government offices. In the modern era, responding to urban demands, most sections were covered: the upper part was converted into roads, and the lower part functioned as a sewer. These characteristics have continued into the present day, with partial restoration projects employing new methods of creating open streams in certain sections.

Consequently, the current Samcheongcheon Stream consists of an uncovered upstream section and covered sections extending from the entrance of Samcheong Park to its confluence with Cheonggyecheon, functioning as roads and sewers. Most of the land parcels presumed to be part of the former watercourse are still designated as waterways, with a substantial portion of the original stone embankments believed to be buried nearby \cite{Rep2011}.

Additionally, the upstream area houses a stormwater retention basin and a mountainous park, which could be integrated into the watershed and stream water supply systems during the restoration of the watercourse.



Figure 14. Samcheongcheon near Dongsipjagak, circa 1900
Source: Cheonggyecheon Citizens' Committee, Seoul Metropolitan Government, & The Seoul Institute. (2014). *Cheonggyecheon – Restoration of historicity and natural ecology*. Seoul: River Management Division, Seoul Metropolitan Government, p. 42.

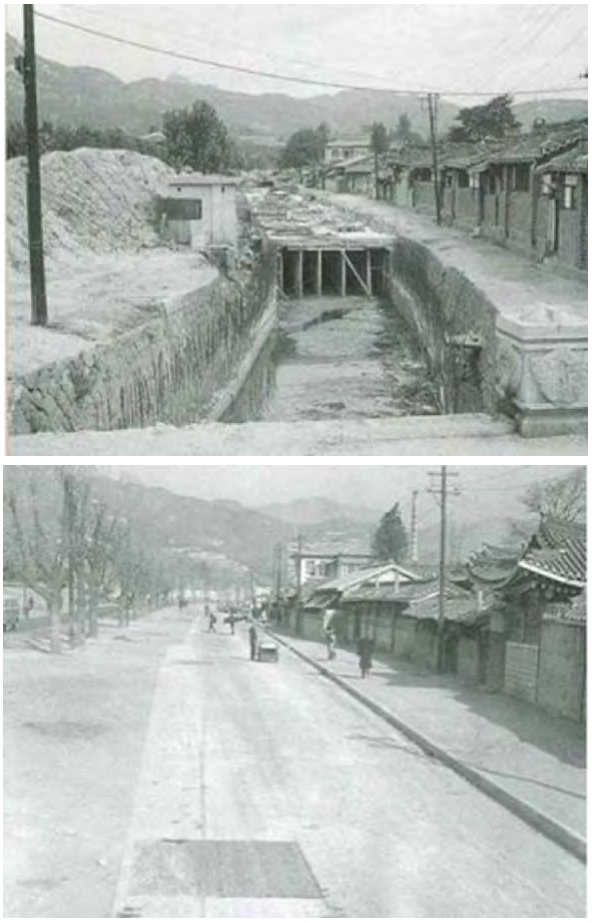


Figure 15. Samcheongcheon during (up) and after (down) covering works, 1965
Source: Geonhwa Corporation & Yushin Corporation. (2011). *Basic and detailed design service report for the creation of the Chungakcheon waterway (phases 2 and 3) in the urban area*. Seoul: Seoul Metropolitan Government, p. 91.



Figure 16. Current State
Source: Google Street View

4.2. Changes in the Socio-Cultural Characteristics

The social character of the upper and middle-lower reaches of Samcheongcheon Stream was distinctly differentiated during the Joseon Dynasty. The upstream area was inhabited by Yangban (aristocrats), who created gardens with scenic views to host literary gatherings, leaving behind artistic works such as poetry, calligraphy, and painting. In contrast, the middle and lower reaches were populated by commoners and lower classes who engaged in daily activities such as washing clothes in the stream.

During the Japanese colonial period, key Japanese facilities such as hospitals were established around Samcheongcheon Stream, leading to increased Japanese residency. People seeking modern education also migrated to the area, intensifying housing shortages. Consequently, large-scale housing projects were implemented, including the conversion of forest lands into residential plots and the subdivision of large parcels to build urban-style Hanok (traditional Korean houses).

In contemporary times, the Hanok districts have been preserved, and with the revitalization of the gallery neighborhood that formed after the U.S. military government period, the area around Samcheongcheon Stream has become recognized as a major tourist destination. Recently, the increase in lodging and commercial facilities has led to diverse consumer activities.



Figure 17. *Okhojeongdo* (Anonymous), Early 19th Century
Source: Cheonggyecheon Citizens' Committee, Seoul Metropolitan Government, & The Seoul Institute. (2014). *Cheonggyecheon – Restoration of historicity and natural ecology*. Seoul: River Management Division, Seoul Metropolitan Government, p. 36-37.



Figure 18. Area around Dongsipjagak
Source: Seoul Metropolitan Government. (2015). *Feasibility Study and Basic Plan Report for the Restoration of Upper Stream Tributaries of Cheonggyecheon*. Seoul: Seoul Metropolitan Government, p. 295.

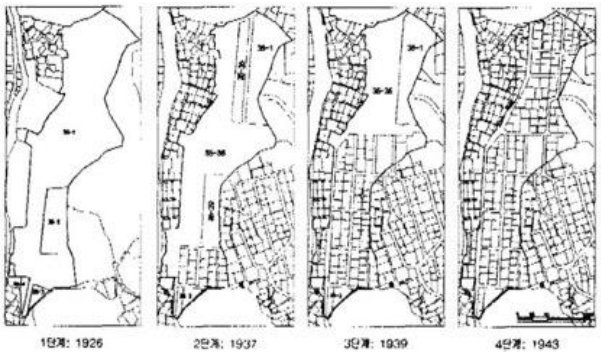


Figure 19. Parcel Changes at Samcheongdong No. 35

Source: Sung, T.-W., & Song, I.-H. (2002). The formation process and morphological characteristics of the urban hanok residential area at 35 Samcheong-dong. *Proceedings of the Architectural Institute of Korea Conference – Planning/Structure Division*, 22(2), 565–568, p. 566.



Figure 20. Historical Relics around Samcheongcheon

4.3. Changes in the Significance

Waterways in Joseon-era Hanyang, located in the northern part of present-day Seoul, were highly significant both from a geomantic perspective and as a means to mitigate the city's chronic water shortages. To address these needs, streams were broadened and ponds were created \cite{Red2021} \cite{Red2017}. Historical records, such as

the Annals of King Yeongjo and Gukyuk Juncheon Sasil, indicate that due to heavy summer rainfall, low-lying areas in Hanyang frequently experienced flooding. Accordingly, waterways like Samcheongcheon Stream were continuously managed through dredging and the construction of retaining walls.

In the modern era, as the population increased, Samcheongcheon Stream came to be viewed negatively due to the accumulation of waste and sediment beyond its capacity, leading to frequent floods. As a result, it was regarded as a candidate for covering. Moreover, the implementation of the Japanese colonial government's radial urban planning was hindered by waterways such as Samcheongcheon Stream, thereby inadvertently preserving the old urban fabric to the present day \cite{Red2021}.

Currently, following the restoration of Cheonggyecheon, discussions regarding the restoration of Samcheongcheon Stream are underway through various projects. Considering the historicity of the surrounding urban space, the presence of numerous cultural assets, public land, and plans for large-scale open spaces, the restoration of Samcheongcheon Stream holds significant potential to reinforce the identity of the historic core, regenerate the diverse values embedded in the waterway, and contribute meaningfully to climate change adaptation.



Figure 21. Samcheongcheon Confluence with Daeunam Stream
Source: Geonhwa & Yushin Corporation. (2011). *Basic and detailed design report for Jungheokcheon stream construction in the city (Phases 2 and 3)*. Seoul Metropolitan Government, p. 97.



Figure 22. Pond within Yukjo District Government Office
Source: Gil, J. H. (2017). *A study on Yeonji (Lotus Pond) within Hanseongbu* (Doctoral dissertation, Seoul National University), p. 36.



Figure 23. Intersection of 1914 Keijō City Planning and Waterways
Source: Go, A., & Yang, S. (2021). Reading the spatial structure of historic downtown Seoul through microtopography and waterways. *Seoul Urban Studies*, 22(2), 127–147, p. 144.

5. Results

5.1. Premises for the Restoration of Samcheongdongcheon

The restoration of Samcheongdongcheon must recognize that the stream itself, along with its historical transformations, constitutes a significant asset within Seoul's historic downtown. It should adopt a critical restoration perspective that acknowledges these changes and the demands of contemporary society, thereby creating new functions. This is because Samcheongdongcheon, as a natural watercourse, has been managed according to sociocultural needs and continues to function as part of the urban system, thus qualifying as an urban heritage asset. Therefore, rather than setting goals narrowly focused on visual regression to a specific period or purely ecological restoration, it is necessary to comprehensively address the diverse issues that arise differently along the stream's long course and to flexibly coordinate the relationships among these issues.

5.2. Scope of Samcheongdongcheon Restoration

The scope should be defined differently across the three aspects derived from the framework for restoring former waterways in the historic city. Firstly, the restoration and utilization of urban heritage related to Samcheongdongcheon Stream's old watercourse may be limited to the extent that road narrowing is feasible. However, from the perspective of waterfront planning, it is necessary to consider an expanded area that includes adjacent public lands, plots with public-use buildings, and private properties, with guidelines for creating publicly accessible open spaces to overcome spatial limitations. Regarding integrated urban water system creation, it is important that Samcheongdongcheon's restoration be integrated into the broader urban water system focused on stormwater management, thus expanding the restoration scope to encompass the entire watershed of Samcheongdongcheon.

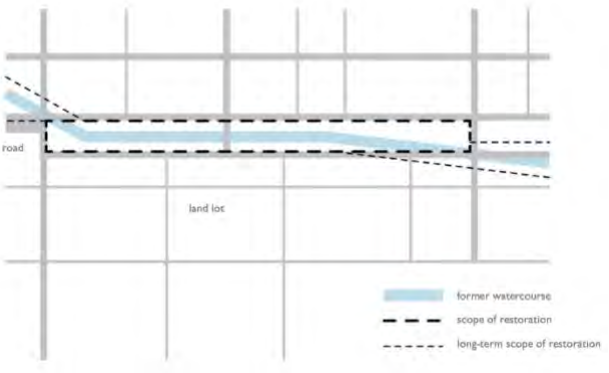


Figure 24. Scope of Restoration and Utilization of Urban Heritage

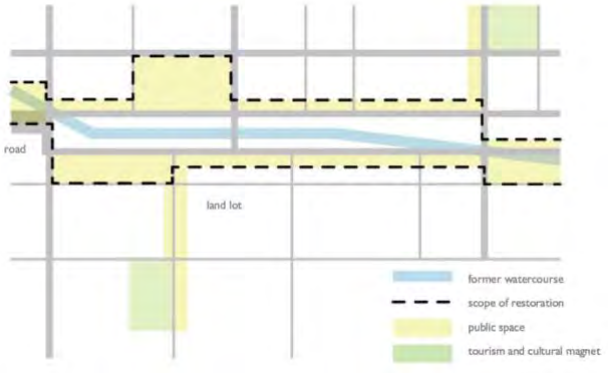


Figure 25. Scope of Waterfront Planning

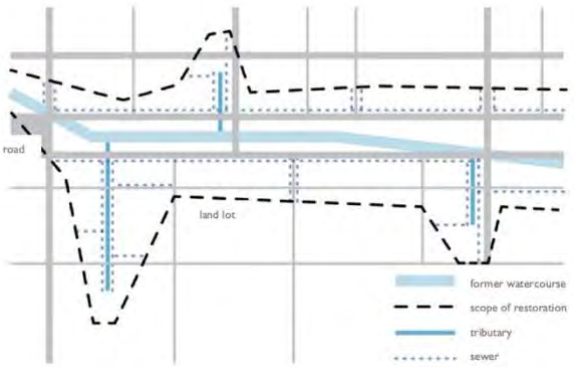


Figure 26. Scope of Integrated Urban Water System Creation

5.3. Directions for Samcheongdongcheon Restoration

5.3.1. Restoration and Utilization of Urban Heritage

It is necessary to examine the restoration and utilization of urban heritage by dividing the stream into upper, middle, and lower sections based on current road conditions.



Figure 27. Sectional division according to traffic conditions

Upper section: Currently functions as a two-lane road with narrow sidewalks, making even symbolic stream restoration difficult. Therefore, in the short term, reconfiguring the water system to focus on fresh water from the source and stormwater management, as well as repairing small-scale infrastructure, is appropriate to lay the groundwork for long-term restoration. Rain gardens and small rest areas can be partially created where sidewalks are wider, such as near the Prime Minister's residence and major intersections.

Middle section: Road lane reduction is feasible here, and cultural relics such as stone embankments, presumed to be buried cultural properties along the old cadastral lines, likely remain preserved. Thus, restoration of the watercourse concurrent with cultural heritage excavation should take precedence. Sections where restoration is difficult should be reinterpreted as waterside spaces linked with pedestrian and bicycle routes. Moreover, historically verified locations and forms of old bridges like Jangsaengjeonggyo and Sipjagakgyo should be restored to integrate with the historic street network.

Lower section: Similar to the upper section, road lane reduction is currently difficult, but the area is adjacent to public facilities such as Jongno District Office, a fire station, and the National Museum of Korean Contemporary History. Additionally, excavation work is underway at the site of the former Uijeongbu, near the area where Daeunamcheon, which once flowed from Gyeongbokgung Palace, joined Samcheongdongcheon. Therefore, the lower section requires integrative urban planning with adjacent lands to restore water culture and place identity, aiming to establish long-term restoration foundations and diversified water space uses.

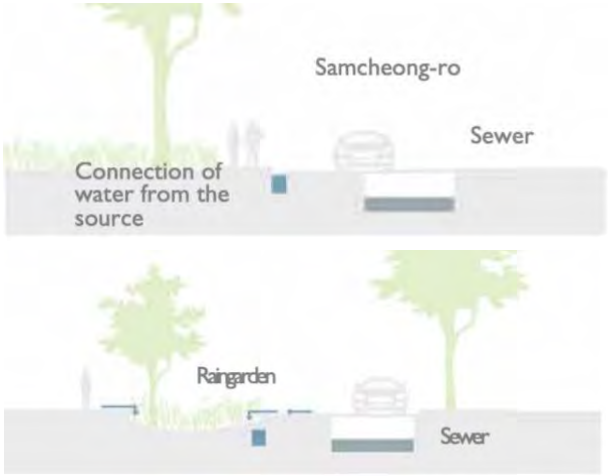


Figure 28. Example of terrain adjustment in the upper section



Figure 29. Example of terrain restoration and heritage utilization in the middle section

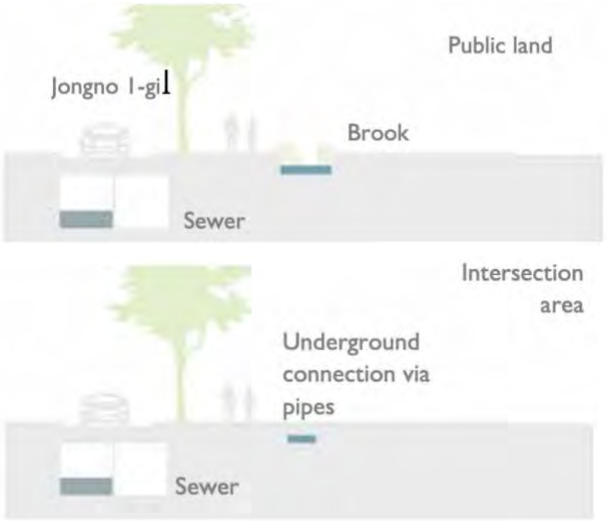


Figure 30. Example of terrain adjustment in the lower section

5.3.2. Waterfront Planning

Priority should be given to selecting focused planning areas by reviewing whether hydrological conditions that allow sustained water supply (such as confluences with tributaries and the vicinity of stormwater detention basins) can be planned together with open spaces along the stream edges. For example, the section where Samcheongdongcheon and Daeunamcheon once converged is currently covered due to private development, but excavations around the site of Uijeongbu—including the restoration of a pond—are underway on adjacent land, making the creation of a waterfront space in connection with this possible. This requires concrete urban planning guidelines, such as mandating wetland-type publicly accessible open spaces during the redevelopment of private lands. This type of open space, utilizing large-scale pilotis structures, could maintain water features while enhancing public accessibility. Additionally, at Cheonggye Square, where Samcheongdongcheon and Baegundongcheon join Cheonggyecheon, wetland-type waterfront spaces could be created to allow people to experience seasonal water level variations and diverse water landscapes.

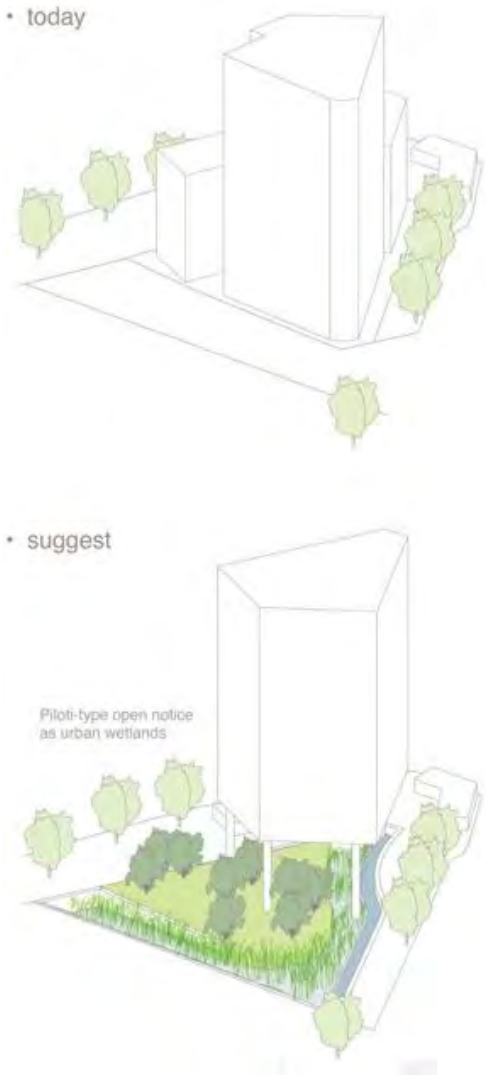


Figure 31. Example of pilotis-type publicly accessible open space



Figure 32. Example of Cheonggye Square

These spaces would support cultural place identity and expand the urban experience through organic pedestrian connections to surrounding open spaces, cultural facilities, and commercial areas.



Figure 33. Pedestrian network strengthening via waterfront

5.3.3. Integrated Urban Water System Creation

A long-term strategy should be developed to improve urban water circulation and mitigate stream drying by linking stormwater detention, infiltration, and utilization systems. This involves conserving surrounding mountainous parks and green spaces and expanding small-scale detention facilities, such as the Samcheongdong rainwater retention basin, to create new urban functions addressing climate adaptation. For instance, small-scale retention wetlands could be constructed where Samcheongdongcheon joins tributaries and the flow rapidly increases, modulating runoff speed during rainfall.



Figure 34. Example of small-scale detention facility creation

The stormwater secured through this integrated water management system would be utilized as water for Samcheongdongcheon, along with the fresh water of the source and groundwater pumped from nearby subway stations, enhancing the sustainability of the watercourse. According to a report, the daily volume of fresh water from the source of Samcheongdongcheon is 1,505 m³, and the groundwater from Gwanghwamun Subway Station is 936 m³, totaling 2,441 m³/day \cite{Rep2015}. However, this is 4,559 m³/day less than the estimated 7,000 m³/day water amount \cite{Rep2011} used during river cross-section design, which considered the restoration of old stone embankments. This deficit must be compensated by stormwater stored within the watershed. To this end, a system should be established to supply Samcheongdongcheon with fresh water from the source during normal times, groundwater from Gwanghwamun Subway Station, and stored stormwater, ensuring connectivity to Cheonggyecheon and integration with the drainage system to prevent flooding during heavy rain. Therefore, the main planned cross-section of Samcheongdongcheon can be designed with impermeable channels for longitudinal water connection that deliver a certain amount of water to Cheonggyecheon, and permeable channels for vertical water connection, possibly configured with wetlands to regulate water levels as needed.



Figure 35. Example of cross-section configuration of Samcheongdongcheon Stream

6. Conclusion and Reflection

The restoration of Samcheongdongcheon is not merely an ecological or historical reproduction project but a strategic and systematic urban design

approach that reimagines how the city coexists with water. This study proposes an adaptive, critical, and multifunctional restoration model by integrating cultural memory, layered landscapes, and modern hydraulic demands. The three frameworks for restoring historic watercourses in the downtown area—restoration and utilization of urban heritage, waterfront planning, and integrated urban water system creation—serve as a planning framework to ensure that the vanished historic watercourses sustainably function as natural and cultural elements meeting diverse contemporary needs. Moreover, the proposed restoration direction for Samcheongdongcheon is significant as it overcomes the limitations of existing waterway restoration cases like Cheonggyecheon and addresses new urban challenges such as climate adaptation.

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BRIDGING LAND AND SEA: SEASCAPE CHARACTER ASSESSMENT FOR SUSTAINABLE NATURE CONSERVATION AND MANAGEMENT IN COASTAL CITIES

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Abstract

At present, nature conservation in the coastal areas of China lags behind that in inland areas. To achieve comprehensive conservation objectives that encompass all elements across the entire region, there is an urgent need for more holistic methods of nature conservation and management in coastal areas. Taking Zhuhai City as an example, we used the method of seascape character assessment to classify seascape characters at a city scale. Seascape character units were used as management units, integrating "function-risk" evaluations to identify regional ecological issues. This method established a seascape protection framework and strategies for Zhuhai's coastal area. The study identified 9 seascape character types and 169 seascape character units within the study area. Results indicated that 31% of the units require high-priority protection actions. The results can serve as an evidence base for coastal landscape classification, conservation, and management.

1. Introduction

Establishing protected areas is a core method in nature conservation of cities, fundamentally involving delineating boundaries to implement strict management in areas with high ecological value. However, extensive areas beyond these boundaries also provide critical ecosystem services and should not be entirely neglected. In coastal cities, marine dynamics intensify ecosystem challenges, as their ecological function hinges on internal protection and significant interactions with surrounding areas (Kremen & Merenlender, 2018). Methods for establishing isolated protected areas fail to buffer external risks or ensure comprehensive protection (European Environment Agency, 2015).

Multiple organizations have advocated innovative methods to integrate coastal protected areas into broader seascape management frameworks (Coates, 2016; Convention on Biological Diversity, 2022). Incorporating protected areas into managed seascapes enhances ecological connectivity, reduces habitat fragmentation, supports species conservation, and facilitates the coordinated management of large-scale ecological processes (Carmenta et al., 2020). Consequently, the conservation of coastal cities requires holistic methodologies that extend management considerations beyond the boundaries of protected areas.

The realization of the goal of ecosystem protection lies in the identification of ecologically interconnected zones, where the critical challenge lies in delineating spatial units aligned with conservation objectives. Internationally, diverse methodologies have been developed for coastal spatial zoning (Balaguer et al., 2008; de Andrés et al., 2018). Expanding on Landscape Character Assessment (LCA) foundations, Seascape Character Assessment (SCA) has evolved as a systematic tool to characterize and assess coastal natural, cultural, and social factors.

2. Method and material

2.1 Study area

Located in Guangdong, Zhuhai is one of China's earliest Special Economic Zones and a major port city, making it a key player in the regional economy. According to statistics, the marine economy accounts for 24.5% of the city's total GDP. The city is actively developing into an "international coastal leisure and tourism destination", representing a model of intensive coastal development in the region. The coastal waters of Zhuhai are influenced by both the Pearl River estuary and ocean currents, resulting in diverse biological habitats. These include critical ecosystems such as mangroves, coral reefs, and seagrass beds, which serve as important habitats for nationally protected species like the Chinese white dolphin. Therefore, it is essential to employ scientific and systematic approaches to assess the current ecological conditions, balance conservation with development, and develop effective strategies for seascape protection and management in the Zhuhai coastal area.

2.2 Identification of seascape character units

Six categories of elements were selected by reviewing classification elements (MMO, 2015) and integrating the local characteristics and development goals of the Zhuhai coastal area. In total, 15 variables were used to characterize the seascape characteristics of Zhuhai (Table 1).

Table 1. Classification elements of seascape character at the Zhuhai city scale

Type	Elements	Coding
Landform	Underwater terrace	G1
	Underwater delta	G2
	Island	G3
Coastal type	Sandy beach	C1
	Muddy beach	C2
Water type	Estuary	W1
	Bay	W2
	Channel	W3
	Sea	W4
Water depth	Shallow waters	B1
	Deep waters	B2
Habitat	Mangrove forest	H1
	Coral reef	H2
	Naturalized island	I1
Development and utilization of islands	Tourist development conditions of the islands	I2

A 500 m × 500 m grid was used to integrate the 15 classification variables. A two-step clustering method was applied to classify the character types based on these variables, which is well-suited for handling large samples containing both categorical and continuous variables. After obtaining the clustering results, the proportions of each variable within the different cluster types were analyzed, and a systematic naming scheme was applied. According to the naming criteria: when a variable's proportion exceeds 60%, it was denoted as "X"; if it fell between 30% and 60%, it was represented as "{X}"; between 10% and 30%, it was shown as "(X)"; and variables under 10% were not indicated. Finally, the cluster type codes were linked back to the original grid cells to enable visualization of the clustering outcomes.

2.3 'Function-risk' evaluation

Seven criteria layers and ten indicator layers were established from two dimensions: function and risk (Table 2)(Bartlett et al., 2017). The criteria layers for functional evaluation were based on the Millennium Ecosystem Assessment (MA) classification framework, which divided ecosystem services into four categories: provisioning, regulating, cultural, and supporting. The MA framework is the most widely adopted classification system for ecosystem service functions. Within the provisioning dimension, fishery value was emphasized; since the spatial distribution of provisioning services in local waters primarily depended on aquaculture locations, the proportion of aquaculture area was used to represent the provisioning function. For regulating services, disaster prevention and mitigation were prioritized, represented by the density of disaster mitigation species. In the supporting dimension, biological support was considered, with biodiversity used as the indicator. For cultural services, the tourism function was the focus, represented by the density of tourist attractions.

The risk assessment criteria layers were based on the Pressure-State-Response (PSR) framework, which included three components: pressure, state, and response. The PSR model effectively captured the risks from interactions between human activities and the natural environment. Based on existing studies for indicator selection, the

"pressure" dimension included coastal engineering density and typhoon intensity to represent ecological pressures from human activities and natural hazards. The "state" dimension was characterized by indicators of eutrophication level, water quality, and sediment quality, reflecting the current condition of the marine landscape. The "response" dimension used the proportion of protected area to indicate human measures to mitigate degradation risks.

The evaluation indicators were integrated using a 500 m × 500 m grid, and both positive and negative indicators were standardized to eliminate the influence of differing units and magnitudes. A combined weighting approach integrating both subjective and objective methods—AHP-CRITIC—was employed to determine indicator weights. The final composite weights were calculated using a multiplicative synthesis method (Table 2).

The Analytic Hierarchy Process (AHP) is a subjective weighting method that relies on expert judgment to compare the relative importance of indicators, generating a judgment matrix from which weights are derived. In contrast, the CRITIC method is an objective weighting approach that calculates weights based on the contrast intensity and conflict among indicators. Indicators with greater variability or conflict carry higher weights. Combining AHP and CRITIC mitigated subjectivity from expert scoring while enhancing the data's differentiation capacity.

Finally, functional and risk indices were calculated using a weighted overlay of the standardized indicators. These grid-based index values were then linked to seascape character units by computing the average value of each indicator within each unit. Based on the natural breaks (Jenks) classification method, the results were categorized into three levels: low, medium, and high.

Table 2. The indicator framework of function-risk assessment

Objective Layer	Criterion Layer	Indicator	Effect	Weight
Function	Supply	Aquaculture area proportion	+	0.35
	regulation	Disaster prevention and mitigation, species density	+	0.25
	Support	Biodiversity	+	0.03
	Culture	Tourist attraction density	+	0.37
Risk	Stress	Coastal engineering density	+	0.02
		Typhoon intensity	-	0.06
	State	Eutrophication level	+	0.06
		Water quality	-	0.18
		Sediment quality	-	0.17
	response	Protected area proportion	-	0.51

2.4 Protection priorities

By overlaying the results of the function-risk assessment, a total of nine categories of units, such as "low function–low risk," could be identified, which served as a basis for prioritizing seascape conservation actions. Units classified as "high function–high risk," "high function–medium risk," and "medium function–high risk" were designated as high-priority areas. Units falling under "low function–high risk" and "medium function–medium risk" were assigned medium priority, while the remaining four combinations were considered low priority.

3. Results

3.1 Identification of seascape character units

Nine seascape character types were identified, and after manual refinement and optimization, 169 distinct seascape units were delineated (Figure 1). The naming of each character type reflected the composition of its elements. For example, Type 8 (naturalized island landscapes with mixed habitats) had the most complex composition. Its code, "G3-B1(B2)-H1(H2)-I1," indicated that it was a naturalized island landscape primarily located in shallow waters (G3), partially in deep waters (B2), with mangroves as the dominant habitat (H1) and coral reefs as a secondary component (H2). Type 6 (deep-water submarine terrace landscape) covers the largest area, totaling 1,265.31 km² or 34.95% of the study area. It was distributed in offshore deep-water zones and was characterized by calm water surfaces with minimal signs of human activity, such as boats, distinguishing it from Type 7 (shallow-water submarine terrace landscape). Types 2, 8, and 9 each account for less than 5% of the total area but exhibit distinctive seascape characteristics. Type 2 was mainly found north of the Qi'ao Island section of the "Zhuhai Qi'ao–Dangan Island

Provincial Nature Reserve" and near the "Zhuhai Wanshan Miaowan Coral Municipal Nature Reserve." While Type 8 represented naturalized island features, Type 9 displayed more evidence of human development, such as road networks and buildings on the islands, boats, and recreational water activities near the coast.

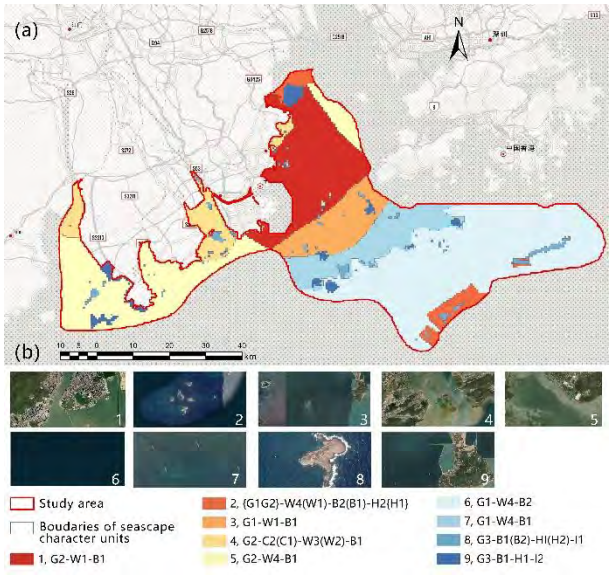


Figure 1. Seascape character types

3.2 Evaluation of 'function-risk'

The results of the functional evaluation revealed a spatial pattern in which seascape units exhibited higher functional values near the coast and offshore zones, with a decline in the intermediate areas. Units classified as low-function accounted for the largest number (86 units) (Figure 2-a), while medium-function units covered the largest total area, representing 61% of the overall extent (Figure 2-b). Type 2 (mixed habitat landscapes) demonstrated the highest overall functional performance, with 75% of its units classified as high-function (Figure 2-c).

In contrast, the risk evaluation showed a spatial trend of increasing risk levels toward the coastline. Low-risk units were primarily distributed around offshore islands. High-risk units constituted the majority, accounting for 63% of the total (107 units) (Figure 2-d), and together, medium- and high-risk units made up 95% of the total area (Figure 2-e). Type 2 (mixed habitat landscapes) and Type 6 (deep-water submarine terrace landscapes) exhibited comparatively low overall risk levels, with low-risk units constituting 75% and 66.67% of their respective totals. (Figure 2-f).

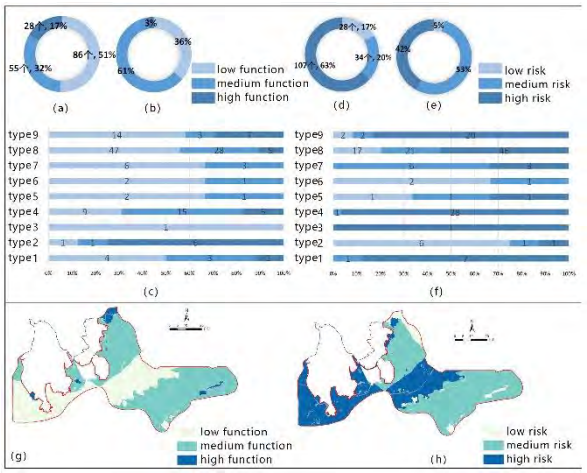


Figure 2. "Function-risk" evaluation of seascape character units

3.3 Seascape protection pattern and strategies

The results indicated that units classified as "low function–high risk" accounted for the largest proportion, reaching 34.91%, followed by "medium function–high risk" (18.34%) and "high function–high risk" (11.83%) (Figure 3-a). In terms of management priority, high-priority units comprised 31% of the total and were mainly distributed along the coastline, while low-priority units were concentrated on offshore islands with relatively intact ecological environments (Figure 3-b).

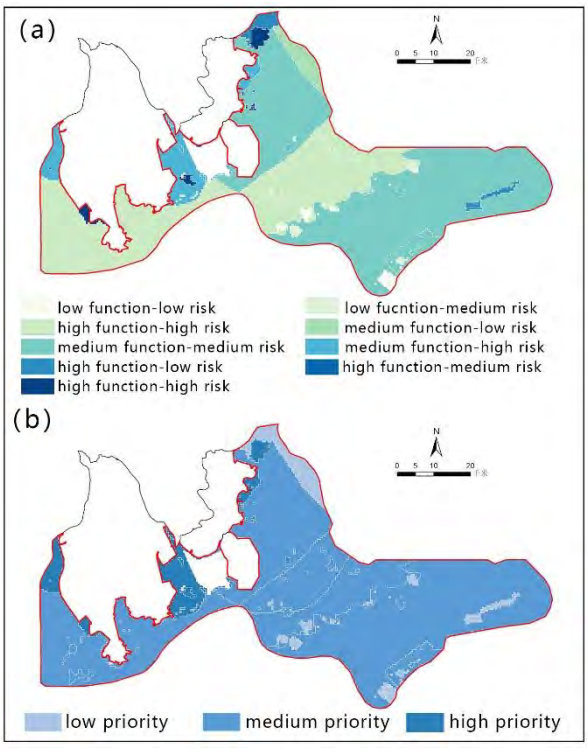


Figure 3. Seascape protect priority

4. Discussion

Our framework advances coastal management by combining SCA with quantitative function-risk evaluation. Based on an analysis of seascape component elements, the framework provides a scientific and transparent approach for understanding and identifying seascape character units through systematic technical procedures. It supplements existing landscape character classification systems, which primarily focus on terrestrial areas, with practical insights for coastal regions.

Furthermore, by incorporating the "function-risk" evaluation, the study offers a quantitative tool for identifying key conservation priority units in coastal areas, presenting a novel perspective beyond conventional qualitative-description-dominated character classification and conservation strategies. Individual indicators within the assessment system can help pinpoint major regional risk sources. At the same time, the comprehensive evaluation results facilitate the clear identification of necessary conservation and management measures for specific units, serving as a preliminary decision-support tool for developing more detailed conservation strategies.

Compared to single-dimensional ecological assessment systems, this study adopts a more holistic perspective by considering ecosystem functional value and risk identification. The results provide a more comprehensive representation of regional ecological conditions, helping to reconcile the relationship between coastal conservation and utilization while assisting in determining implementation priorities.

5. Conclusion

This study identified nine seascape character types and 169 seascape character units within the study area. Among these, 31% of the units were classified as requiring priority conservation actions. The findings can serve as an evidence-based foundation for the classification-based conservation and management of coastal landscapes. They can also complement and synergize with existing fragmented protected areas to enhance the effectiveness of coastal nature conservation.

Under the context of integrated land-sea planning, future research could further explore developing a comprehensive indicator system covering terrestrial and marine protected areas, based on the compositional analysis of landscape elements. Establishing such an overarching framework would enhance the understanding of the complex attributes of land-sea transition zones, better address their composite characteristics, and facilitate the selection of region-specific indicators tailored to the unique features of protected areas within this framework.

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TOWARDS BIODIVERSITY-FRIENDLY URBAN GRASSLANDS - IMPLEMENTATION OF ECOLOGICAL PRINCIPLES INTO LANDSCAPE DESIGN PRACTICE

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Keywords : biodiversity-friendly, urban grasslands, lawns, nature-based solutions, alternative lawns, landscape design.

Abstract

Different types of post-glacial European semi-natural grasslands (meadows and pastures) were the inspiration for creating lawn, a very special type of plant community designed exclusively for human pleasure (i.e. aesthetic appeal and recreational use). This paper discusses different periods of European lawn development, such as meadows in Medieval gardens, manicured French parterres, meadows and lawns in English landscape parks, and finally, regularly mowed lawns in public parks with low biodiversity that also demand high resource inputs for maintenance. By the second part of the 20th century, intensified climate change and biodiversity loss along with the dramatic decline of semi-natural grasslands resulted in the restoration of grasslands and the development of various alternatives for lawns based on nature-based solution (NBS) approach. These NBS types include urban meadows, high grass lawns, grass-free (tapestry lawns), and pictorial (native plant) meadows for parks, private gardens, streetscapes, and other green spaces. In many European countries (Germany, the UK, Sweden, France, Switzerland, Finland, the Netherlands, and Belgium), these new alternative solutions are visible in urban landscapes and have even become landmarks. There are also long-term monitoring surveys of urban grasslands and practical applications of alternative solutions in public parks and university campuses. Lawns arrived in colonial cities of the Southern Hemisphere with European settlers as a symbol of "civilisation". In last century, lawns have become a compulsory part of all urban green spaces. These lawns, often seen as a key element of the cultivated and irrigated gardens, contrasted with the perceived "wilderness" of the Indigenous landscape and served as a visual marker of European civilization, superiority and control. Lawns in the cities of both Northern and Southern Hemispheres provide important ecosystem services (cooling, recreation, human well-being, and even habitat provision for some native wildlife). However, they also have a whole range of disservices. The paper also reflects on the movement towards sustainable and biodiverse lawns that is supported by different principles and theories (e.g., novel ecosystems, post-glacial versus ancient geological landscapes, different responses of plants to disturbance due to long isolation and disturbance regimes), discusses existing nature-based alternatives and concludes with research implications and recommendations.

1. Background and hypothesis

Lawns are the most widely distributed type of urban grasslands, dominating urban open green spaces and covering large areas. For example, in the

United States, lawns cover 1.9%, and in Sweden, 0.6 % of the country's terrestrial lands. In Perth's Urban zone, 7% of land is covered by lawns [1]. Lawns fulfil a wide range of ecosystem services, for example, regulating the water cycle and mitigating the heat island effect in urban areas. At the same time, lawns' positive environmental outcomes are overshadowed by disbenefits (often called as ecosystem disservices) such as water consumption for irrigation and biodiversity decline (replacement of native vegetation by homogeneous, frequently cut grass communities). Further disservices included the high energy consumption for mowing, groundwater pollution by herbicides and fertilizers, and biological homogenisation. That led to searching for new alternative, more environmentally friendly "lawnscapes" in urban planning and landscape design practices [2].

Although there are numerous attempts that examine the effect of alternative lawn management methods (e.g. frequency of mowing) for biodiversity [3;4] (Fig. 1), the results of the implementation of different lawn's management techniques into landscape design practice and their success are rarely analysed. To counteract the further biological and cultural homogenisation of urban lawns and promote biodiversity, it is necessary to adopt nature-based alternatives and integrate them into the local practices. These alternative lawns and associated issues of their management are a part of the NBS concept that was introduced by the International Union for Conservation of Nature (IUCN) 20 years ago. Defined as "actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems" [5], NBS are increasingly recognized as a concept and approach to help deliver global climate and nature goals.

Our main hypothesis is that lawn biodiversity in Europe is higher than in other continents where lawns were introduced as a part of European landscape design. In contrast, lawns in other continents, often rely on introduced (or non-native species) that have been adapted for lawn use. Thus, the conceptual alternative solutions and their implementations in landscape architecture practices could be fundamentally different and require particular ecologically proven and socially justified approaches.



Figure 1. Studies on the association of maintenance and biodiversity in lawns (from Hu & Lima 2024 [4]).

2. History of urban grasslands

Europe is considered the homeland of lawns because this particular type of grassland evolved here from natural and semi-natural grasslands. To understand why the European lawns species are so successful worldwide, it is important to understand the postglacial evolution of the natural and semi-natural grasslands in Europe. During the glacier period, large parts were covered with ice. After the retreat of the glaciers (12000 BC), tundra vegetation spread in Europe before woody plants migrated in various climatic phases, and forest vegetation developed. However, elephants, bisons, and other large mammals depended on grazing. Thus, some landscapes and habitats remained open to grassland species. With the sedentary nature of humans around 5000 BC, agriculture and livestock breeding began, as well as the emergence of pastures with typical grassland species. Another important epoch began with the use of meadows in the Iron Age. However, on a large scale, meadows were introduced by the Romans around the first century AD. The land use of pastures and meadows by humans pushed the evolution and spread of grassland species.

The lawn is a pure human invention for pleasure and leisure. Several written and graphical evidence (drawings in books and paintings) confirmed the use of pastures and meadows as a source for lawns while applying a special management (more frequent cutting) and site preparation (elimination of unwanted plants-weed, bringing soils from pastures etc.). This technique allowed to create a strong sod that can withdraw human recreation such as games, sitting and walking. In Medieval times in Europe, short-cut turf seats were purposely enriched by flowering herbaceous plants, which aimed to recreate the image of the Biblical paradise. European lawns' journey (all over Europe) included periods of

highly managed parterres and green carpets of 17-18 centuries French gardens (Fig.2); more pastoral and extended managed lawns and grazed pastures in English landscape gardens and finally the period of 19th century public parks and gardens which signified the democratic freedom of walking on lawns and improvement of urban environment in the era of urbanisation. These areas, cut with scythes until then, expanded further due to the epoch-marking invention of lawn-mowers with rotating blades in1830, and also due to the further development of the first motorized lawn mower in1900. A large-scale expansion of lawns in settlements began in Europe in the middle of the 1960th due to the increasing use of motorized mowers in public and private green areas. With the exception of lawns in historical parks, urban lawn is therefore a relatively young plant community from an evolutionary point of view.

The USA, Australia and New Zealand were the "receivers" of lawns mimicking Europe and creating an obsession with short-cut green carpet in private gardens and extending open green spaces in public parks. The creation and management of lawns and pastures started at the end of the 18th and in the 19th centuries. They were based mostly on the introduction of European grass species. Lawns were created in all climatic zones and were very different from local biomes. The closest in appearance and ecological essence of European grasslands (e.g. meadows) were prairies of the Midwest and some areas in the Eastern states of the USA, which share similarities with the European postglacial history.

One of the latest "receivers" of lawns was China (the 20th -21st centuries). Lawns were never used as adecorative element in classical Chinese gardens. Lawn's conquest of public parks began in the 1980's and now lawns are also one of the most common types of Chinese green spaces [6].

For isolated and biodiverse hotspots such as Australia and New Zealand, the introduction of lawns and pastures for grazing sheep and cows was the most disastrous from an ecological point of view, because numerous unique native plant communities were cleared forever and many grass species became invasive.



Figure 2. Lawn as an important element of parterres and green carpets (tapis vert) in French formal gardens. Vaux-le-Vicomte Park. Photo: M.Ignatieva

3. Urban lawn : plant biodiversity

Most of the research on lawns' biodiversity is performed in European countries [7 ;1]. Last two decades, however, scientists from China, the USA, New Zealand and Australia started to study the lawn's flora as well. The research on wildlife biodiversity is still remained limited worldwide.

The comparison analysis of existing literature confirmed the hypothesis that European lawns are based on native plants. The most common turfgrass species are the native species *Agrostis stolonifera, A. tenuis, Festuca rubra, Lolium perenne* and *Poa pratensis*. The turf industry has grown a wide range of cultivars from these species which are used today worldwide. After the construction, lawns are colonised by other grasses and herbaceous plants from the soil seedbank. The most common are *Trifolium repens, Bellis perennis, Taraxacum officinale agg., Prunella vulgaris, Plantago lanceolata, Achillea millefolium, Cerastium holosteoide*s and *Dactylis glomerata* [8]. These species are seen as part of the lawn's biodiversity with certain benefits to wildlife.

In contrast, in other parts of the world, lawns are based on non-native plants, including the lawn (turf) grass species (the essence of the turf), and spontaneously appearing plants which are seen as unwanted, thus weeds that must be eliminated by herbicides. The main task of lawns is to create sod/turf that can withdraw trampling and other pressures caused by recreation and sport activities or to be an even decorative surface (green carpet) [1]. Similar lawn creation techniques (humus layer) and the use of particularly selected species from turf nurseries (seed mixtures or prefabricated rolls), as well as similar management, resulted in

the homogenisation of lawns. Despite different climates and geographical locations, there is a common group of spontenously appeared species that can be found almost in all lawns (e.g., *Poa annua, Taraxacum officinale agg., Plantago spp., Stellaria media, Trifolium spp.*).

4. Efforts for biodiversity-friendly urban grasslands

4.1. Europe

By the second part of the 20th century, the intensified climate change and biodiversity loss along with the dramatic decline of semi-natural grasslands resulted in the search for environmentally friendly management, restoration of grasslands, and the development of different nature-based alternatives to traditional lawns based on NBS approach.

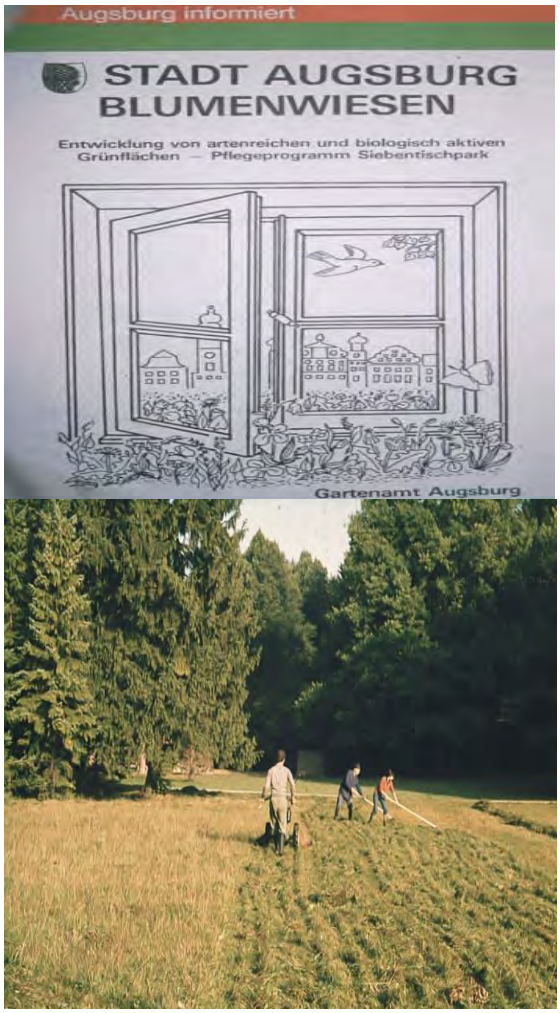


Figure 3 "Flower meadow movement": Information Flyer and management example from the City of Augsburg (Germany) June 1979. Photo: N. Müller

Since the 1970s, several European cities have started to make park maintenance more biodiversity-friendly. In some cities, the litter was left under the trees, and the lawns were mowed only twice or three times during the vegetation season, which means managed like lightly fertilized agricultural meadows. Pioneers for this "flower meadow movement" were cities such as Augsburg in Germany (Fig. 3), Brussels in the Netherlands, and Vienna in Austria [9]. A more recent trend of managing the lawns in large urban parks and gardens is the use of grazing animals like sheep, goats, and cattle (Fig. 4). This type of land use refers to those of the landscape garden period [10]. Thus, this practice is ecologically based and mimics the essence of European original grasslands that were grazed by animals.



Figure 4. Sheep grazing in the Landscape Garden "Ilm Park" Weimar (Germany) in June 2019. Photo: N. Müller

Other European countries, for example Sweden and Finland, introduced a more diverse lawn typology in their municipalities and included 'high grass lawns' that are mowed 2-5 times a year and meadow-like lawns (mown 1-2 times a year). Another nature-based alternative to traditional lawns originated in the UK is a grass-free (tapestry) lawn which is based on using durable groundcovers that can be trafficable and aesthetically attractive and provide resources for biodiversity (pollinators).

One of the most popular NBS for urban lawns in all European countries and the USA is pictorial meadows based on annual species that are aesthetically attractive for people and useful for pollinators. They are planted in a wide range of green spaces (parks, private gardens and streetscapes).

Clover lawns represent another lawn-maintenance and eco-friendly lawn alternative that utilizes clovers as a low-growing, nitrogen-fixing plant as a primary groundcover. Also, moss gardens, creeping thyme, sedges, or ornamental grasses as a groundcover provide specific NBS examples of sustainable lawns offering unique aesthetic landsape design features (e.g. colour, form and texture) and requiring minimal maintenance. In many European countries (Germany, the UK, Sweden, France, Switzerland, Finland, the Netherlands, and Belgium), these new alternative solutions are visible in urban landscapes and have even become landmarks.

4.2. United States

In the United States, the oldest initiative for alternative lawn planting is prairie gardens which are based on species from North American grasslands. The availability of inspiration from remnant vegetation (structure and floristic composition of native prairies) and the development of nurseries growing native species are a good foundation for prairie restoration and promoting native grasslands for private USA suburban gardens. Similar to Europe, the target group of wildlife in this alternative solution is insects. Prairies and European lawns have similarities in geological history (post-glaciation landscapes) and grazing by animals that supported grasslands.

4.3 Southern Hemisphere

Lawns arrived in colonial cities of the Southern Hemisphere with European settlers as a symbol of "civilisation". Since the second part of the 19th century, lawns have become a compulsory part of all urban green spaces. The dramatic loss of unique biodiversity and remnant vegetation for urbanisation and agriculture in Australia and New Zealand (both are biodiversity hotspots) resulted in the development of a strong movement to protect and restore native wetlands, forests and woodlands. Compared to lawns in Europe, the most significant disadvantages of lawns are related to the use of water and the loss of native biodiversity (plants and wildlife) because of clearing native vegetation for human recreation and sport. The passion for sport on grasses has a strong cultural connection with England.

The search for nature-based alternatives to traditional lawns here is much more complex compared to Europe. Both countries were in isolation for millions of years and developed unique endemic ecosystems with specific responses of plants to disturbance.

Last two decades, the European fashion of establishing meadows instead of lawns reached Australian and New Zealand cities. Pictorial meadows with native or exotic annuals appeared in public spaces (Fig.5).



Figure 5. Pictorial meadow in Hagley Park, Christchurch, New Zealand. Photo : M. Ignatieva

However, alternative solutions in these countries are more about re-planning, re-designing, and developing nature-based maintenance process. For example, in New Zealand restoration of tussock grassland species together with other native plants became the mainstream (e.g, groups of clumps of *Poa cita* and *Austroderia richardii* on road verges or along river banks.

In Perth, Western Australia, native low growing shrubs and some grass species from kwongan biome replaced some lawns on road verges, roundabouts, parks edges and in private gardens (Fig. 6).



Figure 6. Roundabout planting with native species. Perth, Western Australia. Photo : M. Ignatieva.

Native grassland biomes in Australia (Eastern states) and New Zealand (South Island) are very different to European grasslands - the lawn's prototype capable to form a solid trafficable sod.

5. Discussion and Recommendations

Lawn has become a global phenomenon and is used in almost all types of green spaces, from public parks and private gardens to roadsides and even (post)industrial areas. People are attached to green "carpets" according to recent social surveys [1] and see them as an important part of their everyday life. There is a growing need for research and practical implementation of alternative lawn solutions that on one hand address environmental concerns, promote biodiversity and use sustainable management practices and, on another hand, are socially acceptable (i.e. correspond with community needs). In this regard, establishing experimental plots in public spaces (e.g. parks and greenways), and involving local communities in their design and maintenance can provide valuable insights into the performance of different lawn alternatives under real-world conditions and foster a sense of community ownership to promote their adoption.

In Europe, where poor meadows are the leading type of lawn alternatives, the efforts should concentrate on searching for an appropriate construction and maintenance regime of lawns. For construction, it is important to use the existing nutrient-poor raw soil and not to carry out a soil application with nutrient-rich humus as usual, because this contradicts the goal of the low-production lean meadow. By sowing seeds typical of the region, colourful lean meadows can be developed with little maintenance, as many European examples have confirmed this practice. Time of maintenance (month) and the number of cuttings are crucial tools for manipulating plant and wildlife biodiversity and should be adopted according to regional circumstances.

In many European countries new alternative solutions were implemented in urban public spaces and have become visible in urban landscapes. However, there are still many unresolved questions that need to be addressed. For example, what group of insects and when should be attracted to public parks? How to plan biodiverse lawns and to manage them.

The practice of establishing lawns in formal British colonies shows the importance of understanding and appreciation of the local environment and the necessity to learn from native ecosystems. A shift in urban landscape planning and management is needed that not only addresses the unification of lawns themselves, but also considers the issue of social acceptance of alternative nature-based practices (e.g. meadows particularly originated from Europe).

For countries such as Australia and New Zealand, the future of alternative lawn solutions will be in research opportunities of local flora and finding suitable trafficable species similar to the lawn alternatives in Europe. However, the task here is more complicated and requires searching new landscape architecture models for public park or private garden where areas of native trees, shrubs and groundcovers would coexist with traditional lawns, which could be socially attractive and efficient to be used for recreation and sport activities.

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TOPOGRAPHY-MEDIATED ECOLOGICAL SYNERGIES: MULTI-SCALE LANDSCAPE OPTIMIZATION FOR THERMAL REGULATION AND AVIAN CONSERVATION IN MOUNTAINOUS CITIES

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Keywords: Urban Biodiversity, Thermal Regulation, Topography, Landscape Planning, Mountainous City

Abstract

Strategically planned urban landscapes can optimize the provision of multi-functional ecosystem services. However, for mountainous cities, which present distinct territorial units, the theoretical framework and regulatory thresholds in which terrain serves as a critical mediator for ecological service provision have not been fully elucidated. The interaction between the urban thermal system and the microclimate system jointly influences avian behavioral patterns and migration dynamics through collaborative feedback mechanisms. Landscape, functioning as a method capable of effectively regulating multiple ecosystem service functions, provides a significant opportunity to promote a comprehensive strategy that simultaneously addresses urban heat mitigation and bird biodiversity conservation.

This paper examines the central urban area of Chongqing, a typical mountainous city, as an example. ArcGIS 3D Analyst was used to construct a three-dimensional spatial model of urban cold-island distribution and avian migration trajectories. A dynamic response framework of "terrain-landscape-temperature-birds" was developed using a Structural Equation Model (SEM). Utilizing a multi-objective optimization algorithm, the landscape regulation threshold facilitating the synergy among these ecosystem services was derived.

Current findings indicate that topography exerts a significant influence on the coordination of ecosystem services in mountainous cities. At three spatial scales (network, corridor, and habitat), terrain distribution differentially influences the distribution of urban cold/hot islands , the establishment of potential ventilation corridors, and the formation of microclimate environments. Avian migration corridors exhibit a high correlation with naturally occurring terrain features, while micro-terrain variably affects daily behaviors and activities such as roosting and foraging. Within specific spatial thresholds , terrain in mountainous cities can simultaneously optimize thermal regulation and avian protection functions via the interaction of its vertical stratification effect and horizontal channel effect. These findings provide actionable guidelines for enhancing urban resilience and supporting ecological governance within Chongqing's landscape planning and design.

1.Introduction

Against the backdrop of accelerating global urbanization, mountainous cities face dual ecological challenges stemming from unique topographical constraints: worsening microclimates due to intensified urban heat island effects [1] and biodiversity loss caused by habitat fragmentation [2]. Traditional landscape planning often treats thermal regulation and biodiversity conservation as independent objectives, neglecting their synergistic potential. This fragmented perspective has led mountainous cities into an 'efficiency paradox' in

ecological governance-optimizing a single service may degrade others [3]. Topography serves as a fundamental controller of landscape functions in mountainous cities. Its three-dimensional morphology influences ecosystem service provision capacity by altering processes such as energy flow and species migration and dispersal [4]. How to construct a terrain-mediated multi-scale landscape optimisation framework to enhance urban ecological services has become an important scientific issue for the sustainable development of mountainous cities. The mediating effect of topography on ecosystem services manifests primarily in two ways. First, terrain directly constrains service distribution through physical limitations [6]. Second, it indirectly regulates servicse synergies by modifying ecological processes such as ventilation efficiency and seed dispersal. While earlier research primarily focused on static associations between terrain indicators (e.g., elevation and slope) and individual ecosystem services, exploring the dynamic regulatory role of topography in service synergies has emerged as a key research focus in recent years. This trend offers significant potential for synergistically optimizing critical ecosystem services like thermal environment regulation and bird diversity conservation in mountainous cities.

The view that terrain has a significant impact on urban surface temperature is widely accepted. As early as the 18th century, geographical studies suggested that, under ideal conditions, there should be a connection between terrain and the regional thermal and wind environments. Han (2014) used Chongqing's central district as an example to reveal the impact of topography on surface temperature. The study found that surface temperatures were higher on southeast and south facing slopes, while they were lower on northwest- and north-facing slopes. Although slope orientation is an important factor influencing the amount of solar radiation absorbed by the Earth's surface, its impact on surface temperature is relatively weak compared to the strong environmental effects generated by dense, large-scale urban construction activities. [7]. Liu (2022) compared Chengdu, located on China's alluvial plain, with Chongqing, located in mountainous terrain, and concluded that differences in urban form resulting from terrain, whether monocentric or polycentric, ultimately led to differences in urban heat island indices [8]. There is a positive correlation between three-dimensional terrain heterogeneity and bird species richness to a certain extent. This effect exhibits a threshold response as vegetation cover types change under different terrain conditions. The study found that three-dimensional landscape data is important for determining the flight paths of migratory birds travelling to and from urban landscapes[9]. Vertical resistance factors such as building height and terrain undulations are important factors reflecting the impact of the vertical landscape pattern of mountainous cities on bird migration [5].

In addition, there is a synergistic relationship between urban thermal environment regulation and bird conservation that holds significant research potential. On the one hand, temperature conditions can directly alter habitat suitability. The spatial distribution of certain temperature-sensitive terrestrial organisms, such as plants, mammals, birds, and amphibians, is significantly influenced by urban microclimates. On the other hand, high temperatures and drought often accompany increased carbon dioxide levels. Due to the physiological response of vegetation to rising carbon dioxide levels, temperature conditions indirectly regulate vegetation phenology [10], thereby influencing bird behaviour such as nesting, activity, and foraging. Previous studies have primarily focused on either urban heat mitigation or biodiversity conservation, exploring how urban ecosystems can better promote ecological value. However, recent studies have found that urban 'cool islands' can simultaneously serve as 'heat refuges' and 'migration stepping stones' for birds, providing opportunities for their migration or dispersal. Due to complex terrain conditions, microclimate conditions in mountainous cities are more diverse and complex, making this synergistic effect more typical in such cities. Therefore, there may be a spatial coupling between cool island networks and bird migration corridors.

Based on the preliminary review of existing research, there are three areas that require further in-depth study: (1) There is a lack of quantitative evidence regarding the threshold effects of topography on ecosystem service synergies, particularly the differentiated impacts of three-dimensional topographic features (e.g., relief, aspect) on urban heat island formation and bird migration; (2) Feedback mechanisms between landscape, climate, and biodiversity are

often based on two-dimensional planar assumptions, failing to account for the vertical heterogeneity of mountainous cities; (3) Existing optimisation models primarily target single services (e.g., improving local microclimates, enhancing habitat connectivity), lacking landscape configuration schemes that integrate multiple objectives.

Therefore, this study uses the main urban area of Chongqing as a typical case of a high-density urban area in a mountainous city, employing a framework based on terrain-mediated ecological mechanisms. It integrates three-dimensional terrain parameters, urban microclimate parameters, and bird migration trajectories into a unified analysis to interpret the mediating effect of terrain on urban ecological services. By employing a multi-level, multi-scale landscape optimisation approach based on the 'network-corridor-habitat' framework, the study integrates urban thermal regulation with bird biodiversity conservation, exploring strategies to enhance the landscape resilience of Chongqing. The research findings will provide a novel perspective for the synergistic enhancement of spatial resilience-ecological function in mountainous cities, leveraging terrain-adaptive design as a nature-based solution to achieve synergistic enhancement of ecological services.

2.Materials and methods

2.1.Study area

The central urban area of Chongqing (106 °14 'to 106 °53' E, 29 °19 'to 29 °67' N) is located in the parallel ridge and valley zone in the eastern part of the Sichuan Basin. It is also known as the "Mountain city" and the "furnace city", presenting typical characteristics of the interaction between rapid urbanization and complex terrain. From 2001 to 2020, the area of the surface urban heat island in the central urban area of Chongqing showed a fluctuating upward trend year by year. Among them, the proportion of the area of the stronger heat island increased from 0.50% in 2001 to 2.95% in 2020, with an average annual growth rate of 0.12%. The problem of urban heat island is very serious. Meanwhile, Chongqing, as a typical mountainous city, has a very typical problem of habitat fragmentation. The green Spaces existing based on landforms such as mountain ridges, cliff walls, rivers and gullies constitute the basic framework of Chongqing's urban ecological network. The central urban area of Chongqing City is developed in a clustered manner along the three parallel valleys between Jinyun Mountain, Zhongliang Mountain, Tongluo Mountain and Mingyue Mountain, with the Yangtze River and Jialing River as the main axes, forming a unique landscape pattern of two rivers, four banks and three valleys. As a key node of the East Asia-Australasia migratory bird route, 23 species of national protected raptors have been recorded in the Chongqing area. Influenced by the orientation of the Parallel Ridge Valley Mountains, the central urban area of Chongqing has become an important stopover on the north-south migration route of migratory birds. A large number of passing birds have been recorded in green patches such as Hong 'en Temple Forest Park and Zhaomu Mountain Forest Park, and there are a wide variety of small and medium-sized forest birds. It can be seen that the residual forest land scattered in the city undertakes the important functions of stepping stone patches or migration corridors, promoting the formation of the potential ecological network of the city. This ternary contradiction of "high-density construction - complex terrain - ecological sensitivity" makes it an ideal case for studying the ecological synergy effect mediated by terrain.

This article defines the research scope as: The east and west sides are respectively demarcated by the Tongluo Mountain and Zhongliang Mountain ranges. Taking the average distance between the two mountain ranges as a reference, the north-south boundary range is selected, and finally a study area range of 20km×20km is formed (106°23 '7 "E - 106°38' 4" E, 29°27 '16 "N - 29°39' 56" N, Figure 1). This area is centered around Yuzhong District, Shapingba District, Jiangbei District and Nan 'an District, which have a relatively high building density. Among them, there are numerous green patches scattered, flanked by mountains on both sides, forming an important ecological source area.



Figure 1. Study location and scope

2.2.Preprocessing of bird data

This study adopts the method of multi-source data fusion to systematically obtain information on bird activities. Firstly, through the interpretation of meteorological radar images, the migration trajectories of birds in urban areas are derived. The data of this part is derived from the CINRAD/SA Doppler weather radar (with a wavelength of 10cm). Estimate the bird density based on the Z value of the echo intensity, and the formula is as follows:

$$D = \frac{Z}{(200 \cdot \sigma)^{1.6}} \quad (1)$$

Where D represents the bird density (individuals per square kilometer), Z is the radar reflectance factor (dBZ), σ is the average radar cross-sectional area (cm2) of birds, 200 is the empirical proportional coefficient, 1.6 is the power-law correction exponent.

Furthermore, through field investigations and infrared camera observations, and by using the distance sampling method, the distribution of bird activities in key habitat areas was characterized and verified on the ground at a smaller scale. Finally, the obtained radar data was spatio-temporal matched with the ground observation points). The accuracy of the radar data was verified by synchronous thermal imaging observation, and the species composition was corrected by the sound recognition technology.

2.3.Retrieval of LST

The retrieval of surface temperature (LST) using the thermal infrared band of remote sensing image data is a commonly used method in the current research of urban heat islands. Landsat TM data has been widely applied due to its moderate resolution and short follow-up period. The Landsat 8 TM remote sensing image data during the high-temperature period in summer in Chongqing were selected. The data were preprocessed such as geometric correction, radiometric calibration and atmospheric correction in ENVI and the LST was inverted. Comparing the quantitative relationship between the standardized LST of a certain raster, the average LST and the temperature standard deviation, The surface temperature is divided into five grades (Table 1). The formula is as follows:

$$T_S = \frac{T_i - T_{min}}{T_{max} - T_{min}} \quad (2)$$

Where T_S is the standardized surface temperature, T_i is the actual surface temperature of the i-th pixel, T_{min} is the lowest value of the surface temperature in the study area, and T_{max} is the highest value of the surface temperature in the study area.

Table 1. Classification of Surface Temperature Grades.

Grades	Classification standard
high temperature zone	TS>(a+2std)
Sub high temperature zone	(a+0.5std)<TS≤(a+2std)
Normal temperature zone	(a-0.5std)<TS≤(a+0.5std)
Sub low temperature zone	(a-2std)≤TS<(a-0.5std)
Low temperature zone	TS<(a-2std)

3.Results and discussion

3.1.The spatial coupling of urban cold islands and bird activity areas

This study intends to reveal the multi-scale coupling characteristics between the distribution of the cold island network in the central urban area of Chongqing and the bird activity area through three-dimensional spatial modeling. Based on the preliminary data analysis results and combined with the study of previous literature, the fuzzy prediction of the research results was carried out:

At the macro scale, the distribution of cold islands shows a significant topographic dependence. The majority of the core areas of cold islands may be concentrated in four parallel anticline mountains such as Zhongliang Mountain and Tongluo Mountain, which are arranged in the urban area of Chongqing, as well as various green Spaces that have not been developed due to the terrain conditions within the high-density urban area (as shown in window areas 2 and 3 in Figure 2 and 3). Including mountain parks, riverside

(river) green Spaces, cliffline green Spaces, etc., the spatial pattern of these undeveloped areas may show a strong correlation with the degree of terrain undulation. In addition, as water bodies have a good cooling effect on the surrounding areas, the Yangtze River and the Jialing River flowing through the main urban area, as well as the numerous secondary rivers deep into the urban area and the surrounding areas of wetlands such as lakes scattered throughout the city, have a greater potential to form urban cold islands. It is worth noting that urban river systems may have formed continuous cold island corridor systems by enhancing local ventilation, and the cold island strength of these corridors may be significantly higher than that of other areas.

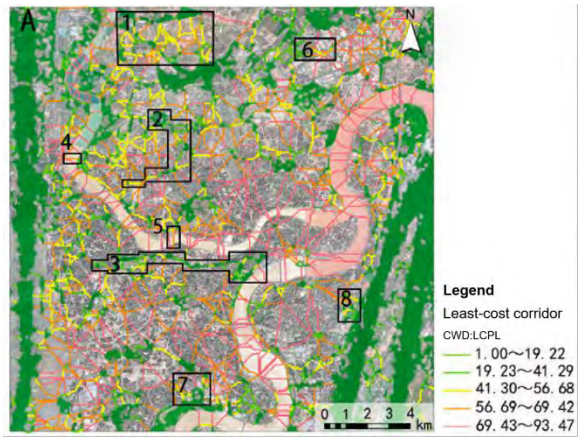


Figure 2. Potential distribution of key species (for example, *Turdus merula*)

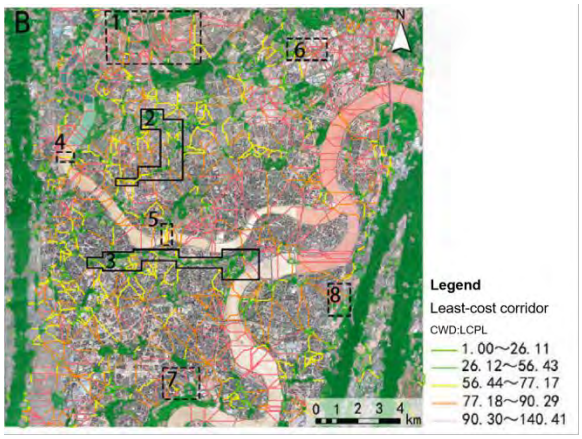


Figure 3. Potential distribution of key species (for example, *Treron sieboldii*)

3.2."Terrain-Temperature-Bird" dynamic response model

This study intends to analyze the dynamic response relationship of "terrain-temperature-birds" through structural equation models and multi-objective optimization methods. The research may draw the following conclusion: In mountainous cities, the terrain can achieve synchronous optimization of thermal regulation and bird protection functions within a specific spatial threshold through the interaction of the vertical stratification effect (VLE) and the horizontal channel effect (HCE), and this effect decays nonlinearly with the expansion of the observation scale. Among them, topographic elements affect bird diversity through two main paths: thermal regulation and habitat maintenance. The main thermal regulation path is "terrain - vegetation - cold island - birds", while the direct habitat path is "slope - connectivity - birds". It is worth noting that the regulation function of terrain may have a certain significant threshold benefit (for example, the altitude gradient shows a significant threshold effect in the range of 100-300 meters, and beyond this range, the intensity of terrain regulation shows a significant downward trend). After being tested by multiple indicators, this model analyzed and identified the key landscape configuration thresholds through the multi-objective optimization method, including vegetation coverage rate, building height and density, etc. Based on this, it provides a reference for achieving a win-win situation of increasing the area of cold islands and improving the quality of bird habitats.

3.3.The landscape planning framework mediated by terrain factors

Based on the empirical findings of this study, we propose a "terrain-mediated" landscape resilience enhancement framework. This framework provides a systematic solution for ecological governance in mountainous cities by integrating three-dimensional terrain elements, including three parts: landscape network planning, corridor optimization, and habitat restoration. In terms of landscape network planning, a multi-scale composite corridor system is constructed based on the orientation of mountain ranges, with a focus on protecting the key gradient zones that feature diverse ecological services, high service coordination, and high comprehensive service values. For high-density built-up areas, a terrain-guided green space layout strategy can be adopted, such as setting up vegetation patches in the leeward areas to achieve local cooling effects. In terms of the optimization of ecological corridors, the coupling index (CI) proposed in this study can be used as a quantitative tool for identifying the weak sections of corridors. Specific corridor optimization measures include: demarcating ecological space planning red lines for rivers,

mountains, etc., and strictly controlling possible ecological damage behaviors in the surrounding areas. If necessary, the width of ecological corridors can be appropriately expanded to ensure ventilation efficiency, etc. At the habitat restoration level, strict protection is carried out in the hotspots of bird activities, and strategies such as rational spatial planning, scientific plant configuration, appropriate distribution of bird-loving facilities, and micro-terrain design are implemented based on the living characteristics of each key species to provide a good habitat environment for birds.

4.Conclusions

This study proposes a "terrain-mediated" landscape resilience enhancement framework and spatial governance guidelines, providing new insights for the optimization of urban ecological space. Through three parts: landscape network planning, corridor optimization, and habitat restoration, it offers spatial implementation guidelines for the ecological planning and design of urban landscapes in Chongqing. The traditional two-dimensional landscape planning methods may underestimate the impact of the vertical dimension on ecological processes. The three-dimensional spatial coupling characteristics and key parameter thresholds discovered in the research can correspond to the study of ecological complexity in mountain cities and have great significance for the sustainable development of mountain cities. Future studies can further explore the response differences of mountainous cities in different climate zones, as well as the long-term stability of these thresholds under the background of climate change.

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INTEGRATION OF URBAN MEADOWS AS INDEPENDENT ELEMENTS INTO THE URBAN GREEN INFRASTRUCTURE

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Keywords: city green structure, urban meadows, municipality management challenges

Abstract

The European Union's Biodiversity Strategy for 2030 and the European Green Deal emphasize restoring biodiversity and improving ecosystem services in urban areas, notably through nature-based solutions like urban meadows. These policies require cities to prepare Urban Greening Plans incorporating green infrastructure elements such as meadows, forests, and accessible nature areas. In Latvia, national strategies – the National Development Plan 2021–2027 and spatial planning guidelines – underscore the importance of integrating urban development with biodiversity conservation. However, municipal implementation varies significantly, revealing the need for in-depth research into regulatory frameworks, practical experiences, and opportunities for scaling up urban meadow practices.

This study examines the regulatory, ecological, and social aspects of urban meadow implementation in Latvia, with a focus on six municipalities: Riga, Jelgava, Cēsis, Valmiera, Tukums, and Salaspils. Urban meadows are managed under less intensive regimes than conventional lawns, supporting pollinators, improving soil and water retention, enhancing climate resilience, and offering recreational and educational benefits. Municipalities have adopted diverse definitions and care regimes for meadows, including delayed mowing, removal of biomass, and monitoring of invasive species. Riga and Cēsis have developed the most comprehensive regulatory frameworks, specifying mowing schedules, maintenance responsibilities, and public information measures. Conversely, other municipalities pursue more flexible or experimental approaches, which can enable innovation but also create challenges in consistent implementation.

Results indicate that urban meadows, when well integrated into broader green infrastructure networks, deliver measurable ecological benefits – increased species richness of pollinators and plants – and contribute positively to residents' well-being. However, social acceptance remains a barrier, as meadows are sometimes perceived as untidy. Proactive communication, clear signage, and public engagement events – as in Valmiera's seasonal festivals or Jelgava's informational stands – have proven effective in fostering support.

Financially, while initial establishment costs can be covered by EU funds (e.g., LIFE projects), long-term maintenance costs are often lower than conventional lawns due to reduced mowing frequency. Nonetheless, the absence of clear national guidelines and limited institutional capacity can hinder sustainable scaling.

The study recommends that municipalities adopt precise regulations defining meadow categories and maintenance regimes, establish systematic monitoring, and invest in public education. Interdisciplinary teams – involving ecologists, urban planners, and civil society – are essential to ensure scientific rigor and community ownership. Finally, knowledge exchange and national guidance documents are crucial to promote widespread, resilient urban meadow integration across Latvia's cities.

Introduction

The European Union's Biodiversity Strategy for 2030 (COM 2020) sets the goal of restoring Europe's biodiversity, including nature-focused landscapes in urban environments such as urban meadows [1]. The strategy emphasizes the need for cities with at least 20,000 inhabitants to develop ambitious Urban Greening Plans by the end of 2021, incorporating water retention, accessible enclosed nature, and nature-like habitats. Simultaneously, the European Green Deal (COM 2019) encourages the enhancement of ecosystem services and climate neutrality in urban areas [2]. Additionally, the Aarhus Convention (UNECE, 1998) has stressed the importance of public participation in environmental planning, which can also apply to urban meadows [5,6].

In Latvia's regulatory framework – particularly the National Development Plan 2021–2027 and spatial planning guidelines – the need to align urban development with the preservation of natural values is emphasized, including the management of green zones and the maintenance of urban meadows. The Municipal Law grants local authorities the power to establish binding regulations that can define different maintenance regimes for various areas, allowing for lower-intensity grass care in urban meadows.

However, in practice, there is no unified approach in Latvia, highlighting the need for broader research into: (1) how national and local regulations facilitate or restrict the integration of urban meadows, (2) the experience of specific municipalities, and (3) what is necessary to expand the use of these nature-based solutions. Within this context, this study aims to analyse the implementation of urban meadows in Latvia, identify challenges, and offer proposals for their long-term integration into green infrastructure. Particular focus is placed on the experience in Jelgava – the experimental implementation of urban meadows initiated in 2024 – and its comparison with the practices of other cities.

The Role and Place of Urban Meadows in Green Infrastructure

Urban meadows are considered an effective nature-based solution that complements the network of parks, gardens, and tree stands in green infrastructure. They can improve soil quality, water retention capacity, climate resilience, support pollinators with appropriate habitats, and promote biodiversity. Urban meadows also provide social benefits – aesthetic appeal, recreational opportunities, psychological well-being, and environmental education [5].

Most traditional urban lawns are intensively mowed, which limits species diversity and diminishes ecosystem value. In contrast, urban meadows are maintained with less intensity, allowing flowers to mature and attract insects. Maintaining them requires a specific care regime – delayed mowing, removal of cut biomass, control of invasive species – which does not happen automatically. They can become connecting corridors between existing green areas and rural landscapes, fostering a mosaic of habitats within the urban environment.

Political and Regulatory Framework

EU Level

The 2019 European Green Deal also includes biodiversity-oriented objectives: increasing the presence of nature, reducing pesticide use, and promoting the integration of ecosystem services in cities [2]. Furthermore, the EU Biodiversity Strategy requires the development of Urban Greening Plans, which include forests, gardens, urban meadows, and other natural or semi-natural area elements. To achieve these goals, the strategy emphasizes the need for combined political, regulatory, and financial instruments, as well as public involvement in line with the Aarhus principles (access to information, participation, justice). This approach lays the foundation for the structural, publicly visible, and sustainable implementation of green infrastructure [1,2].

National Level

Latvia's development plans and legislation clearly express the relationship between urbanization and nature conservation. The National Development Plan 2021–2027 outlines the need to ensure the smart development of green areas, including ecologically sustainable urban maintenance. However, the lack of specific implementation

mechanisms – such as standardized maintenance regimes, designated responsible institutions, and public involvement – points to differing approaches among municipalities [4].
The Municipal Law (Article 44) allows the definition of binding regulations that can specify mowing intensity, timing, and location, including changes in lawn maintenance. However, implementation requires political will, institutional capacity, and resource availability [4]. Moreover, habitat quality – flower diversity, soil condition – must be regularly evaluated, and monitoring of invasive species ensured [5].

Experience of Latvian Municipalities

Riga

Riga actively utilizes LIFE funding (urbanLIFEcircles) for activities including "City Meadows." This project defines "scenic meadows" as areas where lawn maintenance occurs twice a season (by May 31 and again by September 15), with flowers allowed to grow up to 20 cm tall. Additional mowing near pathways is clearly defined (2 meters), and the collection of mown grass is mandatory. An educational tour has been introduced, with responsibilities shared among the municipality, LDF, and project implementers.

Cēsis

Cēsis defines "scenic meadows" as grasslands with 50% wildflower cover and no invasive species. Maintenance includes mowing from July 20 to September 15 and four intensity reduction rounds along public zones. Grass collection and the placement of information stands are mandatory.

Saldus and Aizkraukle

These municipalities use similar definitions – a "scenic meadow" means a natural-character grassland with wildflowers and no detected invasive flora, with clearly expressed ecological and aesthetic functions. In Aizkraukle, the rules specify mowing grass near paths up to 20 cm and mowing the rest only after flowering, along with mandatory grass collection.

Salaspils, Tukums, Valmiera, Sigulda

These municipalities have also implemented demonstrative urban meadow projects. For example, Valmiera organizes community events (e.g., solstice reflections in Dīvaliņa Meadow), Sigulda records meadow colorfulness, and encourages public understanding of wild landscapes. Tukums provides information about integrating natural meadows into the city, using the "Natural Meadow Product Brand" to interpret scenic meadows.

Jelgava

In 2024, Jelgava launched an experimental urban meadow project, applying late mowing and regular grass collection in designated public areas. The project involved public communication via information stands and encouraged community participation in meadow upkeep. Monitoring included soil quality, seed composition assessment, and maintenance cost tracking. It serves as a practical example of how initiatives can be adapted to local needs and contexts.

Methodology and Evaluation Criteria

The study examines six municipal urban meadow projects – Riga, Jelgava, Cēsis, Valmiera, Tukums, Salaspils – assessing land area (m²), population density, degree of urbanization, and historical context. The analysis is based on the following criteria:

- Scale and Ecological Value:
  – Meadow area proportion relative to total public green space
  – Connectivity of adjacent habitats and formation of ecological corridors
- Public Accessibility:
  – Location, accessibility, and usability for residents
- Management Regime:
  – Regulatory requirements (maintenance regime, responsible institutions, grass collection)
  – Practical implementation – delayed mowing, grass removal, invasive species control
- Public Engagement:
  – Availability of information (signs, online presence)
  – Public attitudes and participation in meadow creation and upkeep
- Funding and Sustainability:
  – Municipal budgets, EU and other fund support
  – Cost comparison with traditional lawn maintenance.

Results and Discussion

Ecological and Social Impact

Analysis shows that projects integrating urban meadows into the broader green infrastructure network (Riga, Jelgava, Cēsis) demonstrate higher biodiversity index growth (e.g., pollinators, butterflies, birds) compared to intensively mown lawns dominated by 1–2 species. Furthermore, urban meadows are perceived as relaxing elements by the public, enhancing psychological well-being and access to nature in urban areas.

Regulatory Framework and Its Impact
Comparing municipal regulations reveals that Riga and Cēsis have the most comprehensive guidelines: mowing frequency, timing, grass collection, and signage. Saldus and Aizkraukle use similar definitions but sometimes lack a clearly defined care regime. Jelgava operates outside formal regulations but has an experimental implementation plan.
Currently, Riga and Cēsis are the most advanced in regulatory terms, while others – Tukums, Valmiera, Salaspils – adopt a more flexible approach that allows both experimentation and the risk of unforeseen maintenance issues.
Public Engagement and Communication
Projects employing proactive communication – signs, media presence, engagement events (e.g., Valmiera's solstice event), surveys – achieve better public understanding and support. In contrast, where projects lack clear visual expression or names, the public has shown resistance – perceiving meadows as untidy or neglected areas, which undermines project perception and upkeep.

Financial Perspectives

Riga and Jelgava's meadow projects are supported by LIFE and other EU funds, covering costs for initial sowing, materials, monitoring, and maintenance. Local projects like those in Cēsis and Aizkraukle are funded by municipal budgets. Overall, urban meadows can be more cost-effective in the long term due to less frequent mowing, while also providing ecological and social value.

Material and Regulatory Barriers

The main barrier is concern over unusual aesthetics – untidy, "unkempt" areas. Addressing this requires informational tools, transitional maintenance phases, visible zone boundaries, and community involvement.
Regulatory barriers also stem from legal ambiguity – some places lack defined mowing schedules, responsibilities, or funding, blocking implementation through administrative issues.
Interdisciplinary Approach and Cooperation
The most successful projects (Riga, Jelgava) are implemented by multidisciplinary teams involving landscape architects, entomologists, urban planners, local authorities, and civil society. Such teams ensure both scientific grounding (species selection, monitoring) and practical execution (care regimes) alongside effective communication (exhibits, events, signage).
Without this model of cooperation, projects risk remaining well-meaning ideas that fail in execution.

Conclusions and Recommendations

Precision of Regulatory Framework
– Municipalities should adopt clear binding regulations that define categories of urban meadows (e.g., landscape meadow, city meadow) and their maintenance regimes. For example, the models used in Riga and Cēsis provide a good balance.
– Regulations should also address grass collection, control of invasive species, and the placement of informational signage.
Clear Planning and Monitoring
– Before establishing meadows, an assessment should be carried out regarding soil conditions, seed composition, accessibility, and habitat connectivity.
– Areas should be divided based on public access and recreational potential.
– Regular monitoring is necessary: species diversity (insects, birds), soil analysis, and public perception surveys.
Public Education and Communication
– Visually recognizable elements of the "urban meadow" should be created – illustrations, signs, interactive tools.
– Events for residents should be organized – lectures, seeding days, and flower festivals in October.
– Schools, local businesses, and NGOs should be engaged to help embed urban meadows into community identity.
Collaboration and Multidisciplinarity
– It is recommended to form working groups that include municipal environmental/regulatory departments, landscape architects, biology/ecology experts, and civil society representatives.
– Collaboration ensures both scientific justification (species selection) and practical implementation through mentorship and resource-sharing.
Securing Funding
– EU funding opportunities (LIFE, EAFRD) should be used for demonstration projects and monitoring.
– After the initial phase, maintenance costs should be integrated into municipal budgets, taking into account the financial differences in mowing intensities.
Sustainability and Scaling Up
– After the demonstration phase, the potential for expansion to other urban areas should be assessed.
– Inter-municipal exchange platforms should be organized – seminars, study visits.

– National-level guidance documents should be developed – "Good Practice Handbook for Planning and Maintaining Urban Meadows".

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A BIODIVERSITY POSITIVE DESIGN FRAMEWORK FOR AUSTRALIAN URBAN ECOSYSTEMS: A PROCESS FOR REGENERATIVE LANDSCAPES.

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Abstract
Australian cities face a biodiversity crisis, with urban areas hosting 380 threatened species including 39 found exclusively within city boundaries. This paper presents a comprehensive Biodiversity Positive Design (BPD) framework developed specifically for Australian contexts. The framework has been co-designed over a two-year period by the Australian Institute of Landscape Architects. It takes as its starting point the Royal Institute of British Architects Plan of Works methodology to align it with development processes and reflecting on this, proposes a seven-stage process that prioritises biodiversity across each step of the urban development progression. The guide provides systematic support for prioritising and implementing biodiversity positive interventions across the various urban ecosystem types that landscape architects work within, from pristine remnants to completely transformed environments, and from individual sites to regional networks. The framework emphasises endemic species prioritisation, climate resilient design, Aboriginal Connecting to Country frameworks, and community stewardship over time. Results of this research indicate that Australian cities can transition from biodiversity threats to conservation sanctuaries through creative and systematic application of biodiversity positive design principles.

Keywords: biodiversity positive design, urban ecology, biodiversity implementation framework, Australian cities, ecosystem restoration

1. Introduction

Australia's urban environments have an important relationship with biodiversity. While cities occupy less than three percent of the continent's landmass, they host an astonishing concentration of threatened species, with many endemic species found exclusively within urban boundaries. Urban ecosystems support disproportionately high biodiversity values (1), containing over 40% of Australia's nationally listed threatened ecological communities (2) and more than half of the nation's threatened species (3) underscoring their critical conservation significance at both national and international scales. This concentration challenges traditional conservation paradigms and demands innovative approaches that recognise cities as critical sites for biodiversity conservation.

The Australian Institute of Landscape Architects' 2019 Climate and Biodiversity Loss Emergency Declaration acknowledges the profession's responsibility to lead transformative change in urban design practice (4). In light of this declaration the institute then drafted a position statement (5) and tasked a working group for implementing the work therein outlined and for devising a framework

to guide landscape architects and allied professionals in Australia.

Within Australia frameworks often fail to address the unique characteristics of Australian urban ecosystems, including extreme climatic variability, fire adaptation requirements, and deep Indigenous cultural connections to landscape (6). Existing restoration initiatives also are conventionally focused on reference environments (7) and not adapted to addressing the evolving novel ecological environments in which landscape architects develop most of their projects. These range from high density urban environments to housing landscapes, to industrial zones, peri-urban agricultural landscapes and transport infrastructure. The question that the Australian Institute of Landscape Architects asked in relation to these different landscapes is can future development deliver net positive outcomes when it comes to biodiversity? The forthcoming guide, currently in draft format and under review, grapples with this challenge. While not purporting to deliver "solutionism" or "answers" it nevertheless sets out a way of thinking and acting that empowers landscape architects working at all scales and in an extraordinary range of project types to consider this question and to practically address it within the processes and professional systems of their everyday work.

Biodiversity Positive Design (BPD) represents a paradigmatic shift from conventional environmental mitigation toward active ecological enhancement. Unlike traditional "do no harm" approaches, BPD seeks net gains in biodiversity value, transforming urban development from a conservation threat into a biodiversity positive opportunity (8,9). This position while seeming radical and at odds with current practice and wisdom is at once pragmatic - we are already living in an Anthropogenic reality and with every project designing new ecosystems - rather than these novel environments being pale copies of an original "nature" they need to integrate the best of current science, with brilliant design creativity and the living and ancient wisdom of our indigenous peoples. This paper presents the comprehensive AILA BPD framework specifically adapted for Australian contexts, to address the complexity of urban ecological conditions and institutional constraints.

The urgency of this approach is underscored by the Southwest Australia Biodiversity Hotspot, which encompasses Perth metropolitan area and contains over 5,570 vascular plant species with more than half endemic to the region. Similarly, Sydney's Cumberland Plain Woodland has been reduced to less than 1% of its original extent, with remaining fragments critical for threatened species survival. Around the nation over 80 ecosystems are threatened with some on the verge of collapse (10). Action is required before it is too late for these extraordinary living systems which we rely upon for our survival.

2. Theoretical Framework Development

2.1 NSB, SERA Standards, BSUB, BFD, MIGI and now BPD: a family of approaches

Biodiversity Positive Design complements current existing approaches to urban biodiversity enhancement. Over the past few decades, the theory and practice of integrating and restoring biodiversity within our urban environments has evolved through various key conceptual frameworks. For instance Nature-Based Solutions (NbS) emerged as a unifying framework emphasising cost-effective interventions that deliver environmental, social, and economic co-benefits (11). However, Seddon et al argue that NbS frameworks can overly prioritise human-centred challenges over ecological function, potentially leading to "solution shopping" where interventions are selected for their service delivery rather than biodiversity value. Likewise, the more recent Biodiversity Sensitive Urban Design (BSUD), (12,13) provides an explicitly ecological approach prioritising biodiversity conservation as a primary objective. BSUD's "net benefit" concept requires urban development to contribute positively to conservation rather than simply minimising harm. Similar to Water Sensitive Design, BSUD, adopts a technical approach and despite its major contribution is at risk of being integrated as an add on rather than integral to the design and shaping of cities. The SERA standards – are a significant interdisciplinary approach to ecosystem restoration – prioritising functional reference ecosystems. The approach developed with leadership of ecologists – perhaps more than any other approach - takes the side of nature and more than human considerations. Finally, and fundamentally the Connecting with Country approach acknowledges the deep care and relationships that indigenous peoples of Australia and Torres Strait Islands have with the planet and the living interconnectedness of all things. Seeking to learn from all these approaches Biodiversity Positive Design prioritises both design and process in relation to biodiversity and seeks to align current urban development processes using ecological principles to support enhanced biodiversity. In this way it is similar to Watkin's (14) "Microbiome-Inspired Green Infrastructure" which also takes as

its starting point the Royal Institute of British Architects "Plan of Works" (15) making it ready to implement as part of the urban development process now. This pragmatic approach acknowledges the need for action now. It also recognizes that any approach will require development and learning and continual improvement. We therefore suggest that Biodiversity Positive Design is a "framework for a process" – the structure and content of which can continue to evolve and learn from case study projects as it is tested and rolled out by AILA's professional membership around Australia and elsewhere. In some ways it is like the landscapes that are its target - where initial designs and intents are enriched through living organisms and the relationships between them.

2.2 Australian Context Considerations

Australia's unique ecological characteristics demand specialised approaches. The continent's evolutionary isolation has produced exceptional endemism levels across multiple taxonomic groups (16). Urban environments in biodiversity hotspots like Southwest Australia and Sydney Basin require conservation strategies that address both species-specific requirements and ecosystem-scale processes. Within Australia Traditional Ecological Knowledge (TEK) integration represents both an ethical imperative and practical necessity to conserve this endemism. Indigenous Australians possess sophisticated 65,000 year understanding of ecological processes refined over the long term (17,18)). The integration of TEK with contemporary science requires genuine collaboration and shared decision-making authority that respects Indigenous knowledge systems. The loss of TEK through genocide and colonialism has made climate threats such as wildfire more dangerous. Fire management (19) presents particular challenges in Australian urban environments that can be addressed through TEK. Many native ecosystems are adapted to periodic fire, but urban safety constraints limit current burning practices. Cultural burning techniques developed by Indigenous Australians offer insights for urban fire management that can enhance biodiversity while improving safety standards.

2.3 Framework Development Rationale

Existing biodiversity management frameworks exhibit limitations when applied to Australian urban contexts both in terms of their narrow specialisation and also integration and respect of Traditional Ecological Knowledge owned by Aboriginal people. The need for a flexible yet systematic approach led to development of the BPD framework, which adapts established professional methodologies from SERA and BSUD and NBS while placing both design and biodiversity regeneration as the primary method and objective. The multi-dimensional Biodiversity Positive Design approach enables practitioners to follow appropriate strategies based on local conditions, available resources, and institutional capacity. Here we present the process and address different implementation challenges.

3. Biodiversity Positive Design Process

3.1 Seven-Step Framework

The AILA BPD Framework aligns seven systematic biodiversity focused stages with industry development processes. This systematic approach therefore dovetails with built environment and landscape architecture professional workflows while simultaneously encouraging reflection and challenging practitioners in the built environment to integrate and consider biodiversity at every step of project workflows. The seven steps are set out below:

Stage 1: Community & Stakeholder Engagement

Community and stakeholder engagement forms the foundation that underpins every stage of the BPD process, establishing relationships and building the shared understanding necessary for achieving biodiversity positive outcomes. This stage extends beyond conventional human stakeholders to recognise non-human communities as essential participants whose needs and relationships require understanding and respect.

Stage 2: Ecological Site Analysis

Ecological site analysis provides comprehensive understanding of ecological patterns, processes, and potential across multiple spatial and temporal scales. The analysis integrates scientific investigation with Traditional Ecological Knowledge and community observations to create a rich, multidimensional understanding of place.

Stage 3: Biodiversity, Climate & Country Goals

Goal setting translates ecological understanding into clear, measurable objectives that guide all subsequent design decisions through collaborative processes. Goals should respond to site-specific conditions while contributing to broader landscape-scale outcomes that balance biodiversity conservation with climate action and Country care.

Stage 4: Measurement & Targets
This stage enables evidence-based design and adaptive management of biodiversity by establishing an understanding of ecological baseline conditions and selecting appropriate ecological targets and ecosystem indicators. The measurement framework balances scientific rigour with practical implementation, ensuring that monitoring can be sustained throughout the project lifecycle and beyond.

Stage 5: Design Strategies
Design strategies translate goals and targets into specific environmental interventions that create conditions for biodiversity to thrive across all design phases from concept through detailed documentation. Successful strategies integrate multiple design disciplines and scales of intervention to create synergistic outcomes that inform every decision from spatial arrangement to material selection. Materials and forms area considered for their ability to support life onsite and to limit resource extraction beyond it.

Stage 6: Ongoing Management
Ongoing management transforms design intent into living reality through careful implementation, establishment, and long-term stewardship that recognises biodiversity outcomes unfold over time. Success depends on clear documentation, adequate resourcing, and genuine commitment to biodiversity-positive maintenance practices through adaptive management approaches.

Stage 7: Handover & Use
Handover and use represent the transition from active construction to management of the living landscape where biodiversity outcomes manifest. This stage establishes monitoring systems that track long-term success and creates the foundation for adaptive management and continuous learning.

5. Discussion

5.1 Framework Effectiveness

Australian urban contexts demonstrate the framework's potential for delivering measurable biodiversity gains. Technical challenges persist across multiple dimensions. Species selection for urban environments requires sophisticated understanding of both ecological requirements and urban tolerance. Many native species adapted to natural environments struggle in urban conditions, while urban-tolerant species may not provide optimal conservation value. This necessitates ongoing research into urban-adapted ecotypes and cultivation techniques.

Economic barriers can include higher establishment and ongoing adaptive management costs compared to conventional less innovative landscape construction projects. Native plant materials may be expensive and difficult to source, while establishment requirements can be intensive. However, long-term benefits include ecosystem service delivery and offer compelling economic justification. Equally regulatory complexity across multiple jurisdictions creates approval challenges and may not always be supportive of biodiversity positive outcomes. Environmental legislation designed for large-scale developments may not provide appropriate frameworks for smaller biodiversity enhancement projects. Supportive approval processes for BPD projects represent important policy priorities.

Landscape-scale conservation requires coordination across multiple projects and jurisdictions. Individual projects, regardless of local success, cannot achieve meaningful conservation impact without broader integration. Regional biodiversity strategies and coordination mechanisms represent critical policy needs. Policy integration provides the most immediate scaling opportunity. Incorporation of biodiversity targets into planning schemes could significantly increase BPD uptake. Green infrastructure planning offers another avenue for integration, combining biodiversity objectives with infrastructure service delivery.

5.2 Professional Transformation Requirements

BPD implementation requires fundamental changes in landscape architectural education and practice. Businesses and education programs emphasising aesthetics and traditional construction and conservation approaches will need to evolve to encompass and work with ecological science and conservation biology and as core competencies. Ongoing professional development and interdisciplinary collaboration become essential for an effective and progressive multi species cities ethos and practice.

Community engagement represents both a challenge and opportunity. Many urban residents may prefer conventional landscaping approaches and view native vegetation as inappropriate for urban settings. However, successful projects demonstrate that appropriate design and community education can build strong support for biodiversity conservation.

6. Conclusion

The Biodiversity Positive Design framework with implementation matrices provides systematic guidance for transforming Australian cities from biodiversity threats into conservation opportunities. The eight-step process ensures attention to ecological science while maintaining practical applicability across diverse project contexts. The proposed complementary matrices address the complexity of urban ecological conditions, resource constraints, and institutional capacity variations.

Key framework contributions include: (1) integration of Traditional Ecological Knowledge throughout implementation stages; (2) flexible guidance accommodating diverse project scales and contexts; (3) explicit prioritisation of biodiversity conservation as a central objective; and (4) comprehensive consideration of Australian ecological characteristics and urban conditions.

Implementation success requires coordinated action across multiple dimensions.

Policy frameworks need adaptation to support rather than impede biodiversity enhancement. Community engagement strategies will require support to build understanding and capacity for native ecosystem conservation.

The urgency of the biodiversity crisis requires immediate action. Australian cities host exceptional concentrations of threatened species and represent both critical conservation challenges and by association conservation opportunities. The BPD framework provides landscape architects with tools necessary for professional leadership in urban biodiversity conservation to help guide professionals but also to help them communicate the value of biodiversity in projects. Future research priorities include long-term monitoring of BPD project outcomes, climate change adaptation strategy development, and technology integration opportunities. The framework's adaptive structure enables incorporation of new knowledge and techniques as they become available.

Australian cities can become global exemplars of urban biodiversity positive outcomes - but currently they have amongst the worst outcomes globally. It will take concerted effort to turn this around and bend the curve of biodiversity decline. Achieving this transformation requires professional commitment extending beyond traditional boundaries toward radical ecological stewardship and activism. The BPD framework provides a roadmap for this essential transformation, enabling landscape architects to lead creation of urban environments that celebrate and protect Australia's unique biodiversity heritage. The biodiversity crisis demands transformative action. Through systematic application of biodiversity positive design principles, Australian designers and cities can demonstrate that urban development and biodiversity conservation are not necessarily in opposition but can be compatible and mutually reinforcing, creating models for global urban biodiversity enhancement.

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SAISONS DU RHÔNE: TOWARDS A LIVING OBSERVATORY OF THE RIVER'S CHANGING LANDSCAPES

TOPIC: Guiding cities through what is alive: cities as ecosystems (example)

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Keywords: Rhône, Landscape mediation, Observatory, Socio-ecological perspectives, Livability

Abstract

In the face of accelerating ecological crises, urban expansion, and social fragmentation, landscape is increasingly seen as an active medium for facilitating and enacting transitions toward more sustainable and equitable futures. The action-research project *Les Saisons du Rhône*, led by the interdisciplinary group Paysage Projet Vivant (InTNP, HEPIA) in collaboration with Geneva's cantonal authorities, sets the foundation for a Rhône Landscape Observatory, scheduled to launch in 2026. This initiative aims to co-construct a shared vision for the Rhône river in Geneva's basin, aligning with the broader goals of socio-ecological transition.

The Geneva Rhône basin is a layered socio-ecological landscape shaped by hydroelectric infrastructure, industrial development, and agricultural activity, while simultaneously functioning as a vital ecological corridor and refuge within the urban fabric. Far from being mere infrastructure, these river landscapes are lived and affective spaces, inhabited, and interpreted in multiple ways by diverse human and more-than-human actors. As a common ground, the Rhône is the site of competing demands (ecological restoration versus urban development, public access versus habitat conservation,..) ; highlighting the need for frameworks that transcend the simple balancing of interests to reimagine modes of coexistence under Anthropocene conditions.

This contribution examines how the project mobilizes landscape as a mediating framework that brings together institutional actors, civil society, and local communities along the Rhône. The Observatory conceptualizes landscape as a *living milieu*, a dynamic assemblage of ecological processes, human and more-than-human agencies, and socio-political imaginaries. Understood as an entangled *milieu*, landscape becomes a federating concept that accommodates divergent perspectives, values, and knowledge systems (scientific, experiential, and civic) to co-create new territorial imaginaries. In this way, landscape serves both as subject and medium: an epistemic and political tool for collective inquiry, negotiation, and the re-articulation of common futures. Through this relational, trans-disciplinary approach, the Observatory fosters participatory arenas that bridge policy, administrative, and disciplinary boundaries in support of inclusive, place-based decision-making.

Introduction

In an era of accelerating ecological change, growing urban pressures, and social fragmentation, landscape emerges as a critical medium through which we can imagine, negotiate, and enact transitions toward more sustainable and equitable futures [1]. The Rhône river in the Geneva basin, with its layered histories, contested uses, and ecological significance, provides a case for

rethinking the landscape not as object of design or management, but as a living milieu or assemblage that binds human and more-than-human actors, ecological systems, and socio-political imaginaries.

Since 2023, the action-research *Les Saisons du Rhône* lead by the pluridisciplinary research team Paysage Projet Vivant (InTNP, HEPIA) in collaboration with Geneva's cantonal offices (Office Cantonal de l'Agriculture et de la Nature; Office Cantonal de l'Eau), has been laying the groundwork for a Landscape Observatory of the Rhône expected to launch in early 2026. The geographical scope of the Observatory extends from the outflow of Lake Geneva to Fort l'Ecluse in France. However, the Geneva basin is understood not as an isolated unit, but as one link in a larger chain that connects the alpine headwaters to the Mediterranean sea. Rooted in a institutional partnership dating back to 2017, this initiative seeks to craft a shared vision for the Rhône's evolving territory. Recognizing the complexity of the socio-ecological transition, the approach embraces the landscape as both subject and living medium for co-construction, negotiation, and transformation towards more resilient livable futures.

This contribution examines how the project activates the landscape as a mediating tool [2], bringing together institutional actors, civil society, and local inhabitants of the Geneva Rhône to collectively question and debate the possible futures of this transforming territory. In this way, the landscape is mobilized not only as a space of dialogue but also as a means to support inclusive decision-making processes and foster shared, transparent governance. It further reflects on the political dimension of landscape representation, highlighting how lived experiences, situated perceptions, and physical engagements with place constitute critical vectors in the co-production of collective visions.



Figure 1. Rhône traversing Geneva, Paysage Projet Vivant

Le Rhône Genevois: a multifaceted socio-ecological landscape

The Rhône river landscapes are deeply marked by human presence. Its regulated flow, controlled by hydroelectric dams, and its historical role in supporting Geneva's economic expansion are materially inscribed along its course: industrial zones, excavated gravel pits, and agricultural enclaves nestle within its meanders, testifying to layered histories of use and transformation. Yet the Rhône is more than a bearer of socio-economic infrastructure; it is also a *pénétrante de verdure* and landscape system, a green seam threading through the urban fabric. The riparian gallery forests and open green spaces on the city's outskirts offer not only ecological value but also tranquility and respite within an increasingly urbanized context.
More than a functional or ecological asset providing services, the river landscapes are lived and affective spaces. Despite its partially concealed, sunken geography, the Rhône accommodates a wide spectrum of everyday practices: from joggers and swimmers to festive gatherings, Sunday strolls, and wildlife enthusiasts. This dimension of conviviality, though often underrepresented in planning discourses, positions the Rhône as a shared social and ecological commons.

As common ground, the Rhône carries plural and often divergent meanings shaped by one's situated perspective, be it that of policymakers, ecologists, Friday-night revelers, or joggers tracing its banks. Beyond our individual or collective perceptions and representations, the river landscapes are also composed and continually shaped by the agency and entanglements of living entities. This multiplicity of ways of dwelling in and relating to the landscape, both human and more-than-human, reveals a territory marked by friction and competing claims. The Rhône is caught between conflicting demands and interests: ecological renewal and urban socio-economic imperatives, public accessibility and habitat preservation, energy production and restoring the ecological integrity of fluvial systems, etc. These tensions reflect broader dynamics of the Anthropocene, where planetary crises unfold in localized, material forms that challenge prevailing territorial development paradigms [3] They call for integrative frameworks that move beyond the mere balancing of interests, toward generative models of coexistence capable of reimagining how territories are shared, governed, and cared for in the face of systemic transformation.

Landscape as *living milieu* and tool for mediation

The Observatory proposed by *Les Saisons du Rhône* conceptualises landscape as a living milieu. It is no longer perceived or experienced as an autonomous or external entity by a detached human observer, but rather as a spatio-temporal phenomenon in which our modes of inhabiting are entangled with other forms of life, woven into networks of reciprocal interdependence [4]. This approach mobilises landscape not as a spatial object to be preserved or beautified, but as a dynamic process through which multiple actors, temporalities, and sense-making endeavours converge.

As a co-constructed living milieu, not limited to a fixed physical or functional entity, landscape can be understood as as a federating notion, one that holds together a plurality of perceptions and representations. It embodies aspirations, values, and conflicting interests. In this way, the Observatory mobilises landscape as a device for mediation allowing for collective inquiry and negotiation; landscape is thus used as an epistemic and political medium through which the material and immaterial dimensions of evolving shared life trajectories are rendered intelligible and open to re-articulation. Mediation here is not understood as a means of avoiding differences or conflict, but rather as a mode of articulating them [5]. Gathering and weaving together the many voices of the Rhône, from institutional actors to local inhabitants, the Observatory seeks to craft participatory spaces where divergent perspectives can be voiced, confronted, and potentially transformed in order to collectively envision possible futures for a territory in flux.

The Observatory establishes a transversal approach where disciplinary silos, wether sectoral administrative structures and public policies, or disciplinary knowledge systems, are bridged through landscape. By foregrounding the perceptual, symbolic, and experiential dimensions of place, the Observatory creates the conditions for shared inquiry and situated decision-making. Rather than separating scientific data from social or embodied knowledge, the approach integrates quantitative monitoring with qualitative interpretation. Maps, ecological inventories and territorial data-sets are placed in conversation with oral histories, user practices, and artistic expressions. The landscape becomes a mediating lens through which diverse knowledge regimes interact, not only to aggregate information, but to generate collective meaning.

Relational landscape praxis

Influenced by contemporary ecological thinkers such as Baptiste Morizot [6], Philippe Descola [7], and others, the Rhône Observatory's approach is grounded in the conviction that today's ecological crisis is, at its core, a crisis of relationality, not only a disruption of climate systems or biodiversity loss, but a rupture in how modern societies produce knowledge about, represent, and inhabit the living world. This perspective calls for a shift from extractive and abstract modes of spatial reasoning toward more attentive, situated, and relational forms of spatial knowledge production.

In this light, landscape mediation is not merely a representational technique but a mode of inquiry, a method of attending to the entangled relationships between humans and more-than-human agencies, between affect and infrastructure, between material conditions and symbolic meaning. Rather than reducing space to legible, quantifiable categories, this positioning foregrounds the complexity of interdependencies that shape socio-ecological realities.

At the heart of this epistemic situation lies an understanding of representation as embodied. Knowledge of place is not only discursive or cognitive. It is rooted in how bodies dwell in space, move through it, and develop attachments. The everyday gestures of planners, swimmers, walkers, ecologists, or residents along the Rhône are not incidental; they are situated practices through which knowledge is produced, claims are made, and territories are co-constituted.

Such corporeal engagements disrupt dominant governance frameworks that privilege disembodied expertise and top-down abstraction. They emphasize instead the political agency of presence, perception, and care, asserting that space is shaped not only by policy but through the relational acts of sensing, narrating, and being-with.

This epistemological stance seeks to create a critical distance with the universalizing tendencies of technocratic spatial knowledge and instead elevate situated, relational, and affective epistemologies. It also resonates with ecological justice frameworks, where representation is not merely about inclusion or visibility but about meaningful participation in shaping ecological futures.

In this spirit, the Rhône Landscape Observatory resists the impulse to stabilize or unify representations. Instead, it seeks to multiply them, through experimental cartographies, sensory mappings, embodied observations, and collaborative devices. The goal is not to fix meaning

but to activate a plurality of spatial imaginaries, engaging the Rhône landscapes not as objects of control, but as living palimpsests of stories, rhythms, and transformations.
By assembling and articulating scientific and vernacular knowledge, affective and analytical insights, the Observatory seeks to foster an inclusive and generative framework through which to perceive, interpret, and collectively reimagine landscape futures.

Positioning the Rhône Observatory as mediating infrastructure

Anchored in a landscape mediation approach, the Rhône Observatory is conceived as a transversal, interdisciplinary platform for awareness-building, knowledge centralization, and collaborative interpretation, aimed at supporting the quality of the evolving Rhône landscapes. Positioned at the interface of scientific inquiry, public policy, and civic engagement, the Observatory provides a space for documenting, interpreting, and accompanying territorial mutations in ways that integrate ecological, socio-cultural, and spatial dimensions.
More than a passive repository of data, the Observatory functions as a process of shared construction, one that seeks to federate institutional, professional, and civil society actors while actively engaging local inhabitants. It aims to foster a collective attentiveness to the Rhône as both a material and symbolic resource, and to integrate this perspective into landscape and territorial planning practices in Geneva. As an entity external to state administration, it maintains a neutral and facilitative position, open to the participation of a broad range of stakeholders.
Its multiple audiences include institutional actors, for whom the Observatory provides tools for monitoring, prospective analysis, and informed planning; professionals and associations, who benefit from a dedicated space for interdisciplinary exchange and shared knowledge production; residents of all generations, who gain access to information, awareness of landscape issues, and opportunities for concrete participation; and researchers and students, whose academic work is highlighted and connected to real-world processes of territorial transformation.

The Observatory's missions are structured around six core objectives. First, it undertakes the observation, analysis, and documentation of landscape evolutions, tracking socio-ecological transformations while enriching cartographic, documentary, and field-based resources. It seeks to generate integrated representations of disciplinary knowledge that inform both territorial planning and landscape-oriented decision-making. Second, it focuses on the interpretation and valorization of diverse forms of knowledge, quantitative, qualitative, and experiential, producing analytical tools and frameworks that enable shared understandings of complex socio-ecological challenges.
A third axis concerns public mediation and multi-audience awareness, creating bridges between expert knowledge and a diversity of publics. The Observatory promotes ecological and urban awareness while fostering a broader landscape culture that resonates across institutional, professional, and civic domains. Fourth, it plays a key role in assembling and coordinating a network of territorial actors. This involves organizing forums and participatory structures that support ongoing dialogue, cooperation, and the exchange of knowledge, practices and projects. Fifth, the Observatory supports the integration of living systems and ecological processes into territorial decision-making by disseminating context-sensitive knowledge that can guide both strategic action and deliberate inaction.
Finally, it contributes to feedback and learning processes that reinforce adaptive governance, drawing on experience and experimentation to support transitions in the face of ecological and climatic uncertainties.
Operationally, the Observatory deploys a set of interconnected tools and practices. A web-based platform serves as a central node for resource aggregation, providing access to cartographic materials, documentary collections, and dynamic content related to landscape transformations. In parallel, it implements citizen engagement strategies aimed at cultivating landscape literacy and participatory reflection. These include awareness campaigns, co-construction workshops, and collaborative tools designed to engage inhabitants directly with the evolving reality of their territory.
Events and gatherings, such as multi-stakeholder forums and thematic workshops, are organized to strengthen the social fabric of actors and to sustain a culture of shared intelligence. These occasions foster dialogue between institutional bodies, professionals, civil society organizations, academics, and residents. Lastly, by anchoring its work in situated knowledge and collective inquiry, the Observatory is positioned to contribute meaningfully to the implementation of landscape-

related public policies at both the cantonal and national levels.
This architecture affirms the Observatory as more than a scientific or policy tool. It becomes a relational device, a civic and epistemic common ground through which socio-ecological transitions are rendered thinkable, debatable, and actionable.



Figure II. Landscape mediation, Paysage Projet Vivant

Les Saisons du Rhône: experimenting with landscape mediation

The project *Les Saisons du Rhône* serves as a precursor and prototype for the Observatory to come. As a research-action initiative, it actively tests tools of landscape mediation while constructing the Observatory's institutional and conceptual identity.

Among its key activities are the "*Tables Rhône*," roundtable forums that bring together representatives from public administration, municipal authorities, civil society, and local communities. These gatherings are designed not merely to extract opinions but to collaboratively define problems and envision shared futures. They provide crucial opportunities to convene actors, exchange knowledge and concerns, and facilitate dialogue emerging from diverse perspectives. Notably, these discussions have contributed to the co-construction of the Observatory's mission, objectives, and roles described above.
A key methodological tool employed in these discussions is real-time participatory mapping, which transforms the map from a static representation into an active medium of engagement and debate. This dynamic approach facilitates a collective exploration of spatial issues, enabling stakeholders to visualize and negotiate territorial challenges in situ.
The project also engages directly with local inhabitants to collect their perceptions, representations, and aspirations concerning the landscape quality of the Rhône. These encounters fulfill a dual function: they both enrich the understanding of the landscape's values and expectations, and foster public awareness of the Rhône's ecological and territorial challenges. One of the instruments employed is the podcast series *À l'écoute du Rhône*.
This medium operates simultaneously as a tool for public engagement and as a means to advance and disseminate research findings. Framed around thematic explorations such as the "Nights of the Rhône," the series addresses critical issues for instance soundscape and nocturnal wildlife, light pollution and ecological dark corridors, or the recognition of night as shared common good. By integrating scientific knowledge with lay narratives and experiences, the research aims to observe and nourish a polyphonic, pluralistic portrait of the Rhône, one that acknowledges and embraces multiple ontologies and diverse modes of relating to the landscape.

Through these processes, *Les Saisons du Rhône* embodies an experimental form of knowledge production and support to landscape governance characterized by iteration, reflexivity, and grounding in situated perspectives.

Toward a shared governance

One of the long-term ambitions of the Observatory is to support the emergence of shared governance mechanisms for the Rhône. Such mechanisms must reckon with asymmetries of power, knowledge, and institutional capacity. Landscape, in this context, provides a common referent, a space through which seemingly incommensurable perspectives can be linked.
The Observatory thus becomes an arena for negotiation where policies, values, and territorial imaginaries are brought into critical contact. In contrast to top-down governance models, it supports the construction of horizontal alliances that cross disciplinary, sectoral, and administrative boundaries.
Importantly, governance here is not limited to formal procedures. It includes cultural and symbolic dimensions, such as the ways the Rhône is narrated, remembered, and celebrated. By foregrounding affective and creative landscape practices, the Observatory affirms that socio-ecological transition is not only a matter of infrastructure but also of re-presentation and imagination.
While the project has thus far focused its efforts and partnerships with actors of the Geneva basin, preliminary exchanges and knowledge flows have

taken place both upstream and downstream. In the long term, it aims to support the emergence of a trans-scalar network of actors spanning from glacier to delta, recognizing the Geneva basin as one link within the hydrological continuum of the Rhône, and underscoring the need for coordinated approaches across the entire watershed.

Acknowledgments
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URBAN TREES: FROM NURCERY TO URBAN ENVIRONMENT, HOW TO PREPARE PLANTS PRODUCTIONS FOR URBAN CONSTRAINTS?

TOPIC: Increase the recovery and survival rate of tree in cities.

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Keywords: Urban trees, Nurcery production, Technosols, Urban waste

Abstract
This program aims to develop a technical itinerary to improve tree establishment and growth in urban context. Three main factors are studied here: pot, growing media and the addition of microorganisms. The experiment results show that regarding elongation and the number of nodes, conventional pots and AirPot® yielded better results. The concrete compost Technosols produced better results concerning the average internode length. Overall, little difference in circumference between technosols and topsoil in tested conditions are seen. Mycorrhization did not have significant effect on trees growth. All those results will be refined with further experiments in the ClimArbre research program started in 2024 that will select a suitable route while monitoring the effects on the physiology and aesthetics of trees in nurseries. These trees prepared in this way will be planted in a community and their development will be monitored.

I. Introduction

Urban tree planting is crucial for enhancing environmental quality and human well-being in cities (Pataki D.E. and al, 2021). Their impact on reducing urban temperatures is a key factor in combating the effects of climate change in cities, a 10% increase in leaf cover results in a reduction of 1°C in the air (Triolet L and al, 2021). In addition, numerous scientific studies have demonstrated the beneficial effects of nature in the city on human health. Positive effects on stress, anxiety, depression, attention deficit, nature deficit and physical and social well-being have been proven (Meyer-Grandbastien, 2022). In response of these findings, several planting policies are emerging in all cities. However, the success of urban forestry initiatives depends significantly on the local production of trees adapted to specific urban constraints (Castagneyrol B., and al. 2024). This approach ensures better tree establishment, survival, and long-term performance, ultimately maximizing the multiple benefits of urban trees for communities (Dorneay J.R. 1984). Subject to numerous constraints when transplanted into urban environments, trees face limitations in root system development due to the structure and composition of their growing medium, infrequent irrigation, and other urban stressors (Cermak.G. and al, 2000). Consequently, their growth is often reduced. These conditions also shorten the lifespan of urban trees by one third compared to those in rural environments (Gillig C-M. and al. 2008). In this study 3 potential factors are tested, the type of pot, the use of technosols as a growing media and the addition of symbiotic microorganism.

II. Materials and methods

II.I. Tree species

Two species of trees are studied: *Tilia cordata* and *Carpinus betulus*.

II.II Pots

Most growers use conventional pots, but some are starting to use pots with technical characteristics that are more favorable to root structure. This is why, four types of pots are compared: classic (20 L (37.3x24.8 cm), AirPot® (20 L (31.2x31.5 cm), Anti-

root-spiraling pots (20 L (33x30.5x29 cm) and Root-Push (16 L (28x26 cm).



Figure 1: From the left to the right, pictures of classic pot, Anti-root- spiraling pot, AirPot® and Root Push.

II.III. Growing media

Two compositions of technosols and one control are compared.

Name	Composition (masse percentage)
T1	30% rubble, 40% excavation soil, 30% compost
T2	70% concrete, 30% compost
TV	100% topsoil

Table 1: Growing media composition

II.IV. Microorganism

Microorganisms added are Trilis Ectomycorhize (Sylva Fertilis) at the dose of 600g/tree.

II.V. Experimental design

The system consists of 30 individuals' trees repeated for each of the modalities. The trees are arranged outdoors on a platform with 90cm spacing on the row and 50cm between the rows.

II.VI. Parameters tracked

The following parameters were tracked during 3 seasons:

- Aerial Development:

-Trunk diameter: measured at 1 meter from the collar, monitored on 8 trees by modality.
-Length and number of nodes: measured for the 3 longest shoots of each of the 4 trees by modalities.

- Root development:

-Fresh mass: weighing on 4 trees per modality.
-Mycorrhizae: presence or absence

- Monitoring of health status:

-Presence/absence of pests and pathogens
-Identification of pests and pathogens
-Intensity of attacks

III. Results

III.I. Pots

The four pots were compared to each other for the two species regardless of the growing media.

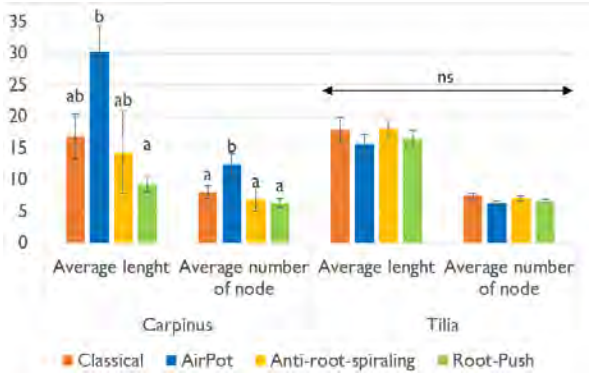


Figure 2: Elongation and number of nodes regarding the type of pot

Regarding elongation and the number of nodes, the AirPot® yielded better results for *Carpinus.*
In other experiments the average root weight was more important in classic pots than in Anti-root-spiraling and root-push. The quality of root structure was also assessed visually to select the pots with the least amount of root spiraling.

III.II. Growing media

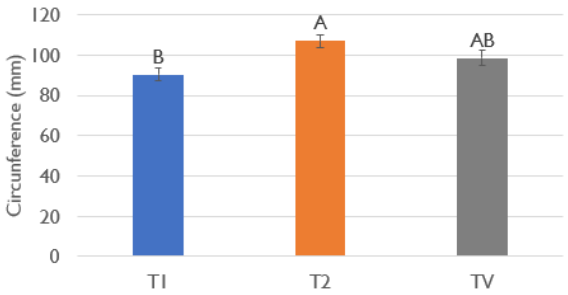


Figure 3: Average circumference regarding growing media (T1: rubble, excavation soil and compost, T2: concrete and compost, TV: topsoil)

The concrete compost technosols produced better results concerning the average circumference than the other technosols. Regarding the number of nodes, the trees in T2 produced a bigger number of nodes than those on TV.

III.III. microorganism

In terms of high branch length, number of nodes and circumference no difference was significant between trees that were in contact with microorganisms and those that were not.

Following those results the percentage of root colonization by microorganism were observed.

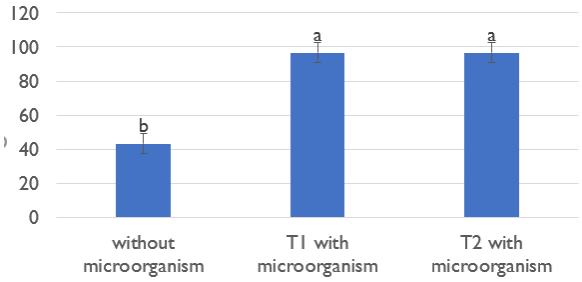


Figure 4: Percentages of root colonization by microorganism

Those data shows that the roots that were put in contact with microorganisms were more colonized than those that were not.

IV. Discussion

IV.I. Pots

The results shown previously are completed by a visual observation of root spiraling. This phenomenon is known to be unfavorable for root spreading in the planting pit and can therefore cause poor anchorage and/or poor absorption of water and nutrients, causing stress to the tree. The root-spiraling is low in AirPot® and Anti-root spiraling pots.



Figure 5: Pictures of roots growing in classical pot, anti-spiraling pot and AirPot® (from the left to the right)

The effects of pots on *Carpinus* average length and number of nodes and the good root structure observed in AirPot® leads us to choose this pot for further experiments.

IV.II. Growing media

In our study the best growing media seems to be the concrete and compost technosol. This substrate is composed of 70% of crushed concrete and 30% of green waste compost (mass percentage). This substrate is both very draining and very easy to rewet. It is possible that these qualities may explain the better growth of the trees produced in this technosols.
In further experiments declination of these compositions will be studied: with food waste compost or biochar for instance.

IV.III. Microorganism

It appears that the addition of microorganism impacts the root colonization by microorganism, but no phenotypical response was seen. In other words, microorganisms have established themselves around the roots, but their potential positive effect has not been expressed. It appears that this association is mainly beneficial to the tree when it is under water or nutrient stress. Experiments must be conducted to know if a potential effect of microorganism can be seen on tree survival and growth in case of hydric stress.

V. Validation of tree preparation techniques in an operational environment

In order to confirm the benefits of preparing the trees in the production phase, two methods evaluated (AirPot® and Root Pouch with technosol based on crushed concrete and compost) were planted in paloxes mimicking urban conditions.

After 6 months of planting, all the trees had budded. Plants grown in AirPot® budded two to three weeks earlier than plants grown in Root Pouch or in the ground. This difference can be explained by a high-quality root system, which was not pruned when the plants were placed in the paloxes.



Figure 6 : Planting trees paloxes mimicking urban conditions

VI. Conclusion

All those results can help in theory to prepare plant production for urban constraints. Those results and solutions will be combined to create a technical itinerary. Based on these results a new research program called "ClimArbre" starts in 2024. It tests trees in AirPot®, with compost-concrete technosols and microorganisms, with or without hydric stress. These trees are studied physiologically, and the vigorous ones are planted on site, in cities, where their establishment and growth are monitored. This new program proposes confronting trees in nurseries with water stress to study the establishment of symbiotic relationships and understand physiological adaptations in young trees. This new study also focus on socio-organizational impacts of the change in technical itinerary on the actors of the sector. From the preparation of the tree in the nursery to its maintenance once planted, the tree goes through a diversity of actors, each of whom has specific knowledge. Landscape architects actively influenced the process and nursery production: from tree species 'choices, size and characteristics of the plants 'material. The introduction of changes and innovative practices at the level of the initial preparation of the tree in the nursery implies an adaptation of all the actors involved downstream as landscape architects, cities dwellers, landscape contractors.

The challenge of the "ClimArbre" project will therefore be to evaluate the influence of tree preparation in a nursery on their ability to recover and their development in urban areas, considering climate change impacts and socio-organization of the landscape and horticultural sector.

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MEDITERRANEAN NATURALISTIC PERENNIAL PLANTING COMBINATIONS - INNOVATION FOR URBAN GREENERY IN MADRID

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Keywords: urban greenery, urban planting design, Mediterranean cities, climate change, low maintenance

Abstract

The design and maintenance of green areas in Spanish cities is facing major challenges related to climate change, the need to preserve biodiversity and the demand of citizens for a satisfactory maintenance of urban greenery.

The effects of climate change are increasingly evident in Spain and in the face of water scarcity and global warming, it is essential to rethink the current models of planting green areas to make them more sustainable. National and international agendas are increasingly emphasizing the key role of cities in conserving biodiversity and natural heritage. In this context, it is essential to develop new planting strategies with a more naturalistic approach, which optimize maintenance, allow efficient irrigation management and contribute to the promotion of biodiversity and sustainability.

The naturalistic approach has been widely adopted in many European countries with success, however, in Spain there are few experiences in public greenery with this approach. This demonstrates the need to develop a model of its own, adapted to the Spanish Mediterranean climate and, in particular, to the conditions of the city of Madrid.

To address this challenge, the Head Office of Urban Regeneration of the Madrid City Council and the Universidad Rey Juan Carlos in Madrid have launched a research project focused on the development of low-maintenance herbaceous planting mixtures with reduced water requirements. The trials will evaluate combinations of herbaceous plants of Mediterranean origin, different types and depths of technical substrates, as well as types of mulch that favor the retention of soil humidity. In addition, optimal irrigation doses will be analyzed to ensure the development of the vegetation and reduce maintenance needs.

The methodology has been developed in close collaboration between the research team of the Universidad Rey Juan Carlos and the municipal technicians, establishing technical specifications for materials, plant mixtures and monitoring protocols, with indicators to evaluate their evolution.

The trials will be carried out between the fall of 2025 and 2027 in a plot of approximately 300 m² in a facility of the Madrid City Council. Once implanted, they will be monitored following defined protocols with specific maintenance tasks.

The final objective of the project is the elaboration of data sheets for Mediterranean ornamental herbaceous planting mixtures, which will serve as a reference in urban regeneration projects. These sheets will include detailed technical specifications, recommendations for implementation and a maintenance protocol. Likewise, the most suitable planting substrate for this type of planting will be determined, testing different mixtures with varying proportions of aggregates, organic matter and topsoil.

The conclusions of this research will be published for dissemination in the academic and professional community, in order to promote its application in other Mediterranean urban environments.

1. Introduction

In Spanish cities, the planning, design and management of urban green infrastructure is facing increasingly complex challenges associated with the impact of climate change, the need to preserve the ecological performance of urban ecosystems and connectivity between habitats, as well as a growing social demand for efficient maintenance of urban greenery and quality ecosystem services.

The effects of climate change are increasingly evident, for example, the summer of 2022 was one of the hottest on record in Spain and with rainfall 35% below average [1][2]. Faced with water scarcity and global warming, it is essential to rethink the current models of planting green areas to make them more sustainable.

The climate of Madrid is classified in the context of the Iberian Peninsula as semi-arid climate BSk to hot-summer Mediterranean climate Csa under the Köppen climate classification and has a precipitation of around 400 - 420 mm per year. However, annual precipitation has been reduced in some years to around 100 mm. Climate change has caused an increase in its variability, with more frequent droughts and rainfall concentrated in intense episodes. These facts significantly affect plantings, which are affected by water stress situations. This situation is reinforced by the +0.5 °C increase in temperature over the last 20 years, absolute records for daytime maximum and nighttime minimum temperatures, and a doubling of tropical nights.

Madrid has recorded record highs in recent years, such as 42.7 °C at Barajas and 42.2 °C at Cuatro Vientos (14 August 2021), reflecting a trend towards greater extremes. Due to these changes, the city of Madrid has experienced an effective shift towards a warmer USDA zone, especially in the city center, from a transitional situation between 8a-8b to a more stable 9a, even 9b in densely built-up areas with a heat island effect, although these changes have not been recognized in official USDA maps for Europe at present.

The 2030 Agenda published in 2015 by the United Nations and the European Biodiversity Strategy 2030 published in 2020 by the European Commission highlights the key role of cities in the conservation of biodiversity and natural heritage. The Madrid City Council has launched several initiatives in this context in recent years, of which the Green Infrastructure and Biodiversity Plan (2018-2030) published in 2018, the Plan for the Promotion and Management of Biodiversity in the city of Madrid and the Manual for Nature-based Solutions, both published in 2023, stand out.

The development of new planting strategies with a more naturalistic approach is a fundamental contribution to achieving these proposed goals. This model encourages sustainable agronomic techniques, such as the use of improved soils, mulching and efficient irrigation management, while promoting biodiversity and sustainability.

Although the naturalistic approach has been widely adopted in many European countries with success, in Spain its application in public gardening is still limited [3]. In the few previous experiences, foreign models have been used with variable results. This evidences the need to develop a model of its own, adapted to the Spanish Mediterranean climate and, in particular, to the conditions of the city of Madrid. Currently, in the municipal gardening of Madrid, plantations with ornamental mixtures of herbaceous plants are being tested on an occasional basis. These mixtures include a large percentage of annual cycle species that, in many cases, are not adapted to the city's climate. As a result, the results are highly variable and in many cases these plantations

fail to thrive. For the moment, there are no mixtures designed and tested specifically for the climatic conditions and use of Madrid's municipal green areas.

Neither are specific substrates for the specific requirements of Mediterranean plants adapted to low water regimes that allow the optimal development of this type of vegetation and the full use of its potential in urban green areas used in current practice in the public greenery of Madrid.

Finally, there is the concern for optimized maintenance with the resources available for the management of public green areas. The city of Madrid has a total of 6,179 hectares of urban green areas, including forest parks and historic gardens. At the same time, it has about 664 hectares of lawn areas, which constitutes ~11% of the urban green areas. This vegetation cover has a high level of maintenance and maximum water consumption, and it would be interesting to look for more sustainable alternatives that meet both the goals of promoting biodiversity that the administration itself has set as an objective.

In terms of economic expenses, in 2022 the city of Madrid spent approximately 32,100 €/ha/year for the integral conservation services of parks and municipal nurseries and 30,000 €/ha/year for urban green areas and urban trees in city districts [4]. This is significantly higher than in Berlin, a city with considerable experience in extensive, nature-based gardening and maintenance practices, which spends an average of 2.01 €/m2/year (20,100 €/ha/year) for the maintenance of its urban green spaces [5].

The objective of the present research project developed by the Universidad Rey Juan Carlos in collaboration with the Head Office of Urban Regeneration of the Madrid City Council is the development of herbaceous plant mixtures adapted to the continental Mediterranean climate with low maintenance and reduced water requirements.

2. Methods and materials

2.1 Previous study of technical literature

There are few publications in Spain or in the Mediterranean basin that have dealt with the development of these concepts, with the exception of authors such as Heidi Gildemeister [6], Günther Kunkel [7] and Olivier Filippi [8] standing out with their books on waterwise gardening in Mediterranean areas.

Given this lack of technical literature in Spain, studies and essays published in Germany have been reviewed, where there has been a long tradition of naturalistic planting with herbaceous plants since the beginning of the 20th century. Since the early 1990s, several herbaceous plant mixtures have been developed with the collaboration of several German universities with the main objective of finding more sustainable solutions for ornamental plantings in public green areas. There are currently more than 30 mixtures certified by the Association of German Perennial Growers BDS that are commonly used in German cities. In the last decade, research has focused on the development of mixtures and substrates for dry soil conditions. Among others, the trials of the Hochschule Anhalt, Bernburg with the Hochschule Osnabrück and the Bavarian State Research Center for Viticulture and Horticulture in Veitshöchheim [9][10] stand out. These studies have served as a guideline for the present research.

2.2 Criteria for the selection of materials

In Spain, materials and methods in gardening and landscaping do not have specific official regulations or standards of obligatory compliance that establish the quality of materials and procedures for gardening work. There is no similar recognition as for example the regulations and recommendations elaborated by the German Institute for Standardization DIN and the German Landscape Research, Development and Construction Society FLL in Germany. However, there are the Technical Standards for Gardening and Landscaping NTJ drafted by the Official Association of Agricultural Engineers and Agricultural Experts of Catalonia, which are intended to provide a regulatory framework, although they do not have any degree of officiality. Therefore, the types and quality of aggregates and substrates available on the market can be very variable. For the present investigation, materials easily available in the Madrid area have been chosen. In the case of the aggregates used for the technical substrates and mulch, we have opted for the usual granulometries on the market, which do not imply difficulties in supply or an increase in price. For the topsoil, we propose the material normally used in municipal green areas.

2.3 Criteria for the selection of species

For the present research, combinations of perennials and ornamental grasses for sunny exposure were sought. Aromatic and ligneous plants were excluded from the selection.

Also, in the selection of species the availability of the plant on the national market has been a relevant criterion. There is a list of plants included in the City of Madrid's price bases that includes, since its last revision in 2023, a considerable new variety of species adapted to the climatic conditions of the capital.

In the initial selection of species, factors such as the plants' seasonal development, character and height of growth have been considered.

In correspondence with the minimum temperature ranges established by the USDA, the plant selection ranges from Zone Z8 (-12.2 to -6.7 °C) to Zone Z9 (-6.7 to -1.2 °C).

In the next step, the species have been reviewed with respect to their water requirements. They have been grouped according to the drought code established by Olivier Filippi in his publications. The drought codes applied to the selection of species are 3 to 4, which corresponds to plants that once established are suitable for a garden without irrigation, under normal soil and exposure conditions, in regions with a duration of 3 to 4 months of summer drought.

The Landscape Coefficient Method, developed at the University of California by L. R. Costello between 1991 and 2000, was also taken into consideration. It is a tool for estimating the water needs of a garden, considering the reference evapotranspiration (ETo) and the type of vegetation present. It is calculated by multiplying the species coefficient (Ks) by the garden density coefficient (Kd) and the microclimate coefficient (Kmc). The species factor (Ks) is based on the WUCOLS (Water Use Classification of Landscape Species) system. The species factor Ke applied is between 0.3 and a maximum of 0.5.

In order to contribute to the promotion of biodiversity, plant species of interest for insects of the order Lepidoptera and for bees and other Hymenoptera have been included in the selection.

3. Results

In the work sessions carried out by the research team of the Universidad Rey Juan Carlos and the municipal technicians between November 2024 and March 2025, the following technical specifications for materials, plant mixtures and monitoring protocols have been established to evaluate the evolution in experimental plots:

3. 1 Technical substrates

Following the methods developed by the Swedish nurseryman and landscape designer Peter Korn, however adapted to the conditions of the Mediterranean climate, three types of technical substrates have been defined: The M1 mixture is composed of 40% topsoil, 20% coarse gravel 10-20mm, 20% fine gravel 5-10mm and 20% very coarse sand 1-2mm. In addition, 0.5l/m2 of biochar is added to the mix to improve soil fertility and increase nutrient retention. In mix M2 the volume of topsoil is reduced to 33% and only two types of aggregates are used with a coarser grain size than in mix M1 (33% very coarse siliceous sand 1-2mm. and 33% fine gravel 5-10mm, of granitic origin). The addition of biochar is maintained at 0.5 l/m2. For mix M3 only two aggregate granulometries are used, 66% fine gravel 5-10mm and 33% coarse sand 0.5-1 mm. In order to verify the results, control plots will be tested with topsoil commonly used in the public gardens of the Madrid City Council.

All types of technical substrates and the top soil for the control plots are applied with a thickness of 40 cm. Prior to application, an agronomic analysis of the following indicators will be carried out on each mixture and topsoil:

- Fertility (texture, pH, electrical conductivity, organic matter, total nitrogen, available phosphorus, active limestone, available calcium, available magnesium, available potassium, available sodium).

- Microelements (iron, manganese, copper, zinc)

- Ratios of interest (carbon / nitrogen ratio, available cations)

3.2 Mulches

Three mulching variants have been defined, two of them being of mineral material and one variant with organic material. Mulching type A1 consists of a 10 cm thick layer of coarse gravel 12/20 mm and for mulching type A2 the same material is applied with a reduced layer of 7 cm thick on a compostable organic membrane to avoid spontaneous plant growth in the first years of vegetation establishment. Mulch type 3 consists of a 10 cm thick layer of organic mulch made from recycled pruning products. This material is produced by the Madrid City Council composting plant and is a cheap and sustainable alternative.

3.3 Planting mixes

Three planting mixes have been defined, differentiated by color in shades of yellow, pinkish red and purplish blue (Table 1,2 3). The mixtures each have 15% of structure plants, 45% of filler plants and 40% of ground cover plants. The overall planting density is 5-7 ud /m2 and by means of a simple linear pattern, easy to carry out even by personnel with little knowledge of gardening.

In order to achieve a better acceptance by the citizens using the green areas, larger plant sizes will be employed in the samples, since their immediate visual effect is more attractive. Plants will be used in C1 and C2 containers of one and two liters respectively. In addition, part of the trials will be carried out with smaller plants, in 11 cm pots (M11), but in these cases the planting density will be increased, reaching more than 9 plants per square meter, to compensate for their smaller initial size.

In the mixtures we have included species with good results in Madrid, such as *Pennisetum*, *Gaura*, *Tulbaghia* or *Salvia*. But also included are native plants even less common in municipal gardening as *Stipa gigantea*, *Achnatherum calamagrostis* or *Teucrium chamaedrys* and species even less used in the capital of the genus *Euphorbia* or evergreen *Hemerocallis*.

Table 1. Planting mix M1.

Yellow mix

(plants per 10 m2)

Structure plants 15%

Achillea filipendulina 'Coronation Gold' (2)
Aspholedine lutea (2)
Euphorbia characias ssp. wulfenii (2)
Euryops pectinatus (2)
Pennisetum alopecuroides (2)
Stipa gigantea (2)

Filler plants 45%

Achillea clypeolata 'Moonshine' (3)
Gaura lindheimeri (3)
Hemerocallis 'Earlianna', 'Mary Guenther' (3)
Iris 'Harvest of Memories' (3)
Rudbeckia fulgida (3)
Salvia greggii 'Alba' (3)
Salviax jamensis 'La Luna' (3)

Ground cover plants 40%

Erigeron karvinskianus (10)
Euphorbia myrsinites (14)

Table 1. Planting mix M2.

Red mix

(plants per 10 m2)

Structure plants 15%

Achnatherum calamagrostis (4)
Calamagrostis x acutiflora 'Karl Foerster' (4)

Filler plants 45%

Centranthus ruber (3)
Dicliptera suberecta (3)
Epilobium canum (3)
Gaura lindheimeri 'Siskiyou Pink' (2)
Hemerocallis 'Merry Monarch' (2)
Salvia greggii 'Peach' (2)
Salvia microphylla (2)
Salvia microphylla 'Hot Lips' (2)
Salvia x jamensis 'James Compton' (2)
Salvia x jamensis 'La Siesta' (2)

Ground cover plants 40%

Erigeron karvinskianus (10)
Euphorbia myrsinites (10)

Table 3. Planting mix M3.

Blue mix

(plants per 10 m2)

Structure plants 15%

Perovskia atriplicifolia 'Blue Spire' (2)
Verbena bonariensis (3)
Calamagrostis x acutiflora 'Karl Foerster' (3)
Pennisetum alopecuroides (3)

Filler plants 45%

Agapanthus praecox (3)
Centranthus ruber 'Alba' (4)
Gaura lindheimeri (3)
Salvia greggii 'Blue Note' (3)
Tulbaghia violacea (4)
Pennisetum alopecuroides 'Hameln' (3)
Nasella tenuissima (3)

Ground cover plants 40%

Ceratostigma plumbaginoides (4)
Nepeta racemosa 'Felix' (4)
Nepeta faassenii 'Six Hills Giant' (4)
Stachys byzantina 'Silver Carpet' (4)
Thymus vulgaris 'Compactus' (4)

3.4 Test plots

The tests will be carried out between the autumn of 2025 and 2027 in a plot of approximately 300 m² in the facilities of the "El Pozo" Training Garden in the district of Puente de Vallecas and managed by the Madrid City Council.

The plot is divided into 30 experimental subplots, thus providing 9 subplots for each substrate mix that allow testing the three planting mixes in combination with the different types of mulch. Three plots are reserved for the control plots for planting the three planting mixtures with mulch type A3 of organic mulch.

For the first year of plantation establishment, irrigation water will be necessary during drought periods. Therefore, an automatic drip irrigation system with water meters will be installed in the plot to control water consumption. As the vegetation becomes established, the irrigation water supply will be adapted in the years after planting in order to provide the minimum necessary water supply.

3.5 Monitoring and maintenance protocol

Once the test plots are established, the evolution of the plantations will be monitored according to defined protocols and the specific maintenance tasks stipulated will be carried out.

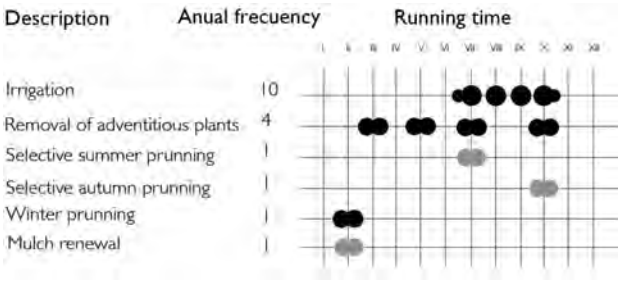
A periodic monitoring system has been established to evaluate the response of different species under experimental conditions, measuring key environmental, edaphological and physiological parameters (Table 4).

Table 4. Indicators monitoring protocol.

	Conditions	Methodology	Periodicity
Data analized: Environment	Temperature Precipitation Humidity	weather station	daily
	Water consumption	water meter	daily
	Soil moisture	tensiometer	daily
	Soil temperature	soil sensor	daily
Data analized: By species	Ground cover	photographs	monthly
	Phenological state	photographs	biweekly
	Height and width	manual measurement	monthly
	Pests and diseases	in situ observation	biweekly

The maintenance schedule (Table 5) has been sized with an extensive intensity. Five work shifts per year are foreseen, including the removal of spontaneous growth, selective pruning in summer, autumn and winter according to species and the renewal of mulch. Dividing, transplanting or separating seedlings is only foreseen as an optional task.

Table 5. Maintenance shedule.



3.6 Teaching innovation project

Throughout the process of this research work, the participation of students of the Bachelor's Degree in Landscape Architecture at the Universidad Rey Juan Carlos is foreseen. Internship students will be involved in the preparation and data collection in the monitoring protocols. In addition, it is foreseen to participate in the subjects Vegetation Composition and Green Areas Maintenance in maintenance tasks of the vegetation.

4. Discussion

The trials seek to identify the effects of different percentages of topsoil in the compositions of technical substrates, in relation to water consumption and plant development. Likewise, the efficacy of organic membranes in the control of spontaneous growth and their possible visual impact over time will be evaluated.

In addition, these trials are intended to evaluate the differences in spontaneous vegetation growth as a function of the thickness of mineral mulch applied. Also, its effectiveness will be compared with that of an organic mulch, in order to determine which of these solutions offers better control of unwanted vegetation.

During the development of the planting patterns, there has been much debate about the most appropriate plant size. The large container plant, being included in the Madrid price base, is easier to incorporate in regeneration projects and generates a greater visual impact on the public. However, small format plants tend to adapt more easily to soil and water conditions from the beginning of planting.

In the process of species selection, interest has arisen in developing, in later phases, specific plant-

ing patterns for semi-shade and dry shade conditions. The possibility of incorporating shrub species with low water requirements is also being considered, thus expanding the options for sustainable design.

5. Conclusion

Due to the close collaboration with the technical team of the City Council, it has been possible to define the components to carry out the trials, taking into account not only the initial criteria of low maintenance and reduced water requirements, but also the restrictions faced by the municipal gardening of the capital with respect to the availability of materials and plants and execution processes.

The implementation and the possibility of a protocol follow-up to the experimental plots starting in autumn 2025 over two years offer the possibility of defining complete solutions combining technical substrate, mulching and planting mixes suitable for Madrid's public green areas.

The final objective of the project is the elaboration of Mediterranean ornamental herbaceous planting mix sheets, which will serve as a reference in urban regeneration projects. These sheets will include detailed technical specifications, recommendations for implementation and an adapted maintenance protocol.

The conclusions of this research will be published for dissemination to the academic and professional community, in order to promote their application in other Mediterranean urban environments.

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ENHANCING CLIMATE RESILIENCE IN COASTAL BROWNFIELD REGENERATION: A COMPARATIVE STUDY OF THREE INTERNATIONAL CASES

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Keywords: Coastal cities, Brownfield regeneration, Climate change, Resilience, Regeneration strategies

Abstract
Coastal cities are regions where global population, economy, and infrastructure are densely concentrated, making them particularly vulnerable to the impacts of climate change. These areas also contain a large number of brownfield sites, further exacerbating their climate fragility. Both theoretical studies and practical experiences suggest that brownfield regeneration is an effective approach to enhancing the climate resilience of coastal cities. Based on a systematic review of relevant literature, this study establishes an evaluation framework for assessing the climate resilience performance of coastal brownfield regeneration. It then conducts a comparative and qualitative analysis of three representative international cases: Sydney Olympic Park in Australia, Freshkills Park in the United States, and Expo Houtan Park in Shanghai, China. Based on this, the study identifies key strategies for enhancing climate resilience through brownfield regeneration. These include systematically integrating climate resilience objectives into the entire regeneration process, strengthening engineering resilience and promoting low-carbon remediation technologies during the remediation phase, and enhancing carbon sink capacity and climate adaptation in the reuse phase. The findings aim to provide theoretical guidance and technical support for advancing brownfield regeneration practices in coastal cities worldwide.

1. INTRODUCTION

Three quarters of the world's megacities are located in coastal areas, with approximately half of the global population residing within 60 kilometers of the coastline. These regions serve as hubs for concentrated economic activities and infrastructure development. However, traditional industrial layouts and extensive development models have long resulted in numerous brownfields—idle and contaminated lands—left behind in coastal zones, including abandoned factories, unused docks, and closed landfill sites.

Against the backdrop of intensifying climate change, coastal brownfields exacerbate complex socio-ecological risks and have become some of the most vulnerable areas within coastal cities. For example, when Hurricane Harvey made landfall on the Texas coast in 2017, flooding submerged thirteen Superfund sites (severely polluted brownfields) in Houston, with one site exhibiting dioxin contaminant levels more than 2,300 times the remediation standard [1].

At the same time, the regeneration of coastal brownfields offers crucial opportunities to enhance urban climate resilience. For instance, Freshkills Park in New York transformed a closed landfill into an urban wetland park that provided significant ecological buffering during Hurricane Sandy in 2012, serving as a refuge against extreme weather events [2]. Similarly, Sydney Olympic Park in Australia revitalized the industrial brownfields of Homebush Bay into a coastal ecological park, restoring and protecting over 24 kilometers of the Parramatta River and surrounding coastal ecosystems, effectively addressing challenges posed by sea level rise.

Therefore, in response to the climate challenges faced by coastal cities worldwide, systematically integrating climate resilience objectives throughout the entire lifecycle of coastal brownfield regeneration has emerged as a cutting-edge and urgent research topic. This paper examines three representative cases of coastal brownfield regeneration to explore strategies for enhancing climate resilience across different stages of the regeneration process.

2. Materials and Methods

This paper adopts a combined methodology of literature review and case study. First, a systematic review of relevant domestic and international literature was conducted to identify key strategies for coastal brownfield regeneration in the context of climate change and to develop a preliminary evaluation framework. Second, three representative cases of coastal brownfield regeneration were selected and assessed for their actual climate resilience performance using the proposed framework. Finally, drawing on insights from both the literature and case analyses, the paper proposes strategic recommendations to guide climate-resilient regeneration of coastal brownfields.

2.1 Literature review

The United Nations Intergovernmental Panel on Climate Change (IPCC) outlines two primary approaches to addressing climate change: mitigation and adaptation. Mitigation aims to reduce greenhouse gas emissions and slow the pace of global warming, while adaptation focuses on enhancing a system's capacity to cope with current and anticipated climate impacts. These two approaches collectively contribute to enhancing climate resilience. Based on the IPCC framework, this study investigates key strategies for enhancing the climate resilience of coastal brownfield regeneration, examining both the remediation and reuse phases from mitigation and adaptation perspectives.

Regarding climate mitigation, during the remediation phase, low-carbon and green soil remediation technologies—such as in-situ remediation, phytoremediation—can effectively reduce carbon emissions associated with soil excavation and transportation [3]. In the reuse phase, the construction of ecological parks and increased vegetation coverage enhance carbon sequestration functions [4]. Integration of brownfield reuse with renewable energy developments, including wind, solar, and tidal power, further contributes to lowering carbon emissions. Existing research indicates that due to their location in well-connected and infrastructurally developed areas, brownfield redevelopment typically results in lower carbon emission intensity compared to new greenfield developments, demonstrating significant climate mitigation potential [5].

From the perspective of climate adaptation, pollution remediation projects emphasize improving system resilience to extreme weather and climate risks by, for example, adopting higher flood protection standards and enhancing the structural stability of remediation works, as well as conducting climate risk assessments to identify vulnerable areas [6]. During the reuse phase, transforming coastal brownfields into wetlands, ecological buffers, and nature reserves significantly enhances urban climate regulation capacity [7]. Specific measures include combining brownfield regeneration with floodplain wetlands, detention basins, and levees to strengthen responses to extreme events such as heavy rainfall, flooding, and sea level rise, thereby playing a critical role in climate adaptation and regulation [8].

2.2 Case study

This paper selects three representative cases of coastal brownfield regeneration: Sydney Olympic Park in Australia, Freshkills Park in the United States, and the Shanghai Expo Houtan Park in China (Figure 1).

The regeneration of these sites began in the 1990s and has continued to the present day, covering a considerable time span and demonstrating representative significance. Although these projects did not explicitly target climate resilience in their early stages, their remediation and transformation processes have fully embodied the core principles of green low-carbon development, resilience enhancement, and sustainability. Substantial

progress has been made in flood control, disaster mitigation, and ecological restoration. Currently, the three sites are at different stages of development: Sydney Olympic Park and Shanghai Expo Houtan Park are largely completed and operational, whereas Freshkills Park remains under ongoing construction. The following sections present a brief introduction and comparison of the three coastal brownfield regeneration cases, providing a basis for the subsequent comparative analysis and evaluation (Table 1).



Figure 1. Global Map of Three International Cases

2.2.1 Sydney Olympic Park, Australia

Located in Homebush Bay, Sydney Olympic Park covers about 4.05 square kilometers. Formerly an industrial and naval ammunition storage site, it suffered severe contamination with 65% of soil polluted and river corridors fragmented. Remediation began in 1992, treating around 9 million cubic meters of soil in situ [9]. PWP Landscape Architecture transformed the site by creating five iconic conical mounds from contaminated soil and restoring over 15 miles of waterfront, including indigenous forests and mangrove wetlands. Now, Sydney Olympic Park is a successful example of coastal brownfield regeneration, serving as an urban green space that enhances environmental quality and supports climate resilience efforts.

2.2.2 Freshkills Park, United States

Located on Staten Island, New York City, Sydney Olympic Park covers 8.9 square kilometers and was formerly the world's largest landfill. Since its closure in 2001 and the initiation of redevelopment, the site has undergone over 20 years of remediation and is gradually being transformed into a coastal ecological park [10]. Currently, only part of the park is open to the public, with full opening anticipated in 2036. During Hurricane Sandy's impact on New York's west coast in 2012, Freshkills Park played a critical ecological buffering role. Its wetlands, streams, and multi-layered ecosystems attenuated flood impacts, providing vital natural protection for surrounding areas. Additionally, the landfill's waste transfer station temporarily resumed operations during the hurricane disaster [2].

2.2.3 Shanghai Expo Houtan Park, China

Shanghai Expo Houtan Park covers 18 hectares and is one of the core green landscapes of the Expo site. Originally, the area housed a steel plant and the Houtan ship repair yard. Ecological restoration began in 2007 under the leadership of Turenscape Landscape Architecture & Urban Design, regenerating the site into an urban wetland park. The park uses sedimentation, aeration, filtration, and biological absorption to purify poor-quality Class V water, which is then reused for landscape irrigation and cleaning within the Expo area. The park's design features a transitional and buffer zone between the Huangpu River and land, formed by a flood embankment designed for a two-year flood event and another designed for a millennial flood event. This zone serves as an urban flood detention area during extreme floods. The layered embankments significantly reduce the height and strength requirements for flood walls, allowing the original concrete embankment to be replaced with low-intensity earth and natural material ecological levees, thereby improving the riverside ecosystem.

Table 1. Comparison of Three International Cases

Project	Sydney Olympic Park	Freshkills Park, New York	Shanghai Expo Houtan Park
Country	Australia	United States	China
Area	4.05 km²	8.9 km²	0.18 km²
Former Use	Heavy manufacturing and naval ammunition storage; landfill	Landfill	Steel plant and Houtan ship repair yard
Current Use	Ecological wetlands and recreational park	Ecological park	Wetland park
Design Firm	PWP Landscape Architecture	James Corner Field Operations	Turenscape
Period	1992–2000	2001–present	2007–2009

2.3 Evaluation framework

Based on the preceding literature review, a preliminary qualitative evaluation framework encompassing both the remediation and reuse

phases of coastal brownfield regeneration was developed to serve as an analytical foundation for the subsequent case analysis (Table 2).

Table 2. Evaluation Framework of Coastal Brownfield Regeneration for Climate Resilience

Phase	Evaluation Indicators	Climate Resilience
Remediation Phase	A1 In-situ treatment of contaminated soil and groundwater	Climate Mitigation
	A2 Use of low-carbon construction materials and green equipment	
	A3 Implementation of climate change emergency response plans	Climate Adaptation
	A4 Enhance remediation engineering's capacity to respond to climate change	
	A5 Identification of areas vulnerable to climate change	
	A6 Improve site drainage and flood protection standards	
Reuse Phase	B1 Regeneration as green infrastructure to enhance carbon sequestration	Climate Mitigation
	B2 Integration with sustainable energy development	
	B3 Construction of flood control wetlands, detention basins to resiliently respond to floods and sea level rise	Climate Adaptation
	B4 Flexibility for multi-functional reuse (daily and emergency uses)	
	B5 Improve public awareness of climate change	
	B6 Experience extreme climate events and play a positive role	

3 Results and Discussion

3.1 Results

Drawing on the assessment framework introduced in Section 2.3, relevant materials—including academic reports, official documents, park planning records, and journal articles—were collected to conduct a qualitative analysis of the three case studies. The climate resilience strategies were scored across various indicators (Table 3, Table 4, Figure 2, Figure3).

In terms of overall performance across both the remediation and reuse phases, Freshkills Park in New York (22 points) demonstrates the strongest overall climate resilience performance, leading in both phases. Sydney Olympic Park and Shanghai Expo Houtan Park each scored 19 points, tying for second place. To better understand the implications of these scores, a brief analysis of each case is presented below.

(1) Sydney Olympic Park, Australia: Notable performance during the remediation phase, especially in in-situ soil remediation, which significantly reduced carbon emissions. Climate adaptation goals have been integrated into the *Sydney Olympic Park Master Plan 2050*.

(2) Freshkills Park, New York, USA: Balanced performance overall. While the park lacks a dedicated emergency response plan for climate change, its management strategies align closely with New York City's climate change action plan.

(3) Shanghai Expo Houtan Park, China: Strong performance in water remediation and engineering resilience measures, but room for improvement in soil in-situ remediation, sustainable energy use, and public awareness of climate change.

Table 3. Climate Resilience Performance Scores during the Remediation Phase

Evaluation Indicators	Sydney Olympic Park	Freshkills Park	Shanghai Expo Houtan Park	Score
A1	●	●	◐	5
A2	●	●	●	6
A3	◐	○	◐	2
A4	●	●	●	6
A5	◐	●	●	5
A6	●	●	●	6
Score	10	10	10	30

● (2): Well implemented;
◐ (1): Partially implemented or in progress;
○ (0): Not implemented or insufficient data.

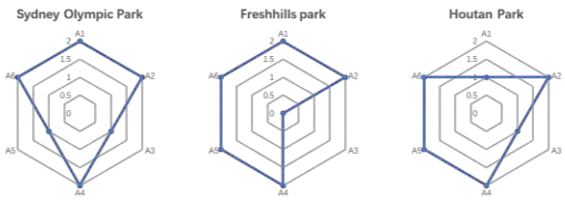


Figure 2. Climate Resilience Scores Illustrated by Radar Diagram during the Remediation Phase

Table 4. Climate Resilience Performance Scores during the Reuse Phase

Evaluation Indicators	Sydney Olympic Park	Freshkills Park	Shanghai Expo Houtan Park	Score
B1	●	●	●	6
B2	●	●	○	4
B3	●	●	●	6
B4	◐	●	●	5
B5	◐	●	◐	4
B6	◐	●	●	5
Score	9	12	9	30

● (2): Well implemented;
◐ (1): Partially implemented or in progress;
○ (0): Not implemented or insufficient data.

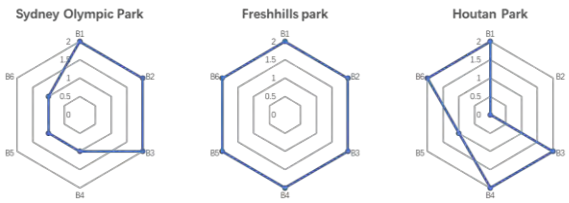


Figure 3. Climate Resilience Scores Illustrated by Radar Diagram during the Reuse Phase

In terms of specific indicators, during the remediation phase, A2 (use of low-carbon construction materials and green equipment), A4 (enhance remediation engineering's capacity to respond to climate change), and A6 (improve site drainage and flood protection standards) generally receive higher scores. In contrast, A3 (implementation of climate change emergency response plans) tends to show weaker performance.

For the reuse phase, B1 (regeneration as green infrastructure to enhance carbon sequestration), and B3 (construction of flood control wetlands, detention basins to resiliently respond to floods and sea level rise) demonstrate relatively strong outcomes, whereas B2 (integration with sustainable energy development) and B5 (improve public awareness of climate change) are comparatively less addressed.

3.2 Discussion

Although this study attempts to evaluate the three cases within a unified framework, significant differences in their size, function, geographic location, and regeneration stages mean that the selected assessment indicators may not fully or accurately reflect each case's actual climate resilience. Moreover, since the indicators are primarily derived from literature, further refinement is needed in future research to enhance their applicability and accuracy. For example, indicator A2, "Use of low-carbon construction materials and green equipment," should include a detailed inventory of low-energy materials and equipment. Similarly, indicator B2, "Integration with sustainable energy development," requires more precise quantification of sustainable energy utilization efficiency, including calculations of the resulting carbon emission reductions.

4 Conclusion

This study demonstrates that systematically integrating resilience concepts throughout the entire lifecycle of brownfield regeneration can effectively enhance coastal cities' capacity to respond to climate change. Based on the literature and case study findings, the following comprehensive strategies are proposed:

(1) Systematically integrate climate resilience goals into brownfield regeneration

Embed climate resilience objectives across the full life cycle of brownfield remediation and reuse. Promote coordinated actions spanning mitigation and adaptation by integrating engineering, technology, design, and governance at multiple scales, thereby enhancing the climate resilience of coastal urban areas.

(2) Enhance engineering resilience and promote low-carbon remediation technologies in the remediation phase

In the remediation phase, prioritize enhancing resilience to climate risks by identifying vulnerable brownfield sites and developing emergency response plans for extreme weather events. Promote the use of in-situ and phytoremediation techniques to minimize emissions during remediation and transportation processes.

(3) Strengthen carbon sink capacity and climate adaptation in the reuse phase

During reuse phase, enhance the carbon sink function of ecological infrastructure while integrating sustainable energy sources such as wind, solar, and tidal power. Employ low-impact development (LID) strategies such as floodplains and retention basins to build adaptive capacity against flooding and sea-level rise.

The evaluation framework for climate resilience performance in coastal brownfield regeneration developed in this study remains preliminary and primarily qualitative. Future research should focus on developing a more comprehensive assessment model that combines both qualitative and quantitative approaches, grounded in systematic literature reviews and in-depth case studies. The findings aim to offer theoretical guidance and technical support to advance brownfield regeneration practices in coastal cities worldwide.

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THRIVING ON DISTURBANCE: RETHINKING DISTURBANCE AS AN ECOLOGICAL DESIGN TOOL

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Abstract
The paper explores how disturbance ecology can inform planting design and maintenance practices in urban landscapes. Drawing on the author's PhD research from the Ruhr Valley, Hermannshof research garden, and a landscape design project in Cleveland, Ohio, the research proposes a shift from viewing maintenance as a separate phase to understanding it as strategic disturbance that shapes plant and animal communities. The paper argues that contemporary landscape practice must bring together ecological observation, design, and maintenance into an integrated approach that acknowledges landscapes as dynamic milieus rather than static compositions. Through three case studies, the research demonstrates how disturbance regimes can encourage biodiverse designs while meeting aesthetic expectations. This approach furthermore challenges the traditional separation between design conception and maintenance inherited from industrial management models.

Text

1. Introduction

Extreme weather events such as fires, floods, and droughts are shaping the daily lifes of people more and more, especially so in urbanised contexts. To be able to better respond to such events as landscape professionals, we must understand the role of disturbances in landscapes. This argument builds on the hypothesis that landscapes in the Anthropocene face accelerated cycles of collapse and transformations due to altered disturbance regimes (Newman, 2019). Instead of denying these dynamics, the paper asks what opportunities disturbance creates, what challenges they pose, and what kind of perceptual shift is required to actively participate in them.

In conventional approaches to landscape design disturbance is treated as something to be 'get rid of' and to control. The field of disturbance ecology reveals though, that disturbances—whether fires and floods or mowing and grazing—are important drivers of ecosystem dynamics (Jentsch et al., 2022). This insight challenges landscape practitioners to reconsider their role from controllers of static compositions to participants in dynamic ecological processes.

Drawing on extensive fieldwork in Germany and the United States, this paper demonstrates how disturbance ecology can inform planting design and maintenance in urban contexts. The research reveals how strategic disturbances can foster biodiversity white taking into account aesthetic appeal, and create resilient plant communities adapted to urban conditions. Crucially, this approach requires challenging the separation between design conception and maintenance execution — which as the author argues is a division inherited from industrial management that proves counterproductive when working with living landscapes.

2. Theoretical Framework: From Static Design to Dynamic Participation

2.1. Disturbance as Creative Force

Disturbance ecology shows that many ecosystems depend on regular disruptions to maintain their characteristic diversity and structure (Connell, 1978). This is even more true for those bioms that inspire contemporary planting design such as prairies, steppes and meadow plant communities.

Fire and grazing are crucial disturbance regimes that keep a high species variety as well as a high visual interest. The Intermediate Disturbance Hypothesis suggests that such moderate levels of disturbance create optimal conditions for species diversity by preventing competitive exclusion while avoiding catastrophic system collapse (ibid.). Missing disturbance, can on the contrary build up to catastrophic events, such as large scale forest burns — if too much biomass builds up on a forest ground, the probability of a severe and dramatic forest burn are much higher. Regular disturbances can thus prevent catastrophic collapses.
In urban landscapes, this principle becomes particularly relevant. Sites often exhibit conditions that resemble naturally disturbed habitats: highly diverse substrate composition, irregular topography, harsh microclimates and regular disturbance events. Rather than viewing these characteristics as deficits to be corrected, an ecological design approach based upon disturbance can recognize them as opportunities to support specialist species and diverse plant communities.

2.2. Challenging the Design-Maintenance Divide

A process-based approach to working with disturbance requires landscape design practices that operate across the phases of a project : The separation into strict phases of analysis, design, implementation, and maintenance, reflects an industrial management model developed for manufacturing contexts. Frederick Taylor's principles of scientific management promoted the division of complex tasks into simple, repeatable actions performed by specialized workers under oversight of managers (Baecker, 2003). While this approach proved effective for producing standardized goods, such as cars, it becomes problematic when applied to living systems that are based upon complexity (Hahn, 2023).
Still, contemporary landscape practice often treats maintenance as a simple execution of predetermined management tasks. This does not do justice to the complexity of the work with dynamic plant communities. Such work requires the practitioner to simultaneously understand ecological processes, take into account aesthetic considerations, and community needs and integrate these in regular site interventions.

2.3. Toward an ecological-aesthetic integration

This research proposes an integrated approach that bridges ecological understanding and aesthetic experience. Drawing on phenomenological perspectives that view humans as embodied participants within place rather than detached observers, this approach acknowledges that work with place and landscape involves both scientific knowledge and sensory experience (Seamon, 2006).
The challenge for ecological design lies in the fundamental invisibility of most ecological processes: soil microbiology, food chains, water cycles, and carbon sequestration occur largely beyond human perception, while what is readily apprehended are visual patterns, seasonal changes, and atmospheric qualities. Landscape - as the perceptible realm - thus becomes the crucial medium through which ecological values must be communicated and ecological design must gain acceptance (Gobster et al., 2007). This creates both opportunity and responsibility: designers must craft experiences that make ecological relationships sensible and compelling, transforming invisible processes into perceptible patterns that foster care and stewardship.

3. Methodology

This research employed a practice-based and action-research inspired approach involving extended engagement with three primary sites: the Landscape Park Duisburg-Nord in Germany's Ruhr Valley, the Hermannshof research garden in Weinheim, Germany, and a design project in residential neighborhoods in Cleveland, Ohio. The methodology combined participant observation, interviews with practitioners, and collaborative design projects to understand disturbance-based approaches in practice.
At each site, the research was based upon diverse methods: Extended periods of observation served to understand existing disturbance regimes and plant community dynamics. Interviews with gardeners, ecologists, and landscape architects shone light on their experiences of practice. Furthermore participation in design processes and maintenance activities gave first-hand experience of strategic disturbance as design tool. These formats were integrated with the documentation of responses of citizens to design and management interventions.
The underlying phenomenological approach to the research prioritized understanding the lived experience of working with dynamic landscapes rather than extracting generalizable principles from a distance. The research aimed to develop what Tim Ingold (2011, 65) calls "skilled practice"

— embodied knowledge that emerges from contextual engagement and judgement.

4. Case Studies: Strategic Disturbance in Practice

4.1. The Prairie and Steppe Plantings at Hermannshof

The research garden Hermannshof, until 2023 under the direction of Cassian Schmidt, has pioneered approaches to low maintenance plantings, especially for plant communities inspired by North American prairie landscapes as well as steppe landscapes. Rather than treating plants as individuals to be arranged in an aesthetic way, the team addresses plant communities as ecological wholes that require specific disturbance regimes to maintain their patterns and their diversity.
The prairie and steppe plantings at Hermannshof demonstrate how understanding reference ecosystems and their disturbance regimes can inform maintenance strategies: Prairies in the Midwest of the US, for example, co-evolved with regular burning practices and grazing. This prevents shrub encroachment and maintains space for herbaceous species. In the garden context, these disturbances are mimicked through annual mowing in early spring, while grazing by bizons is mimicked by the gardeners through selective "editing" with scissors.
Looked at through disturbance ecology, these actions lead to important changes in the plant community: Spring mowing removes accumulated biomass and reduces cool-season grasses that would otherwise quickly dominate the planting. Furthermore, editing removes vigorous species that threaten to overwhelm less competitive plants. Two disturbances that keep the community diverse and aesthetic.
As might be evident by now, such a maintenance approach requires strong ecological knowledge and careful observation. Each intervention must consider not only immediate visual effects but also long-term community dynamics. A gardener removing competitive grasses must understand how this action will affect soil moisture, light availability, and space for other species. The timing, intensity, and spatial pattern of disturbances all influence how the plant community develops over time.
This approach also addresses aesthetic considerations by creating recognizable patterns within the apparent “wildness” of prairie vegetation. Subtle geometric arrangements and clear edge treatments provide visual ‘Cues-to-Care’ that help visitors read the landscape as intentionally designed. Nassauer (1995) has shown that this is crucial for public acceptance. Disturbance-based management can thus serve both ecological and aesthetic goals simultaneously.

4.2. Railway Habitats at Duisburg-Nord

The Landscape Park Duisburg-Nord, developed on the terrain of a former steel production facility, is an striking example how post-industrial sites can become remarkably biodiverse through strategic disturbance management. The park's former railway lines are e.g. maintained as a species rich meadow community through regular disturbance. The black railway substrate is similar to sub-mediterranean dry grasslands: high temperatures, low fertility, and excellent drainage. Stress-tolerant species thrive in these conditions: Oregano (Origanum vulgare), evening primrose (Oenothera biennis), and viper's bugloss (Echium vulgare) would struggle to compete in more fertile environments, such as agricultural landscapes and find a habitat here.
‘Maintaining’ this community requires understanding its need for disturbance : As a meadow community, the railway meadow requires periodic grazing or mowing to prevent succession. Otherwise, woody vegetation would shade out the herbaceous species and succession would take its course. However, the timing and frequency of this disturbance must be carefully judged. Too frequent mowing would prevent plants from completing their reproductive cycles, while insufficient disturbance would allow competitive grasses and shrubs to dominate.
Taking into account the frequency and intensity of disturbance, the management team at Duisburg-Nord has developed a regime of annual late-summer mowing with complete removal of cuttings. This allows most species to set seed while preventing nutrient accumulation that would favor competitive species. The practice maintains the low-fertility conditions that support the community's distinctive character while providing visual appeal through extended flowering periods.
The example reveals several key principles of disturbance-based management: First, the intervention attunes to existing site conditions rather than attempting to impose an external vision of ecological health. Second, the timing and intensity of disturbance are calibrated to support desired ecological processes. Third, the approach requires ongoing observation and adaptive long-term management rather than mechanical prescriptions.

4.3. Urban Prairie Gardens in Cleveland

Further research explored how prairie plant communities could be adapted for residential landscapes in urban neighborhoods. The design intervention is being developed and tested as part of a National Science Foundation project led by Prof. Mary Gardiner, an entomologist from Ohio State, with design leadership by Prof. Nassauer, University of Michigan, accompanied by an interdisciplinary team. The project addresses the challenge of creating pollinator habitat while respecting community aesthetic preferences. Especially East Cleveland, one of the study areas, shows high vacancy rates and economic disinvestment following the decline of manufacturing industries. Previous attempts to establish prairie plantings on vacant lots had met resistance from residents who found the tall, dense vegetation threatening and undesirable (Turo/Gardiner, 2020). The research project sought to develop design approaches that could provide ecological benefits while addressing community concerns about safety and appearance. The design iteration that the author participated in, involved understanding aesthetic affordances of prairies at a finer scale and adapting design strategies. Rather than choosing prairie plants that reach full height and density (up to 2m), the design iteration used species from sand barrens that remain low and tidy; and strategic management to create more visually accessible plantings — crucial to meet communities preferences. The design approach allowed to introduce the ecological benefits of prairie vegetation in urban neighborhoods, such as diverse flowering resources for pollinators, soil health through deep root systems and drought tolerance.
Simultaneously urban landscapes that felt safe and attractive to residents were created.
Key design strategies included using shorter prairie species, creating clear sight lines through plantings, and incorporating 'Cues-to-Care' (Nassauer, 1995) that were observed in the neighborhood, such as mown edges and geometric arrangements that signal human intention and maintenance. As for maintenance, more frequent intervention is necessary than would be typical in larger prairie restorations, but an intensive approach proved necessary for community acceptance.
This case study illustrates how disturbance-based approaches must be adapted to specific social and cultural contexts. The ecological principles remain constant, but their application requires sensitivity to community needs and preferences. Successful implementation depends on understanding both plant community dynamics and human community values.

5. Implications for Practice

5.1. Toward Integrated Landscape Management

The case studies reveal that effective disturbance-based management offers an approach that transcends either control-based or laissez-faire approaches that overemphasize or neglect human intervention. Instead, it positions practitioners as participants who integrate ecological knowledge, aesthetic experience and community preference. This challenges conventional professional boundaries that separate ecologists (who study), urbanists (who consult), landscape architects (who design), and maintenance crews (who implement). The most successful examples from this research involved practitioners who maintained close involvement with sites over extended periods, rather than doing one-off interventions. Cassian Schmidt's work at Hermannshof demonstrates how design and maintenance can be integrated when the same individual or team maintains responsibility for both conceptual development and daily care. Similarly, the original management approach at Duisburg-Nord involved close collaboration between landscape architects, ecologists, and gardeners who worked together over years to develop adaptive strategies.
This integration requires changes in the educational system to prepare landscape professionals to work with dynamic systems over time. Currently designers and architects are not necessarily trained to understand ecological relationships, neither to maintain plant communities. Too much emphasis is placed on static design intentions and graphic representation of these. At the same time, maintenance crews lack ecological knowledge or design skills to adjust their interventions. A disturbance-based approach would instead emphasize process understanding, adaptive management, and long-term engagement with particular designs in particular places.

5.2. Strategic Disturbance as Design Tool

The research shows that understanding disturbance regimes provides landscape designers with powerful tools for shaping plant community development. Rather than viewing maintenance as simple preservation of an original design intent, practitioners can use strategic disturbances to guide ecological succession toward desired outcomes.

This approach requires shifting from static to dynamic thinking about landscape composition. Instead of specifying exact plant locations, designers might establish initial conditions and disturbance regimes that encourage desired community characteristics to emerge over time. This requires understanding processes within plant communities, competitive relationships, and responses to different management practices. The timing, intensity, frequency, and spatial pattern of disturbances influence plant community development crucially. Depending on *when* a disturbance event happens within the life cycle of a plant, it might be encouraged to live on, expand or even disappear. Early-season mowing favors for example warm-season grasses over cool-season species, as they get a competitive advantage. Late-season cutting instead allows flowering plants to complete reproduction and seed for the next season. Understanding such ecological relationships allows landscape practitioners to use disturbance as a helpful tool in accompanying dynamic plant communities.
Furthermore, understanding disturbance regimes can help choose plant communities that are well-suited to sites with high intensity or high frequency disturbance patterns. This proves particularly valuable in urban contexts where some level of ongoing disturbance may be inevitable – just think about people walking through meadows, plantings, leave trash, road salt and so on! Rather than attempting to impose stability on inherently dynamic sites, designers can select plant communities that are already adapted to similar disturbance regimes.

6. Discussion of Challenges and Limitations

6.1. A professional field marked by mechanistic work processes

So far, the theory. However, implementing disturbance-based approaches requires organizational set-ups that allow and support integrated long-term engagement with sites. The current organization of the landscape professions separates in a majority of cases ecological field studies from design contracts from maintenance services, making it difficult to maintain the continuity necessary for an adaptive, responsive management.
The research suggests that integrated approaches actually prove more economical in the long-term than a compartimentalization. Design intentions that fail because of lacking accompaniment are a major cost point and a regular experience in the landscape field. The prairie plantings at Hermannshof on the other hand are long-term plantings that require less labor and fewer inputs than traditional static gardens once they are established. The key shift necessary is to invest in site understanding, choosing fitting plant communities and setting up long-term dynamic maintenance regimes.
The railway meadows at Duisburg-Nord show that such an approach comes with minimal intervention cost compared to intensive turf or ornamental management. The annual mowing regime costs significantly less than weekly maintenance while supporting greater biodiversity and providing unique aesthetic experiences.
These examples suggest that disturbance-based design and maintenance approaches make economic sense for municipalities that struggle with low budgets. However, they require initial investment in practitioner education and organizational restructuring to support integrated management approaches.
Current professional attribution systems create rigid boundaries between different types of expertise – these barriers between landscape architects, ecologists and maintenance crews impede integral approach as sketched out here. Landscape designers are e.g. rarely payed for more than a couple of site visits after implementation – if at all. However, continuous collaboration between designers and maintenance crews are crucial for a design intention to express in the long term.

6.2. Public Perception and Aesthetic Expectations

One of the primary challenges in implementing disturbance-based approaches involves public perception of landscapes that appear "messy" at certain times of the year. A meadow for example is colourful during spring and summer, but becomes high and brown in later summer and autumn. The Cleveland case study demonstrates how community resistance can make well-intentioned ecological initiatives fail. Many people associate tidy, controlled landscapes with care and investment, while more naturalistic approaches may be perceived as neglect or abandonment (Nassauer, 1995).
Addressing this challenge requires careful attention to visual communication and community engagement. Successful projects often incorporate ‘Cues-to-Care’ that signal human intention and ongoing management. These might include clear edge treatments, selective mowing patterns,

however, what is perceived as a 'Cue-to-Care' changes with the locality and context (ibid.).

6.3. Ecology as a fundamental part of education

Effective disturbance-based management requires sophisticated understanding of plant ecology, community dynamics, and ecosystem processes. This knowledge is currently neither incorporated in landscape design degrees, nor easily transmitted through brief training sessions. Instead, it develops through extended experience working with particular plant communities and observing their responses to different management practices. Municipal maintenance crews typically receive limited training and work across diverse sites with little opportunity to develop deep expertise with particular plant communities. Expanding these approaches would require significant investment in education and training programs.

7. Conclusion: Cultivating disturbance literate practice

Disturbance ecology offers valuable perspectives for designing and accompanying dynamic, resilient and biodiverse urban landscapes. By understanding better how disturbances regimes shape plant communities, practitioners can work with rather than against ecological processes to achieve both ecological and aesthetic goals.

However, "disturbance-literate" practice requires fundamental changes in how the professional field is organized. The artificial and mechanistic separation between landscape design and maintenance must give way to integrated approaches that treat landscape development as an ongoing collaborative process between human practitioners and more-than-human communities. The case studies have demonstrated how a disturbance perspective offers a nuanced approach to the practitioner as a participant in landscape development.

This shift furthermore demands new forms of professional education that prepare practitioners to work with dynamic living systems over extended time periods. It requires an organisation that supports such long-term engagement with particular places rather than one off project-based interventions. Static design approaches that attempt to impose fixed compositions are proving increasingly inadequate – especially as volatility of climate increases. Practitioners thus have to learn to work with disturbance as a creative force.

The post-industrial and urban landscapes explored in this research offer glimpses of what such an approach might achieve. Sites like Duisburg-Nord demonstrate that former industrial areas can become remarkable biodiversity hotspots when management works with rather than against dynamic ecological processes. The prairie gardens at Hermannshof show how scientific understanding of such dynamic processes can inform artistic practice to create landscapes that are both ecologically functional and aesthetically compelling.

Perhaps most importantly, this research suggests that practitioners are not positioned outside ecological systems as external managers or controllers. Instead, we can learn to participate skillfully within dynamic meshworks of relationships that include multiple species as well as environmental forces. This shift requires both humility and attention.

The title "thriving on disturbance" describes both the ecological principle at stake and the perceptual shift it requires. As the research shows that many plant communities need disturbance to flourish. But landscape practice itself must be willing to be disturbed in its 'ways of doing' —to question comfortable assumptions about separate professional roles, in favor of more responsive, adaptive, and collaborative approaches. By learning to understand disturbance as potential and creative force, practitioners can find a ressourceful perspective for their work with urban and industrialised landscapes.

An important step for the professional field would be to educate practitioners who hold simultaneously skills in ecology, design, and gardening. This would allow to integrate scientific understanding with aesthetic sensitivity and a commitment to long-term engagement.

As cities continue to grow and disturbances e.g. through strong, unexpected weather event intensify, the stakes for learning how to work with dynamic landscapes will only increase. Post-industrial landscapes that have faced extreme disturbances are valuable experimental grounds from which we can learn for these future challenges. Duisburg-Nord is a hopeful example of how disturbance creates a diverse meshwork of life on which we all depend.

Acknowledgments
This paper draws extensively on the author's PhD dissertation, *Thriving on Disturbance: An Ecological-Aesthetic Approach to Design in Post-Industrial Landscapes* (Goethe University Frankfurt, 2025). The research findings, theoretical frameworks, case studies, and conclusions presented here are based on original fieldwork and analysis conducted by the author between 2021 and 2024.

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The accuracy of the references in the paper is under the full responsibility of the Author/Authors of the paper. All publications cited in the text should be referred to by a number in square brackets, [1,2,3].
The full reference **(maximum 10 references)** should be given in a list at the end of the paper according in the following format / ISO690 / International standart for bibliographic elements :

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GRADIENT SHIFT IN URBANIZATION IMPACTS ON WATER-HEAT-CARBON RISKS: IMPLICATIONS FOR GUIDING SUSTAINABLE URBAN DEVELOPMENT

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Keywords: Urbanization, Water-Heat-Carbon Risks, Threshold Effects, Mechanism Identification, Sustainable Landscape Planning

Abstract

Rapid urbanization destabilizes water-heat-carbon systems, amplifying interconnected risks such as urban flooding, urban heat islands, and carbon imbalances that threaten urban sustainability. Focusing on Beijing, this study investigates the nonlinear mechanisms by which urbanization gradients shape these risks through integrated spatial analysis, structural equation modeling, and threshold-based zoning. The results show demonstrate an inverted "S"- shaped response of water-heat-carbon dynamics to urbanization intensity, with two critical night-time lighting thresholds (34 and 296 nW/cm²/sr) defining three zones: Urban Core, Urban Expansion, and Urban Periphery. These thresholds mark irreversible shifts in risk dynamics: Urbanization transitions from direct negative impacts in peri-urban areas to complex interactions in highly urbanized areas, where direct and mediated effects coexist with trade-offs and synergies. Crucially, natural topography, vegetation cover, and landscape patterns act as mediators across gradients, revealing strong spatial heterogeneity in ecological vulnerability.

This study identifies priority management areas in Beijing by analyzing spatial transitions in water-heat-carbon risks using cumulative distribution functions. Two critical thresholds classify regions into priority restoration zones (19 units likely to transition to low-risk conditions) and protection zones (31 units requiring intervention to prevent high-risk degradation), which are integrated into Beijing's "Two Rings and Six Wedges" ecological framework. In the Urban Core Area, dominated by impervious surfaces, strategies emphasize retrofitting gray-green infrastructure to counter urban heat islands and urban flooding, while leveraging microclimate regulation. The Urban Expansion Area, facing encroaching urbanization, adopts ecological corridors and riparian buffers to reconnect fragmented habitats. The Urban Periphery Area, critical for regional ecological security, enforces strict red-lines to prohibit land conversion. These policies preserve forests and wetlands, which play an essential role in carbon sequestration and water retention. These threshold-based strategies align urban development with ecological gradients, balancing growth intensity with environmental carrying capacity. By embedding nonlinear water-heat-carbon responses into land use policies, Beijing's framework exemplifies adaptive urban governance. It offers a scalable model for megacities to harmonize sustainability with urbanization. This approach emphasizes the need for targeted spatial interventions to mitigate compound risks. It also promotes long-term resilience in urban and regional governance.

By bridging landscape science and policy, this study advances a paradigm for guiding cities and regions toward climate-resilient futures. The gradient-aware framework demonstrates how nonlinear responses and mediating environmental factors can inform targeted interventions to reduce compounding risks while supporting SDGs 6, 11, and 13. The findings provide scalable insights for global megacities facing similar water-heat-carbon challenges, emphasizing proactive governance over reactive solutions. This approach not only addresses immediate ecological threats, but also redefines urban landscapes as dynamic, adaptive systems where human and natural processes coexist sustainably.

Text

1. Introduction

Rapid urbanization in the context of the Anthropocene is pushing urban development onto an unsustainable trajectory. Cities are facing water-heat-carbon risks intertwined with flooding, heat islands and carbon emissions, with the core driving mechanism originating from the spatial mismatch of supply and demand (ESSD) of key ecosystem services (e.g., urban cooling, carbon storage, flood mitigation). To address this challenge, spatial management strategies based on ecosystem thinking are urgently needed to enhance urban resilience.

This study focuses on the nonlinear relationship between urbanization and water-heat-carbon risks. The "agglomeration effect" of urban expansion shows complex patterns in spatial gradients (e.g., distance decay, S-shaped inversion), which profoundly disturbs ecological structure and function, leading to significant gradient changes in risk response and potential critical thresholds. Exceeding the thresholds may trigger abrupt systemic changes (e.g., runaway heat islands, collapse of the hydrological cycle), but current research lacks mechanism analysis along the urbanization gradient. The core challenge is that risk response is highly dependent on the environmental-socioeconomic context [1,2], and different gradients (core, peri-urban, and far-peri-urban) show different impact mechanisms, and ignoring these differences will lead to policy failure.

Therefore, this study takes Beijing as an example, and reveals the gradient change mechanism of urbanization impact on water-heat-carbon risks through the following steps, and provides a basis for sustainable governance: first, we validate the relationship between urbanization and water-heat-carbon risks, find the nonlinear change between the two, and determine the impact threshold of the urbanization gradient. Second, we verified and analyzed whether socio-ecological factors, as a mediating variable, have a different impact on the relationship between water-heat-carbon risks response to urbanization at different urbanization gradients. Finally, based on the identified priority management areas and issues, as well as new insights into the mechanisms by which urbanization affects water-heat-carbon risks, we provide sustainable and optimized solutions in the context of current sustainable management policies.

2. Methods

2. 1. Study Area

Beijing (116°20′E, 39°56′N), a typical representative of China's urbanization, covers an area of 16,410.54 km² and has a temperate monsoon climate (average annual temperature of 10.9-12.7°C and annual precipitation of 500-800 mm). The ecological pattern is characterized by distinctive features: the built-up area is concentrated in the central plains, surrounded by arable land; forests and water bodies are mainly distributed in the western and northern mountainous areas.

Between 2000 and 2020, Beijing's urbanization rate increased by 10%, population doubled, and GDP increased tenfold. Rapid urbanization has exacerbated human-land conflicts, triggering risks such as the heat island effect, flooding, and high carbon emissions [3], prompting the government to implement a number of ecological projects. The complete urbanization gradient provides an ideal scenario for analyzing the water-heat-carbon risks response mechanism, and the research results are of great value for the sustainable development of small and medium-sized cities.

2.2. Methodological framework

In order to address the ecological crises associated with urbanization and to support sustainable urban development, this study proposes a new methodological framework for identifying management options on the urbanization gradient (Figure 1). The process consists of three steps: (1) exploring the relationship between water-heat-carbon risks responses to urbanization and delineating urbanization impact gradients based on thresholds, (2) validating and elucidating differences in the mechanisms by which urbanization affects water-heat-carbon risks across the urbanization

gradient, and (3) setting priority issues and areas of governance priorities for urbanization control and restoration of water-heat-carbon supply.

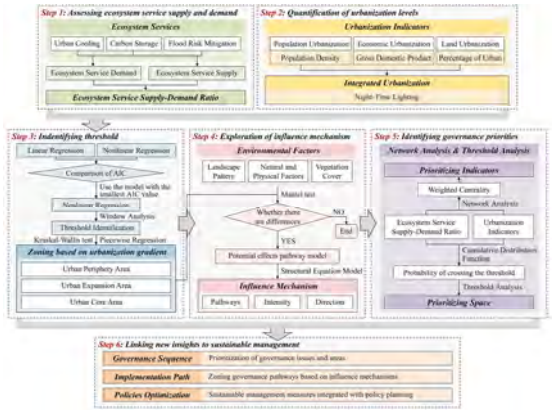


Figure 1. Methodological framework.

2.2.1 Quantification of water-heat-carbon supply and demand ratios

The ESSD ratio (ESDR) visually describes the relationship between ecosystem service provisioning and human demand [4]. This provides a basis for understanding the spatial mismatch between water-heat-carbon supply and demand. A value of less than 0 indicates a deficit of ecosystem services, while a value of 0 indicates a surplus of ecosystem services. Conversely, a value of 0 indicates that ESSD is in equilibrium. The formula is as follows:

$$ESDR = \frac{S - D}{(S_{max} + D_{max})/2}$$

where S and D are the supply and demand of each ecosystem service, respectively, and S_{max} and D_{max} are the maximum supply and demand values of ecosystem services, respectively.

Furthermore, the magnitude of ESDR varied considerably. To gain a more comprehensive understanding of the overall situation of multiple ESSD, we first normalized the supply-demand ratios of the three selected ecosystem services to ensure that the indicators had the same weighting and quantified the comprehensive ESDR (CESDR) by summation.

$$ESDR' = \frac{ESDR - ESDR_{min}}{ESDR_{max} - ESDR_{min}}$$

where $\mathrm{ESDR_{min}}$ and $\mathrm{ESDR_{max}}$ are the minimum and maximum values respectively.

$$CESDR = \sum_{i=1}^{n} ESDR'_i$$

where n is the number of types of ecosystem services, and $\mathrm{ESDR_i}$ is the supply-demand ratio of ecosystem service type i.

2.2.2 Assessing levels of urbanization

Urban development varies in terms of economic, demographic and physical spatial distribution, especially in megacities. Therefore, this study measures urbanization in terms of population urbanization (POP, people/km²), economic urbanization (GDP, million RMB/km²), and land urbanization (PU, %). In order to quantify comprehensive urbanization in a more rational way, we chose nighttime lighting as a suitable proxy for measuring the intensity of the spatial distribution of socioeconomic activities. This is because nighttime lighting can more comprehensively characterize the spatial distribution of urban growth, socioeconomic development status and energy consumption.

2.2.3 Characteristics of water-heat-carbon risks response to urbanization

To assess the response of water-heat-carbon risks to urbanization, this study uses linear and nonlinear regression (general additive model) modeling based on the smallest administrative unit (township) in China. The optimal model was screened by Akaike's information criterion, and if the nonlinear fit was better, sliding window analysis was utilized to identify structural changes at inflection points. Based on this, segmented linear regression using Python's pwlf package was used to detect threshold inflection points in the relationship between ESDR and urbanization. The bootstrap method (Bootstrap) was further used to calculate the slope and intercept of each segment and assessed for statistical significance by Kruskal-Wallis test.

2.2.4 Exploration of the mechanism of urbanization's impact on water-heat-carbon risks under the urbanization gradient

The Mantel test was used to quantify the differences in the association between urbanization, environmental factors (natural physical elements/vegetation cover/landscape pattern) and water-heat-carbon risk in different subregions, and to verify the independence of environmental dependence on water-heat-carbon risks under the urbanization gradient. In view of the significant differences in the gradient of variables, structural equation modeling (SEM) is introduced to resolve the differentiation mechanism of urbanization on

subregional environmental degradation and post-disaster recovery. The a priori model was constructed with reference to the LUCC and MEA frameworks, and the final path diagrams were obtained after stepwise correction (excluding p≥0.05 paths). The reliability of the model was assessed by goodness-of-fit (values <0.45 were considered invalid).

2.2.5 Identifying governance priorities and spatial locations

To further support sustainable urban management, we identified two types of key governance priorities: first, quantifying governance indicators for urbanization water-heat-carbon risks; and second, identifying priority governance areas. For Component 1, we used time-weighted centrality to quantify the importance of network nodes to elucidate topological differences between urbanization and water-heat-carbon supply indicators. This approach allows us to prioritize multiple indicators for decision makers' governance.

In component 2, we analyze the probability of crossing cells. This is achieved through a cumulative distribution function, which allows visualizing the cumulative probability of a unit crossing a certain threshold [5]. Subsequently, a cross-validation method was used to assess the model's ability to generalize across different thresholds. This allows the selection of the probability threshold with the best performance. Mapping their spatial distribution can provide decision makers with more accurate areas for restoration and protection .

3. Results

3.1. Analysis and Visualization of water-heat-carbon Supply

water-heat-carbon supply is becoming increasingly important in the urbanization of Beijing. There is an obvious mismatch in the spatial distribution of these services; however, the degree of spatial mismatch varies among the three services. Flood risk areas are concentrated in the central urban area, accounting for about 4% of Beijing's area. The degree of mismatch between supply and demand is higher for urban cooling and carbon imbalance, which account for about 48% and 23% of Beijing's area, respectively.

3.2. Response characteristics of water-heat-carbon supply to urbanization

To test the hypotheses, we evaluated the characteristics of the response of the integrated ESDR to POP, GDP, PU, and integrated urbanization (nighttime lighting). In addition, we identified the number of thresholds and the level of urbanization at which these responses appear to change abruptly (Fig. 2a-d). The results show that the water-heat-carbon supply decreases with increasing urbanization gradient, and there is a clear turn; therefore, the nonlinear model is more suitable for the relationship between water-heat-carbon risk and urbanization. Among them, there is one critical value for the effect of POP on water-heat-carbon risk (527.33*103 people/km²), and two critical values for the effect of GDP on water-heat-carbon supply (32.26*107 RMB/km² and 2348.70*107 RMB/km²), and the negative effect of PU on water-heat-carbon supply is in an inverted S-shape, with critical values of 21% and 89%. The negative impact of PU on water-heat-carbon supply was inverted S-shaped, with critical values of 21% and 89%, respectively. In order to more comprehensively and accurately describe the overall impact of urbanized watersheds on water-heat-carbon supply, we focused on describing the response of ESDR to integrated urbanization (nighttime lighting). Regression results show that ESDR tends to increase and then decrease as the urban gradient increases. Two thresholds were identified, i.e., 33.57 and 295.73. The results indicate that water-heat-carbon supply undergoes significant changes with urbanization. Therefore, the study area was further divided into three different zones: urban core area (UCA), urban extension area (UEA) and urban periphery area (UPA)(Fig.2e,f).

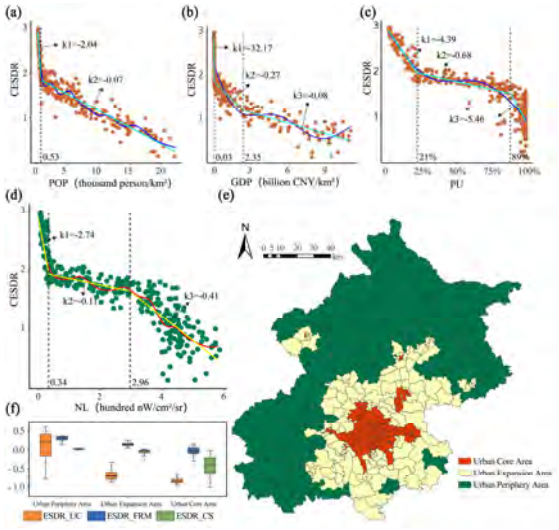


Figure 2. Nonlinear changes in water-heat-carbon supply along the urbanization gradient. (a-d) Nonlinear response of CESDR to demographic urbanization, economic urbanization, land urbanization, and integrated urbanization. (e)

Urban zoning based on ESDR response characteristics of integrated urbanization. (f) ESDR for different zoning districts.

3.3. Relationship between urbanization, environmental factors and water-heat-carbon supply under urbanization gradient and their differences

In order to verify the environmental dependence of urbanization on water-heat-carbon supply, Mantel test found that there are significant differences in different urbanization gradient subzones. In general, the number and coefficients of urbanization indicators that are significantly related to environmental factors and the risk of environmental degradation show a tendency of decreasing and then increasing, while the correlation between environmental factors and water-heat-carbon supply, and the correlation between environmental factors are weakened with the increase of urbanization gradient. Specifically, natural physical factors in the UCA are negatively correlated with water-heat-carbon supply and other environmental factors; vegetation cover and landscape pattern in the UEA are highly positively correlated with water-heat-carbon supply; and landscape pattern in the UPA is weakly correlated with other environmental factors, but maintains a significant correlation with water-heat-carbon supply.

3.4. Mechanisms of urbanization on water-heat-carbon supply under different urbanization gradients

The mechanism analysis based on the SEM method shows that the higher the urbanization level, the number of pathways directly affecting water-heat-carbon supply increases while the share of indirect influence decreases. In the UCA, the direct effect of urbanization on water-heat-carbon supply is greater than the indirect effect, and the environmental degradation is mainly improved through the three positive pathways of URB-NPF-VC-ESDR, URB-VC-LP-ESDR and URB-LP-ESDR. ESSD pathway are all negative effects. In the UPA, the indirect negative effect of urbanization through natural physical factors is significantly stronger than the direct effect, in which the URB-NPF-ESDR and derived paths contribute 75% of the indirect effect, which highlights the central intermediary role of natural elements in the low-urbanized area.

3.5. Identifying conservation priorities and governance areas in different regions

In order to identify governance priorities in different sub-regions, we further explored mechanisms for collaboration between urbanization and water-heat-carbon supply and demand indicators. This was done internally to prioritize governance (the size of the circle represents the level of importance) (Figure.3a). Overall, in terms of urbanization, the centrality of PUs increases as the urban gradient decreases, while GDP shows the opposite trend. POPs show a tendency to weaken and then strengthen. For ESSD, the centrality of FRM and CS increases as the urban gradient declines, while the centrality of UC shows the opposite trend. As the urbanization gradient decreases, the control order of urbanization is POP>GDP>PU, PU>GDP>POP, PU>POP>GDP, and the repair order of water-heat-carbon supply and demand is FRM>CS>UC, FRM>UC>CS, and UC>FRM>CS.

In order to clarify the prioritized zones for treatment, we calculated the probability of crossing the thresholds for each variable in different zones. Among them, the probability of crossing the first threshold for cells between relative ecologically preferred protected areas (EPPs) and ecologically preferred restoration areas (EPRs) was significantly greater than the probability of crossing the second threshold for cells between urbanization-priority control areas (UPCs) and urbanization-priority management areas (UPMs). We identified 19 EPPs and 21 EPRs by cross-testing based on the probability of crossing the first threshold, and we identified 11 Urbanization Priority Control Areas (UPCs) and 31 Urbanization Priority Management Areas (UPMs) based on the probability of crossing the second threshold (Fig. 3b).

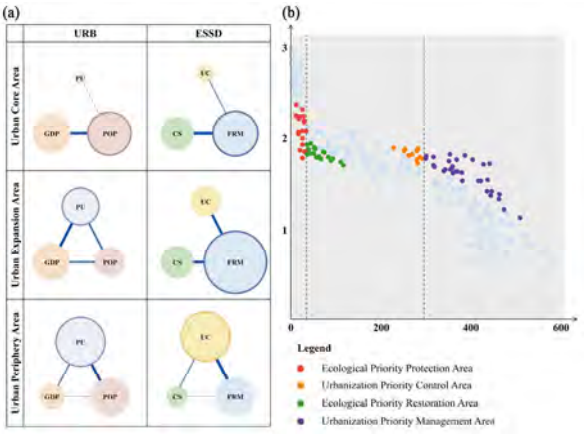


Figure 3. Priority issues and governance areas. (a) Priorities for governance of water-heat-carbon supply and demand and urbanization in different regions; (b) Priority areas for governance and restoration.

4. Discussion

The differential impacts of urbanization on ecosystems and the identification of these impacts are critical for the development and implementation of sustainable urban management strategies to address the growing challenge of climate change. To this end, our study proposes a novel research framework that aims to provide insights to policy makers on sustainable urban land use management. The framework addresses three main aspects: elucidating the mechanisms by which urbanization affects water-heat-carbon risks in threshold-based zoning, identifying critical thresholds for the impact of urbanization on water-heat-carbon risks, and delineating priority governance issues and areas.

4.1. Identifying the nonlinear response of water-heat-carbon risks to urbanization in urban areas

This study adopts the threshold identification and segmented regression method to resolve the nonlinear relationship between urbanization and water-heat-carbon risks. Compared with the traditional concentric circle model, this method provides a more accurate and reliable zoning management basis for the intricate polycentric structure and multifunctional zoning of megacities [6,7], and reveals the complex features of risk decoupling in the three types of urbanization gradients (UCA/UEA/UPA). The negative effects of urbanization on water-heat-carbon supply show a gradient shift pattern of "sharp-delayed-sharp". Specifically, the UCA has seriously damaged the native ecology due to high industrial and population concentration, exacerbating the regionalized pressure on the ecological environment; the UPA has retained its complete ecological functions, but the expansion of scattered villages and towns has strengthened the edge effect, leading to the precipitous decline in the capacity of water-heat-carbon supply; and in the UEA, the transformation of farmland has not triggered the industrial agglomeration, and the intensification of agricultural production has maintained the health of the vegetation [8], so the negative response of supply and demand to urbanization in this zone is relatively flat.

4.2. Analysis of the mechanisms by which urbanization affects water-heat-carbon risks

Studies have shown that the pathways of water-heat-carbon risks response tend to be complicated and direct impacts are enhanced by increasing urbanization gradients, confirming the argument that urbanization alters risk transfer mechanisms through environmental dependence. Urban expansion and densification (industrial agglomeration, increased impervious surfaces) lead to degradation of natural landscapes, climate variability, and fragmentation of ecological patterns [9], contributing to the complexity of indirect impacts of urbanization on natural systems. Specifically:

In the UCA and UEA, urbanization erodes vegetation cover to push up the risk, but there is a simultaneous bidirectional mechanism in the UCA - large-scale construction raises temperature and CO2 concentration but promotes rainfall by improving thermodynamic conditions and water vapor circulation, which, together with centralized vegetation management , results in a localized ecological gain (i) UPA zone: all the impacts of the UPA zone are localized and localized;

In the UPA, all impact pathways show negative effects, and the core mechanism is that human activities (land reclamation, village and town construction) change natural physical factors such as soil structure, nutrients, and water quality , disrupting ecological homeostasis. The proximity to the UCA is characterized by low temperatures and rainfall due to the water vapor circulation, and the agricultural system is weak in resilience , which leads to 75% of the negative effects of urbanization mediated by natural physical factors, and triggers a precipitous drop in water-heat-carbon supply capacity.

4.3. Linking new insights to sustainable urban management

Prioritizing spatial restoration is key to developing sustainable urban planning. Based on the identification of mutation points in water-heat-carbon risk in response to urbanization, we focused on diagnosing and analyzing the probability of crossing mutation points in our study units. Our results show that the probability of recovery is significantly higher in areas with well-preserved ecosystems than in highly urbanized areas. It also suggests that urbanization changes regions in a progressively irreversible way as the level of urbanization increases. We used a cross-validation approach to select the optimal probability thresholds for delineating restoration management zones associated with ecological management priorities. Network analysis reveals topological relationships between urbanization and water-heat-carbon supply and demand metrics that are interdependent across different subregions, and prioritizes governance. These findings provide an innovative understanding of how to improve the characterization of multiple urbanization and

water-heat-carbon risk states and help policymakers identify key governance and restoration priorities.

Undoubtedly, combining our findings with information on policy planning in specific regional development contexts is critical for improving the effectiveness of management measures. Therefore, we have compiled research findings on the regional delineation of water-heat-carbon risks from urbanization, the mechanisms of impacts, and the priorities for restoration. We also combine these insights with planning and management measures, such as the government-implemented Beijing Urban Master Plan and the million-mu plains afforestation. Development proposals are made for different regions, and specific programs are shown in Figure 4.

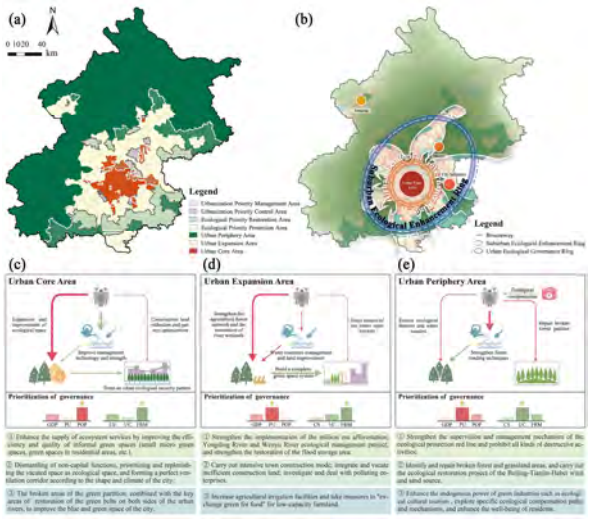


Figure 4. Sustainable management and planning in Beijing (a) identified as priority areas for governance and restoration; (b) framework plan for ecological spatial restoration in Beijing; (c), (d), and (e), governance pathways and strategies for different sub-areas.

4.4. Research limitations and future plans

There are several limitations to this study. First, quantifying hydro-thermal-carbon risk in the real world is complex, and the quantification methods used may ignore this complexity. Future research should focus on developing more accurate quantitative models to effectively support relevant studies. Another limitation of this study is the selection of indicators. Policy implementation, financial inputs, and industrial development are also critical to regional sustainability, but we did not consider these indicators, even though they are difficult to quantify. Finally, models such as the Multi-Objective Decision Making Model could be used to support more detailed strategies. Although there are still some problems with this study, our framework could deepen policymakers' understanding of the relationship between urbanization and water-heat-carbon risks and provide guidance for developing cities.

5. Conclusion

Urbanization is often regarded as a major driver of environmental problems for sustainable development, but differences in the spatial gradient of urbanization are often overlooked. In reality, however, there are significant regional differences in the impacts of urbanization on water-heat-carbon risks, especially in megacities, due to the spatial agglomeration of urbanization. Given the increasing environmental security challenges facing cities, our approach provides a framework for a comprehensive understanding of the impact of urbanization on ESD. Our study provides strong evidence that the impact of urbanization on water-heat-carbon risks is nonlinear and provides a rationale for zoning governance. At the same time, we explore differences in the potential mechanisms by which urbanization affects the reduction of water-heat-carbon supply in different subregions. We found that the impact pathways become more complex as the urbanization gradient increases, while the proportion of indirect impacts decreases. Subsequently, we identify priorities and areas for governance in different subregions. Finally, we discuss the feasibility of combining new evidence with existing policies to optimize sustainable urban management. Future urban planning and decision-making must consider the characteristics and mechanisms of water-heat-carbon risks responses to urbanization. This study contributes to our understanding of the differential impacts of urbanization on water-heat-carbon risks across spatial gradients and highlights the importance of analyzing such differences when planning for sustainable urban management.

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BECOMING WITH MANY: ECOLOGICAL NICHE THINKING FOR POST-ANTHROPOCENTRIC URBANISM

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Keywords: Ecological Niche, City Making, Urban. Metabolism, Interspecies Cohabitation, Eco-centric

Abstract
The paradigm of traditional city planning has been questioned by the ramifications of ruptured urban conditions where dormant infrastructures, fragmented habitats, and socio-economic disparities are in abundance. These landscapes, shaped by obsolescence and environmental degradation, require new spatial frameworks that integrate both anthropogenic and non-anthropogenic forces into a cohesive urban ecosystem. Anne Spirn [18] suggests that cities are/as ecosystems, entangled with metabolic flows and subtle but undeniable interspecific interactions. However, being anthropocentric from the beginning, urbanization has altered territories for human use, disregarding the share of other cohabiting species and depleting resources. This human-centered model brought about a decline in urban complexity regarding infrastructure, biodiversity, resource distribution, and developmental issues.
The concept of the ecological niche allows for reimagining cities as ecosystems formed by numerous biotic and abiotic elements interacting and affecting one another. Hutchinson's [13] "N-dimensional Hypervolume" model provides a basic framework for understanding the possibility of coexistence of multiple-species via various strategies such as environmental grain, niche differentiation, resource partitioning, and symbiotic interactions. On this basis, it would be possible to achieve an eco-centric urban planning via categorizing various urban processes operating interactively with their surroundings. In order to categorize those processes, it will also be needed to transfer some biological concepts into urban terminology so that creating a meaningful parallel between these two domains could be possible. This perspective could create a chance for a shift from human-centric planning to a dynamic urban metabolism that accommodates diverse organisms, facilitates ecological resilience, and embraces adaptive rewilding. Haraway [12] reconsiders the idea that "to be one or not to be at all" is the only option; instead, she argues that we must "learn to be many." so that urban environments can be shifted from sites of exclusion to spaces of metabolic collaboration, where wastelands, brownfields, and infrastructural voids become regenerative landscapes capable of sustaining biodiversity. Methods such as parametric ecologies, environmental proxies and metabolic simulations help operationalize this vision and respond to urban complexities effectively. Therefore, Post-industrial landscapes, often dismissed as obsolete, can be converted into functioning biotopes where interspecies cohabitation is facilitated through niche-informed design interventions.

A niche-informed city-making practice offers a shift in anthropogenic paradigm by recognizing cities as ecosystems in which interspecific interactions inform both spatial design and the distribution of resources. Rather than reinforcing human dominance over urban ecosystems, this research posits that cities can function as interspecies landscapes, where cohabitation, biodiversity, and environmental affordances shape spatial organization. Contributing to emerging discourses on post-anthropocentric urbanism, the study advocates for a methodological synthesis of ecological science, computational design, and urban theory—guiding cities toward a future where spatial intelligence emerges from metabolic interdependencies rather than anthropocentric optimization.

1.Introduction

We are living in an unusual era. The socio-spatial transformations of recent decades have led to the blurring of urban boundaries, the increase of interdependencies, and the disappearance of "wilderness" [2]. Geo-historical developments such as mega-cities, the regionalization of urban areas, and the integration of non-urban areas into the urban fabric have rendered the traditional conceptual framework of the built environment and urban design inadequate. As the uncertainties of the Anthropocene increase, the traditional understanding of urban form and production falls short of responding to the problems and requirements of "planetary urbanization." [16]

In her compilation book Site Matters, Andrea Kahn [14] argues that today's designers and planners need to develop a new way of looking at, understanding and producing against social and ecological uncertainties. According to Kahn, the artificial distinction established between cities and nature should be overcome; a new mental habit compatible with the fact that "Cities are part of nature" should be developed.

According to Spirn [18], adapting to variability and to notice invisible relationships, designers and planners should focus on the interaction of human activities and urban form with natural processes. When cities are seen as part of nature and their own ecosystems, their ontological structures and frameworks of investigation change radically.

With this understanding, the duality of "subject and object" emerges. All species in the ecosystem, including Homo sapiens, become subjects; the structures they produce become objects. The difference between a bird's nest and a skyscraper becomes blurred, and both can be evaluated in the same category (Figure 1). This type of classification, which is made without prioritizing design, provides an equal and balanced approach to biotic and abiotic entities within the city; it makes it possible to consider the biological needs and limits of species. This egalitarian perspective, which is not anthropocentric, suddenly expands the community of the urban ecosystem. Today's built environment is not suitable for non-human creatures, and this threatens biodiversity. However, with an "Organism Democracy" in which all organisms are included impartially, the necessary environmental conditions and life economy for a livable urban ecosystem can be established. Haraway [12] reconsiders the idea that "to be one or not to be at all" is the only option; instead, she argues that we must "learn to be many." so that urban environments can be shifted from sites of exclusion to spaces of metabolic collaboration, where wastelands, brownfields, and infrastructural voids become regenerative landscapes capable of sustaining biodiversity.

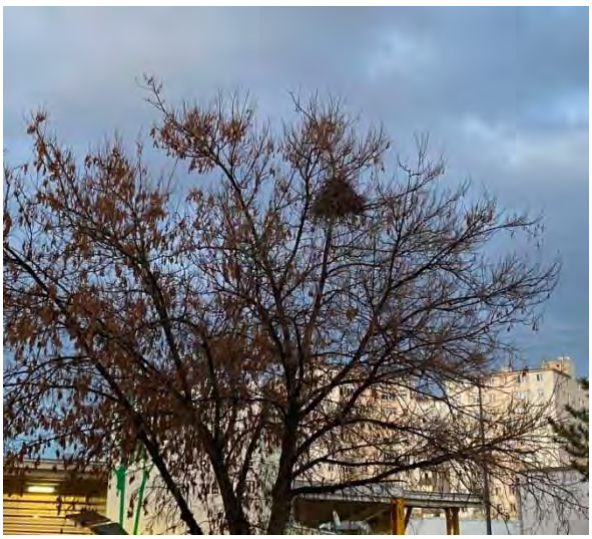


Figure 1: An image showing bird nests on a tree located in an urban space

Although Odum's open system diagram is anthropocentric, it shows that cities are real ecosystems with the flow of resources, the effects of abiotic conditions and species mobility (Figure 2). This representation of the city is very close to the concept of "Ecological Niche", which examines the interactions and functional position of a species in a particular ecosystem. Ecological niche theory is a comprehensive approach that tries to understand inter-species, intra-species and biotic-abiotic relationships, and provides a basic ecological framework when analyzing nature.

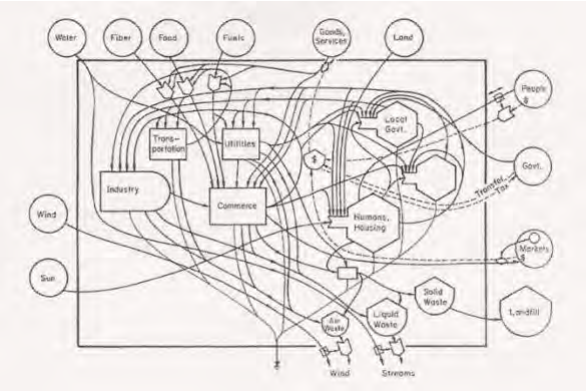


Figure 2: An image describing the urban metabolism components

Shaping the built environment with the principles and concepts of the ecological niche allows the urban design process to be addressed on an objective and scientific basis rather than reductionist or formalist approaches. In this innovative approach, landscape architecture stands out with its knowledge of managing the relationship between the artificial and natural environment and its expertise in many areas from infrastructure to public space. However, this pioneer activity should be carried out in collaboration with a team consisting of different disciplines such as biologists, engineers, and material scientists.

In the following chapter, a new way of the city-making practice will be introduced building upon the Niche Theory, Urban Theory, and Community Processes within the Operationalized Niche: Processes and Strategies section while integrating both urban and ecological terminology into a fused-space.

2. Methods

2.1. Ecological Niche Theory

Cities are not only human settlements; they are also complex ecosystems with dynamic, multi-component and often unpredictable characteristics where biotic (living) and abiotic (non-living) elements are constantly interacting. Therefore, it is not possible to be content with only socio-political, economic or cultural analyses to understand urban environments. Urban systems also function as multi-layered, continuously reconfigurable and highly adaptable organisms where evolutionary processes, ecological networks and metabolic flows intersect [8]. Ecological niche theory provides a potent theoretical framework that unites modern ecology and urban theory to understand these intricate patterns, in a way an unmissable opportunity to obtain anew "urban synthesis" . Even, niche theory was only used to explain how species adapt to environmental conditions, originally, with this synthesis, now this concept has developed into a useful and multifaceted analytical tool that can examine how urban metabolisms function, the composition of species interactions, and the course of environmental decision-making processes.

In the last century, the concept of ecological niche was first nucleated by Grinnel and Elton focusing on abiotic and biotic elements in terms of niche definition, respectively. The "niche" term in ecology was first introduced by **Joseph Grinnell** in 1924. In his study the ecological niche was defined as:

" ... the concept of the ultimate distributional unit, within which each species is held by its structural and instinctive limitations…" [9]

The most distinctive characteristic of the Grinnellian theory is that the proposed niche does not take inter- or intraspecific interactions into consideration. This is why it is called the "pre-interactive niche theory." The niche boundaries and model emerging from Grinnell lan understanding are contemporarily called 'the Fundamental Niche,' meaning the potential distribution of the species in the absence of other species. The **fundamental niche** (Figure 3) is related to the species' capability to tolerate and survive in certain conditions.

From this perspective, when the current urban form and development habits of our built environment are examined, it can be realized that cities are kin to be the fundamental niches of Homo sapiens, created by reducing interactions with other species, eliminating them, and thus reducing biodiversity and complexity.

Later, in the niche theory of **Charles Elton**, the food habits and the distribution of the resources available in the ecosystem play a major role.

" ... and the 'niche' of an animal means its place in the abiotic environment, its relations to food and enemies," [6]

The Eltonian niche theory is also called **post-interactive niche theory** because it reveals an understanding of the events and systems of interspecific interactions and competition for resources (since the theory is based on the food habits of the species). The post-interactive niche is contemporarily called the 'realized niche,' meaning that the niche occupied and gained by the species within its fundamental niche. In the context of urban design, the concept of the realized niche promotes the possibility of an urban form and design practice that is aware of the interactions and other biotic factors. However, the definition of the ecological niche has found its place in the scientific literature with the "n-dimensional hypervolume" model proposed by **Hutchinson [13]** which covers all environmental variables in which a species can live, reproduce and sustain its generation. This hypervolume includes not only physicochemical parameters such as temperature, humidity and pH, but also biotic relationships such as resource availability, competition with other species or mutualism, and physical structural features of the habitat. This model gives us a comprehensive understanding of the variables influencing a species' distribution and means of survival. This approach offers a vital way to comprehend the niche preferences, survival tactics, and coexistence patterns of multi-species communities, which include both humans and wildlife, particularly in fragmented, artificial, and ever-changing habitats dominated by urbanization [4][5]

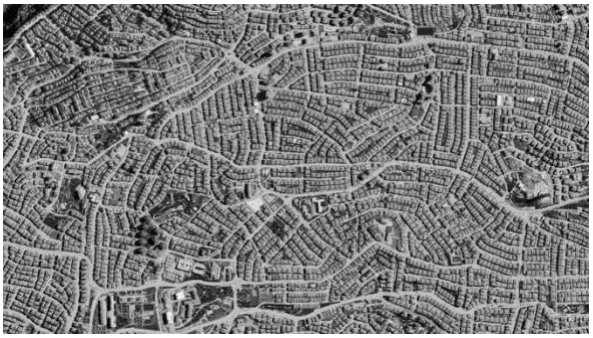


Figure 3: A depiction of the fundamental niche

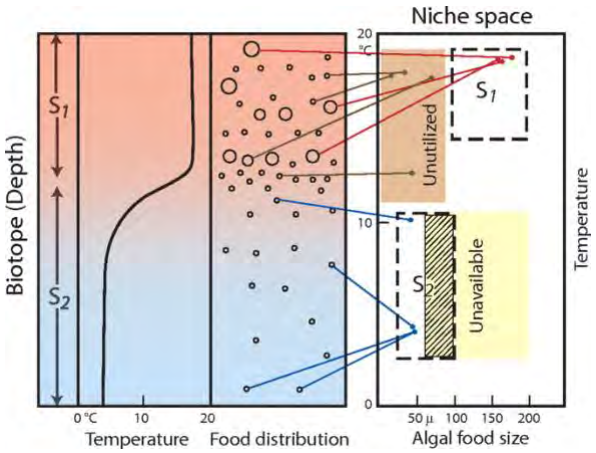


Figure 4: *Hutchinson's illustration of the niche-biotope duality for a temperate lake with algae and two consumers of algae (species S1 and S2)*

2.2 Operationalized Niche: Processes and Strategies

When it comes to consider urban ecology in the context of community ecology, **Vellend** [19] proposes the four fundamental processes namely as, selection, dispersal, drift, and speciation – and strategies generated by them are critical to understanding urban niche dynamics and operationalize it. By translating these ecological concepts into the realm of urban design and planning, we can begin to operationalize niche thinking and embed ecological intelligence into the practice of city-making. In this chapter, the four core processes of community ecology will be examined as a basis for constructing a critical discussion on their relevance and applicability to city-making practice.

2.2.1. Selection

Urban specific environmental conditions such as heat, light, and noise like physical, and also chemical pollutants, along with habitat fragmentation, provide some species an advantageous habitat over others [9]. Some species of rodents, birds and insects are able to adapt to this selection pressure by taking benefits from the warmth, protection and food advantages provided by urban structures, and this association is known as human-commensalism [7] Selection process includes not only adaptation but also the ability of species to transform the environment to their advantage.

Human-commensal species reconstruct urban niches by using anthropogenic niches and affect the evolutionary course of the city. Dong et al. [4] highlight that urban adaptations create morphological, physiological and behavioral feedback in the environment. Nonetheless, this feedback can also bring about the disruption of existing niches and species roles with rapidly increasing anthropogenic activities [1] Therefore, although anthropogenic niche construction is important, it should be made more stable and sustainable.

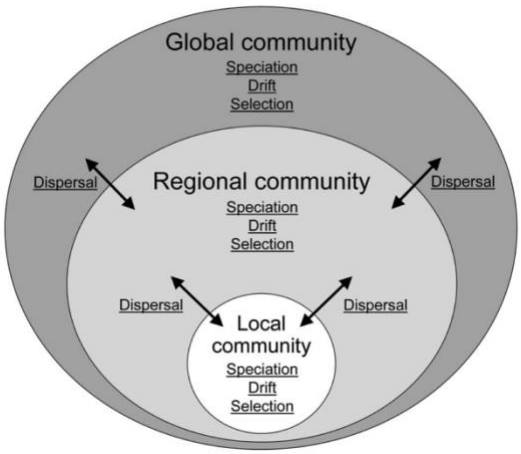


Figure 5: The Theory of Community Ecology. Selection, drift, speciation, and dispersal interact to determine community dynamics across spatial scales.

2.2.2 Dispersal

Dispersal refers to the mobility of a species within the urban matrix and its access to new niches. Transportation infrastructure, building density, and the presence or absence of natural obstacles directly affect species movement. For example, tall buildings that change the wind direction can prevent the seed dispersal of some plant species, while the night lights of skyscrapers can cause deviations in the migration routes of birds [3]. Therefore, the decisive effect of urban structure on dispersal cannot be ignored. Strategically placed green areas, water bodies, or urban parks can provide temporary habitats for species such as migratory birds and amphibians. However, the lack of connectivity between these areas (e.g. lack of green corridors) limits this function. The concept of environmental texture can be used to explain this situation. The concept describes the relationship between the level of dispersal of environmental heterogeneity and the scale at which species are exposed to it [20]. If environmental diversity is spread over a wide area but the species experiences it only at a narrow scale, the habitat is defined as “coarse-textured”. In such environments, it becomes difficult for species to perceive environmental patterns and develop adaptation strategies.

For example, if a bird species can easily reach different green areas within the city, the environment is perceived as “fine-textured”, while a frog species with limited mobility experiences the same areas as “coarse-textured”. Therefore, the different perception of environmental texture by species affects many ecological dynamics, from niche preferences to dispersal strategies and survival possibilities. In this context, areas such as the METU campus, which will be our case study in this paper, used jointly by different species and people, can be considered as important micro-niche environments where environmental texture patterns are embodied.

2.2.3 Drift

Drift is a process in which changes in the composition of populations occur through random events—such as natural disasters, construction activities, transportation projects. In terms of urban metabolism and environments, these haphazard alterations in urban environments are frequently brought on by anthropogenic activities. Particularly for small and remote communities, this can have profound ramifications. For instance, a large-scale transformation project in a neighborhood can lead to local extinction of a rare or even endemic animal/plant species in that area.

2.2.4 Speciation

Speciation is a long-term process that might occur via means of urban isolation and habitat fragmentation, which may lead to accumulation of microevolutionary processes [16]. Speciation is not only the result of geographical barriers but also of ecological niche differentiation. Especially in the Anthropocene Era, with the dramatic alteration of environmental stress factors and the diversification of human-made habitats, the speciation process has become more complex and multidimensional.

Cities or Urban Ecosystems are now dynamic, variable habitats where not only humans, but also other numerous species redefine their evolutionary interactions. In this context, cities

require rethinking traditional ecological niche definitions. Unlike natural systems, niches in urban ecosystems are not only about reaching to available resources, but also about how species adapt, transform, and shape those resources and interactions. Therefore, urban niches should be considered as operational structures that change dynamically according to the survival and cohabitational strategies of species, rather than being fixed definitions.

3. Urban Synthesis: A case study of the METU campus

The urban niche is not a fixed and passive space; it is a phenomenon that is actively constructed, transformed, and reshaped by evolutionary feedback under the influence of both biotic and abiotic factors. To illustrate the applications of above-mentioned urban synthesis, the campus of Middle East Technical University/Ankara (Figure 6) will be the focal area where multi-layered conditions at ecological, evolutionary, and socio-spatial levels are in abundance.



Figure 6: A competition drawing of the METU Campus created by Altuğ and Behruz Çinici

3.1. Strategies to Prevent Over-Dominance of Human Commensal Species

Species that establish commensal relationships with humans, such as birds (pigeons, sparrows, crows, seagulls), rodents, and mammals (dogs, and cats) occupy a significant portion of the ecological niches on the METU campus. This situation both creates ecological homogenization and causes the retreat of native wild species. To avoid this overdominance caused by niche amplification of commensal species, strategies follow as; *waste management* around the dining hall, garbage containers and dormitory via reconstructing compost systems, biofilters and physical restrictions, *habitat enrichment* with structural and vegetal shelter areas (e.g. dense shrub groups, stone piles, hollows) should be established at forest borders and between structures for non-commensal species, and an environment that balances competition in terms of ecological diversity should be created.

3.2. Redefining the Role of Domestic Animals

One of the important ecological pressures observed on the METU campus is the competition phenomenon that occurs with the uncontrolled increase of stray or semi-domestic dog populations. It is clear that native wild species, especially foxes, are negatively affected by this process. Dogs on the campus not only dominate resources (shelter areas, passage routes, food waste), but also physically outcompete foxes from the environment by showing aggression individually or in groups. Observations show that in some cases, dogs directly kill foxes and this species' presence on the campus has almost completely disappeared. This situation can be explained by the concept of niche exclusion. A competitive species, especially one that has reached a high population density, can physically or behaviorally exclude other species in resource-limited environments. This effect, when combined with the increasing density and mobility of dogs on the METU campus and the increasing isolation and habitat fragmentation of foxes, turns into a competition-based displacement process. In addition, this process harms not only interspecific relationships but also the evolutionary balance of the urban niche. Species such as foxes are critical for the continuation of urban biodiversity as intermediate species with high adaptability that can integrate into urban ecosystems without direct interaction with humans. However, the monopolization of these roles by dogs reduces urban niche diversity and suppresses evolutionary plasticity. Strategies as; rebalancing the dog population according to its biological carrying capacity with comprehensive neutering and monitoring programs, designing protected and dog-free transition areas (micro-refugia) for wild species, directing the transition and behavioral patterns of dogs with ethologically based planning (e.g. pheromone barriers, behavioral restrictive zones). This approach does not only mean protecting a species but also reestablishing niche justice within the urban ecosystem. Overdominance of commensal

species in cities often results in the unseen extinction of native biodiversity. Urban planning and habitat design should therefore be concerned not only with "creating space" but also with managing niche conflicts. Areas where dogs are active can be transformed into passage corridors where species such as foxes can shelter. As well as dogs posing risk on mammals, cats are well-known for their ramifications on wild bird presence. Domestic species should be defined as functional components in planning, not threats. However, this approach should be carried out together with population control and prevention of overly aggressive behavior.

3.3. Ecological Transportation Typologies in Combating Fragmentation

The roads, parking lots and structures at METU create a patchy and fragmented ecological structure by isolating many habitats from each other. The current transition infrastructure is inadequate for most species. Transition from *ecological bridges* to *living transition structures* might be beneficial for this battle, so instead of simple grass roads, structures that contain separate micro-passages for day-active and nocturnal species, with vertical habitat separation, light and sound insulation, and enriched with odor and behavior-guiding elements should be proposed. In this way, niche pressure of monotonous transition areas permanently occupied by predatory species is reduced. Also, with introduction of *roadside eco-strips*, the edges of existing roads should be redesigned with permeable surfaces, mini stream beds that will support water flows, and slope-friendly green belts. Especially potential areas such as the "Fox Road" can be closed to vehicle traffic and converted into micro-corridors for controlled and multi-species transitions.

3.4. Elemental Richness and Micro-Habitat Design

The elemental composition distributed across different regions on the METU campus as the nitrogen-rich student dormitory surroundings and phosphorus-rich garbage dumps (those are significant nutrients for plants and all) creates "elemental hot spots" that attract certain species. When this situation is mapped with stoichiometric models, following strategies as; *habitat zoning according to elemental diversity* obtained via selecting plant diversity by matching it with the elemental structure of the soil, and *functional microhabitats with food chain support* via meeting the vital needs of certain species through micro-compost areas, secluded shelters and water bodies that will meet the vital needs of certain species (for example, hedgehogs) should be created. [10][14]

4.Discussion



Figure 7: The drone image of the METU campus

4.1. Holistic Turn in City Making

In urban and landscape design, we should reclassify humans as one among many species, not separated, and thus this new approach could lead to a paradigm shift in our understanding; however, this shift requires including management measurement, and organizational structure which means this approach needs to be supported via proper regulations by governmental authorities, who need to invent new metrics of success in urban planning, and prioritizing not only economic return but also overall habitat well-being. The METU campus with the urban area surrounding its well-isolated space, provides us a unique chance to study varying scales of environmental grains with an alternative authority. Even the to speculate on this approach certain conditions like ecosystem patches and observable interaction between species are needed, therefore, applying these strategies into strongly urbanized regions may require a more comprehensive observation and measurement techniques.

4.2. Disciplinary & Methodological Reconfiguration

As the scale and complexity of the problems are increasing, the structure of the teams also needed to be changed accordingly. In this new era, ecologists, geologists, architects, planners, and material scientists need to configure potent teams capable of designing cohabitation .Even though the synthesis between ecological sciences and city

making proposes new toolkits to work with, it also creates a methodological tension. Thus, the question "How urban designers, planners and architects can utilize concepts and techniques like n-dimensional hypervolume and stoichiometry without reducing their complexity and precision?" needs to be discussed during the process.

5. Conclusion

The ecological identity of *Homo sapiens* in nature is no longer as untouchable and godly as it was in the past; since we live in an age of increasing uncertainty, complexity and unfamiliarity. This age marks a period in which we face the consequences of our actions and the need of a new way of thinking. In today's world where urban boundaries and forms are blurred [13], perspectives that can make sense of this complexity will most likely be found in the realm of positive sciences. Seeing cities through the lenses of nature and accepting them as ecosystems, enable us to transform the way we perceive and prioritize reality. The concept of urban synthesis build upon ecological niche theories, provides a strong basis for rational and sensitive modeling and design of urban ecosystems. The knowledge provided by niche theories has the capacity to reveal unseen potential solutions.

Ecology has both theoretical and practical knowledge that can be adapted to the built environment. With the contemporary niche approach based on the operationalized niche idea and four major community processes, discussed in the paper, redesign of the environment can be mathematically modeled and simulated. Going beyond anthropocentric, formalist and reductionist urban approaches; the concept of the ecological niche also reveals the temporal, spatial and representational inadequacies of our traditional modes of production. It also encourages a more balanced and efficient use of resources.

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REIMAGINING URBAN RIVERFRONT DEVELOPMENT IN INDIA:

a critical realism approach to ecological and urban imperatives

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Keywords: Urban Riverfronts, Critical Realism, Ecological Resilience, Landscape Planning, Reading Landscapes

Abstract
Rapid urbanization in India has intensified pressures on river ecosystems, resulting in land scarcity, severe pollution, flooding, and ecological fragmentation. In India, land adjacent to rivers, especially in urban areas, is contested. This is because the place's history, culture, traditions, and political economy govern the structuring and development. This research proposes a critical realism-based integrative planning framework that values river landscapes' objective (biophysical) and subjective (social, cultural, political) realities, recognizing the conflict between ecological necessity and urban development imperatives. Given urban constraints, reverting to pre-urban ecological conditions is impractical, and engineering interventions remain inevitable. This research demonstrates how philosophical position (theory) and design approach (practice) can lead to sustainability. This is done through two distinct case studies – the Sabarmati and Mula-Mutha riverfront projects in India. The Sabarmati riverfront in Ahmedabad demonstrated one of India's first large-scale integrative riverfront development design models—combining flood protection, land reclamation, and public-space creation—which paved the way for rethinking land adjacent to urban rivers. Building on this, the Mula-Mutha riverfront project in Pune later emphasized ecological rejuvenation and community participation. In both these urban projects, place-making is at its core, as lands adjacent to rivers in urban areas are of prime importance to people. The biggest problem when designing urban river landscapes is finding a way to keep the natural system's ecological integrity while also making the land adjacent to rivers usable, accessible, and economically viable. Hence, the study proposes "reading landscapes," an empirically-grounded methodological framework that uses transect studies, quadrant analysis, longitudinal ecological mapping, advanced technologies (GIS, remote sensing), semi-structured interviews, and focused group discussions to fill the critical information gap. The discussion centers on landscape architects, urban designers, and planners. They can mediate between ecological imperatives and urban demands by leaving buffers for living corridors along rivers to thrive. This can be accomplished effectively by adapting to technological advancements (to generate data), utilizing the knowledge of all allied professionals, and engaging in collaborative practice rather than merely duplicating design decisions.

Introduction

Landscapes around the world show how people have interacted with nature throughout history. Land-water mediation boundaries and their patterns and processes enhance these landscapes and promote riverine diversity and richness. River landscapes in India are among

the most contested urban spaces due to rapid urban growth. Socially, riverfront developments often prioritize modernist functionality and economic growth over the lived experiences and cultural meanings of local communities, marginalizing stakeholder voices. Environmentally, hybridizing high-quality natural river systems with unplanned urban sprawl has degraded ecosystem resilience, reduced biodiversity, and disrupted self-renewal processes along riverbanks. Such tensions motivate this study's focus on reconciling ecological imperatives with urban development demands in Indian contexts. Today, riverfront development in India illustrates the evolving paradigms of practice in urban design, planning and landscape architecture in India. Through the two case studies: Sabarmati Riverfront in Ahmedabad and Mula-Mutha Riverfront in Pune, this research examines different planning models within the same country. The paper demonstrates how varying interpretations of river systems—given their different ecological structures and stakeholder inputs—result in diverse design outcomes. It also raises questions about the validity of generalizing design guidelines for river systems.

Review of literature (Shift in paradigm)

Early landscape theories, rooted in late-18th-century British Picturesque aesthetics, emphasized controlled nature, carefully composed vistas, and leisurely public enjoyment. Ian McHarg's Design with Nature (1969) emphasized on overlaying mapping, which will directly inform our use of GIS-based longitudinal maps. Mapping hydrology, soils, and vegetation should inform land use decisions. Although similar to Bernard Kohn's 1961 ecological valley idea for Sabarmati, this perspective did not become popular in India until many years later. Lefebvre's Production of Space (1974) and Harvey's Accumulation by Dispossession (1973) revived modernist pragmatism after 1970. It revived functional utility and commodification, leading to late-1990s riverfront redevelopment projects focused on land reclamation and global-city branding. By the early 2000s, a growing emphasis on ecological urbanism and blue-green infrastructure complemented traditional engineered solutions. Political ecology scholarship has since enriched our understanding of how power and local knowledge shape outcomes in riverfront projects.

In practice, engineering, ecology, and culture have long intersected on urban riverfronts worldwide. London's Victoria Embankment (1870) and Chicago's Chicago River reversal (1892–1900) demonstrate 19th-century infrastructure solutions that prioritized sanitation and navigation over riparian ecology and public access. Seoul's Cheonggyecheon restoration (1994–2005) shows a shift towards ecological rehabilitation and placemaking: daylighting buried waterways, reintroducing native vegetation, and creating vibrant public realms. Riverfront initiatives in South Asia have followed a similar path but with different socio-political and environmental constraints. In India, the 1960s Hooghly embankment schemes and the 1980s and 1990s Ganga and Yamuna Action Plans focused on engineered pollution abatement and flood control, with little attention to biodiversity or community engagement. Building on this literature, we adopt critical realism to synthesize ecological data and stakeholder narratives in our case studies.

Theoretical framework

This study uses critical realism to move between objective ecological structures and subjective human interpretations. In our work, applying critical realism meant mapping the river's physical manifestations and community narratives—so that design solutions on Sabarmati and Mula-Mutha were grounded in data and local lived experience. Most of the case studies that were referred to illustrated how engineering changes and alterations to landscapes occurred. Several methods effectively combined biophysical data with social and cultural insights in an ongoing design process. The issue was that important questions regarding the balance between the objective data of river ecosystems and the subjective perspectives of various stakeholders remained underexplored. While rivers in India may exhibit distinct subjective preferences, the objective realities of river systems can be comparable to those found globally.

Methodology – "reading landscape" framework

The "reading landscapes" framework is the heart of this study's methodology. It combines a mixed-methods approach—blending quantitative, data-driven tools with qualitative, socio-cultural insights. The process combines transect studies, quadrant analysis, and longitudinal ecological mapping, drawing on total station surveys, Google imagery, and drone-based documentation. It is supported by participatory methods and enriched by historical and academic research. Transect walks help document environmental conditions across site sections—capturing details like soil and sediment layers, vegetation types, and water flows. Quadrant analysis zooms in to examine specific ecological zones in greater detail, identifying relationships between use, function, and biodiversity. Longitudinal mapping, using archival maps and satellite images, helps trace how the landscape has evolved—highlighting shifts in land use, ecological linkages, and the changing nature of floodplains. What grounds this method is its participatory layer—community mapping, stakeholder conversations, and iterative feedback loops that shape the work at every stage. These steps ensure that the outcomes are technically sound and rooted in people's lived experiences and local knowledge. Altogether, the "reading landscapes" approach gives a practical form to critical realism—balancing the tangible and the intangible through the following interconnected components.

1.1. Transect Sampling

Transect sampling gives you a cross-sectional view of important ecological and geomorphological factors at regular intervals along the river corridor. We measured hydrological metrics, sediment characteristics, vegetation structure, and topographic profile. Water depth, flow velocity (using a current meter), and seasonal changes were measured during surveys before and after the monsoon for each transect. Mula Mutha is a perennial river with frequent flooding, while Sabarmati is a seasonal river. Hence, the surface runoff and the water levels for both rivers, post the riverfront development, had to be calculated precisely using advanced simulation software. Also, both rivers had existing water infrastructure, like check dams, barrages, and aqueducts were present, which also had to be considered. Sediment characteristics included grain size distribution (through sieving) and organic content (through loss-on-ignition). This was important, as the soil type for both cases played an important role in how their embankments would be designed. Mapping of the vegetation structure included measuring the canopy cover (measured with a densitometer), types of plant species present (measured with standard floristic methods), and the presence of invasive species. In the case of Mula-Mutha, it was prominent, while in the case of Sabarmati, it was less relevant. Using differential GPS to find differences in elevation and cross-sectional profiles to show the edges of the floodplain helped with an accurate topographic profile and ground countering. This data, gathered over the years, becomes a starting point to learn more about the corridor's hydrodynamics, substrate conditions, and ecological gradients.

1.2. Mapping of Longitudinal ecology

Rivers pass through the middle of the city; so, it's important to learn about the history of the area and how it has changed over time. Historical maps and Google images were used to understand this. It was important to have correct base information on the lay of the land and the river in both the project - using total station survey, historical satellite images (when available), and cadastral information, which gives clarity on river land vs private and city land. Another set of information is detailed hydrological data (empirical) to understand rainfall, historic floods in the last 30 years, catchment area, river land and obstructions to understand the flood-carrying capacity of the river and use of this data to propose river hydraulics to determine what will happen in the case of riverfront development and also informs project how high the embankment should be built keeping flood level and in relation with existing city levels. In the case of Mula-Mutha - a detailed total station survey of existing trees was mapped with location, tree details such as level, height and spread, type of trees (species), etc. and using modern tools (BIM 3D software) in coordination with terrain maps and river embankment proposal to determine the impact on tree and how to integrate them with embankment strategy by

protection, few critical location systematic transplantation to safe area was considered.

1.3 Involvement of Socio-Cultural Activities

Any in-situ development or river-edge intervention inevitably reshapes the relationship between the city and its river. In some cases, it alters long-standing connections; in others—primarily where significant social or cultural sites exist—it helps deepen and renew them. Stakeholder consultation and public participation in urban development projects are not required, but river-connected stakeholders were crucial. This included historians, caretakers of religious and cultural sites, communities involved in long-standing practices like weekly flea markets or riverside washing (as seen along the Sabarmati river), and residents of informal settlements. In Pune's case, the temples, heritage sites, public parks, and ecologically sensitive zones along the Mula-Mutha were given attention. Engagement took many forms—direct meetings, public presentations, site visits during construction, and discussions with NGOs and environmental experts familiar with the local context. Equally important was communicating these complex redevelopment and rejuvenation efforts in ways that citizens could fully understand. Presentations were given in the local languages, with large maps, physical models, and visualizations were shown at public exhibitions all over the city. Social media and project websites were used to share updates and ask for feedback. This made sure that people had access to correct information and chances to share their thoughts. The riverfront project was carried out differently because of what the community knew and what stakeholders valued. This shows that good planning must be based on real-life experience. Stakeholder consultations and community inputs played a crucial role in the large-scale developments of this nature. Stakeholder participation in the Indian context functions quite differently from that in first-world countries—tends to be more fragmented and less community-driven. Given this reality, what was achieved was likely the best possible. In many cases, stakeholder input remains subjective, and domain experts must make decisions on behalf of the broader society. Community members' and experts' feedback on physical models and digital visualizations was taken at early proposals and post-design stages. Efforts were made to integrate access from temples to the riverfront ghats, ensuring cultural and religious continuity. For example, special consideration was given to routes for events like the Rath Yatra, ensuring that the redeveloped ghats—especially those of historical importance—remain accessible, yet vehicle-free during such occasions. Many of these suggestions were meaningfully incorporated into the final design.

Case Study 1_Sabarmati Riverfront Development Project, Ahmedabad, India

The Sabarmati Riverfront Development (SRFD) Project, conceptualized in the late 1990s, marked a turning point in how Indian cities approached riverfront redevelopment. Initiated in 1998 by the Ahmedabad Municipal Corporation (AMC) under the Sabarmati Riverfront Development Corporation Ltd. (SRFDCL) – a Special Purpose Vehicle (SPV), the project aimed to transform the neglected riverbanks into a vibrant public space embedded within the dense urban fabric of Ahmedabad. Its vision included constructing protective embankments, cleaning the river through integrated infrastructure, and developing continuous promenades, parks, streets, and public amenities. A key aspect of the project was its financial model—reserving a specific per cent of the reclaimed land for commercial development to make the project largely financially self-sustainable.

Historically, the banks of the Sabarmati were overlooked and underutilized. Over the years, industrialization, urban development and poor city infrastructure planning have led to severe pollution and seasonal monsoon flooding, which made much of the river's edge unsafe and inaccessible. The sandy floodplains became informal grounds for weekly flea markets, open-air washing activities, and settlements lacking basic services. Once a cultural and ecological asset, the river had effectively become the city's backyard. The 1998 master plan proposed a comprehensive solution—incorporating flood control through embankments, interceptor lines to treat sewage before it entered the river, and reclaiming nearly 200 hectares of land largely for public use and some portion for revenue-generating uses. Construction has spanned

more than two decades, with new stretches and phases of the project added subsequently. Over time, SRFD's large-scale public spaces naturally attracted wide attention—first across India, then internationally—reflecting the project's success in integrating infrastructure, ecology, and civic life. While SRFD's integration of embankments, interceptor lines, and mixed-use public spaces has inspired similar initiatives, subsequent projects have tailored these elements to their ecological and cultural contexts. Decisions made 25 years ago—while visionary in their time—may not align with present-day priorities or ground realities elsewhere. While the project offers valuable lessons in infrastructure integration and land management, not every design choice or planning principle should be treated as a universal solution. Importantly, the project has made efforts to account for those affected by the redevelopment. Informal settlements that once occupied the vulnerable riverbanks were relocated to permanent housing within the city, improving their access to infrastructure and services. The long-standing Sunday flea market was reimagined as a more organized, dedicated space on the riverfront. At the same time, dhobi ghats (open-air laundry areas) were incorporated into the masterplan to preserve livelihoods. Though not without controversy, these gestures reflect an attempt to balance large-scale urban transformation with social sensitivity.

Today, SRFD offers good lessons and insights—showcasing how large-scale integration of flood control, land reclamation, and public spaces can succeed and how ongoing adaptive measures further strengthen ecological and social outcomes. As more Indian cities look to redevelop their river edges, the lessons from Ahmedabad underscore the need for context-specific, inclusive, and adaptive planning approaches.

Application of the "reading landscapes" Approach: Using the Reading Landscapes framework on Sabarmati River shows how structural and agentic forces led to the results we saw. The project's objective Realities and engineering Imperatives included first creating hydrological models that predicted extreme seasonal flow variability (this was carried out by a hydrology-hydraulics expert input). Based on this, the solutions for embankment design were taken. There is no sediment transport within the city area as the city is built around - only drainage comes in. Yes, the natural edge is redefined with engineered embankments, but it has incorporated all natural outfalls and tributaries.

The subjective perceptions and power structures also played an important role in the creation of this project. The master plan foregrounded grand promenades and landmark bridges to craft an "image of the city". The completed phase (2002–2012) delivered signature public spaces (various parks, promenades, iconic pedestrian bridge, urban forest) and boosted tourism. In subsequent phases of the development in recent years, a significant change in design was made, which primarily included the change in embankment design and promenade, where the vertical single wall was broken down into levels, with a more biodiverse planting palette. Working closely on Sabarmati's later phases, we saw how adding green buffers around the embankments enriched biodiversity and improved microclimate comfort for walkers.

Case Study 2_Mula Mutha riverfront Project, Pune, India

Pune lies on the Deccan Plateau's western edge, in the Sahyadri range's rain-shadow, at the confluence of the Mula and Mutha rivers, forming the Mula-Mutha, which joins the Bhima. Pawana and Indrayani rivers flow through its northwest. The city has a tropical wet-dry climate with hot summers, a July-heavy monsoon (722 mm/year), and cool winters. River levels fluctuate seasonally—narrow in summer, swollen during monsoon—posing flood risks due to urban encroachment. Historically, riverside lands supported agriculture and small settlements, but urban expansion replaced farms with built-up areas, stressing the river system and eroding traditional flood resilience.

Embankment Design – To prevent erosion and flooding, the Mula-Mutha embankments were categorized by context: rural (natural vegetation in low-density areas), urban (moderately developed zones), and engineered (high-density areas with stricter control).

Pollution-Free River – Numerous outfalls discharged sewage and stormwater into the river. The project integrated with the JICA sewerage initiative and proposed interceptor sewers within embankments to divert sewage to STPs, reducing pollution and planning long-term infrastructure.

Flowing Water – Dry stretches were addressed by replacing reservoirs with low-crest barrages to retain water without blocking flow. Treated STP water ensured continuous year-round flow and improved hydraulic function.

Ecological Improvement—Green embankments use boulders, native grasses, and trees to stabilize banks and restore riparian habitats. This approach improves biodiversity, supports groundwater recharge, and enhances ecosystem health.

Activating Public Realm – Riverfront zones were planned as active (parks, ghats), calm (walkways), or restricted sensitive areas like confluence of *Ramnadi* (tributory to Mula River). Existing cultural sites were integrated with new ghats, gardens, and *"visarjan" (idol immersion)* tanks to preserve heritage and promote access.

Application of the "reading landscapes" Approach: Given the ecological richness of the site—including native vegetation, mature trees, bird nesting areas, and other wildlife habitats—it was essential to document the landscape in fine detail before any intervention. The entire river zone was carefully recorded using modern technologies such as GIS, drone surveys, and sectional mapping. This included mapping native and invasive species, topographic levels of densely vegetated zones, river and embankment sections, soil and rock strata, and historically significant trees—some over 50 years old. Water quality was also tested to understand the health of the river system. A detailed landscape strategy was then developed in close consultation with horticulture experts, local NGOs, and Parks and Gardens Department professionals. Field studies and historical references informed a plan to integrate seamlessly with existing vegetation, support biodiversity, and provide habitats for local fauna, especially birds. Today, parts of this strategy are already visible on the ground—where people and wildlife actively use restored landscapes.

Equally important was understanding the social dimensions of transformation. Local fears and concerns were addressed through regular site visits, public presentations in local languages, and open discussions. The aim was to minimize ecological disruption and maintain the continuity of natural corridors. In contrast, SRFD's early design choices—shaped by urgent flood-control and financing self sufficiency—favoured comprehensive embankments, Mula-Mutha opted for site-specific, water-sensitive interventions. Every part of the project, from the design levels and landscape treatments to the materials used and the paths to get there, was tailored to the site's specific conditions, whether it was a forested area, a group of historic trees, or a ghat or temple. The "reading landscapes" method is based on this contextual and responsive way of river rejuvenation.

Analysis and Findings

Urban riverfront transformations are still a relatively recent phenomenon in India. Projects like the Sabarmati Riverfront in Ahmedabad and the Mula-Mutha River Rejuvenation in Pune offer two very different canvases—both valuable in understanding how cities can begin to repair and reconnect with their rivers. They also reflect how such projects constantly evolve, shaped by political intent, funding models, regulatory frameworks, and social expectations.

Sabarmati Riverfront: A Model in Transition

Sabarmati's initial phases prioritized comprehensive flood control and self-financing through land reclamation—choices that reflected Ahmedabad's urban pressures at the time. The early phase was driven by the need to finance the project through real estate—unsurprising, given its location in the dense heart of the city. The outcome was a clean, organized, and evident transformation that helped reposition Ahmedabad as a forward-looking, "global" city. Over its multi-phase rollout, Sabarmati riverfront development delivered foundational flood-control and self-funding mechanisms, while later phases have deepened public-space richness and ecological plantings in response to emerging needs — embankments that integrate forests, gardens, walkways, and social nodes. It is far from perfect, but it shows a growing awareness that the riverfront is more than a spectacle; it is a landscape people live with. There is also hope that earlier sections of the riverfront will be retrofitted over time to be greener and more ecologically sensitive.

Mula-Mutha: A River Responded To, Not Reshaped

In contrast, the Mula-Mutha, initiated under different ecological and institutional priorities, integrated water-sensitive design and phased ecological restoration. Instead of transforming the river to fit an urban agenda, the design responded to the river's existing conditions. Ecological health and social engagement took precedence over spectacle or uniformity. Embankments were designed with natural materials like gabion walls instead of concrete, and native species were planted to stabilize the banks and support biodiversity. Interventions like constructed wetlands were used to treat polluted water before it entered the river.

Discussion

Reading landscape and rethinking approach: a few parameters become clear when we look at these two case studies through the lens of critical realism and the "reading landscapes" framework. Behind every visible transformation lies a set of generative forces—economic mandates, political ambitions, technical constraints—that shape design decisions, public engagement, and outcomes. Sabarmati Riverfront project is a large-scale infrastructure integration, while Mula-Mutha demonstrates ecological sensitivity—and that future cities can draw selectively & suitably" with "lesson learnt" from both and adapt to local context and need.

Both projects show that riverfronts are not just about infrastructure or beautification but about how we understand rivers in a city's life. What if planners, designers, and decision-makers stopped thinking in terms of engineering vs. aesthetics and instead used more layered, contextual approaches? That means we can develop urban riverfronts that work well with the city's people and local context, are robust enough to protect from floods, and are accessible to all.

Conclusion and future directions

Urban riverfront transformations are still relatively new in the Indian context. Rather than elevating one model over the other, future urban riverfronts can combine the Sabarmati riverfront development project's large-scale infrastructure integration with Mula-Mutha's phased ecological sensitivity to craft solutions tailored to local ecologies and communities. These projects also show us that these kinds of changes are not set in stone; they change over time based on political priorities, available funding, policies, and the needs of society. A collaborative, interdisciplinary approach is essential. Knowing the terrain, or "lay of the land," and using techniques like reading landscapes, even if they sound academic, helps make design choices based on real-world conditions. This approach makes sure that both urban needs such as public access to river, promenades & public spaces, social inclusion, along with underlying factors are also well integrated - protection from flood, improving water quality, and integrated biodiversity. River transformation gives an opportunity to create places for all and connect people with rivers. In the past, rivers have had a significant impact on how cities grow and change. Over time, these relationships have changed, but the connection remains important.

Acknowledgement

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HEALTH AS A RESOURCE FOR RENEWING THE PRACTICE OF LANDSCAPE URBANISM

TOPIC : Guiding cities through what is alive: cities as ecosystems

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Keywords: Health, living environment, hospital, biodiversity, biophilic approach

Abstract

Accelerated environmental change, and more specifically the sixth mass extinction of biodiversity, is prompting wide-ranging action on the ecosystem of cities and the multifunctionality of open spaces for human and non-human life (Clergeau and Blanc, 2013; Ahern 1991). In addition, the COVID 19 pandemic has highlighted the importance of these ecological networks for human health, from the perspective of health-generating urban planning approaches (PFVT, 2024; Health in Action, 2022; Benzoni 2020).
Our hypothesis is that landscape architects rely on a renewed reading of the geographical environment to build a project for human and non-human living beings (human health and biodiversity), operating both within the framework of inter-professional work and multi-actor exchanges for the operational implementation of the project.

Through the evocation of projects developed by the landscape and urban planners of the AIA Territoires agency within the Paris metropolis, we will highlight the structuring role of open spaces associated with architectural projects for healthcare facilities (Chabrol, 2022) connected to ecological networks. These projects include the UGECAM rehabilitation center in Lieusaint, the Institut Pasteur campus in Paris and the Institut du Cerveau de l'Enfant, Hôpital Robert Debré in Paris.

When hospitals are modernized, outdoor spaces are often seen as purely utilitarian (parking, logistics, technical). Yet these spaces are key to the reception and management of flows (pedestrians, hospital entrances, logistics) and to the management of nature (biodiversity management, walks, etc.). Today, the challenge is to give back a place and a role to these spaces as vectors of environmental quality and well-being. In addition, as a public facility, the hospital project is intended to contribute to the renaturation of the city and the improvement of the living environment, by integrating the project's landscaped areas in interaction with the other vegetated areas of the district and in a vision of urban resilience. This quality-of-life strategy and biophilic approach thus contribute to the process of sustainable health and well-being.

These 3 projects, inspired by the “One health” approach, apply the results of research carried out by the AIA Foundation on interactions between environment and health (https://www.aiafondation.fr/), focusing on three areas: the foundation (geo-historical and climatic structure), the living (ecosystems of the non-built with the built, soil, water, plant species and cycles, fauna), and activation (participation, appropriation, uses). This approach is integrative of various types of knowledge, and is useful for multi-actor work and project evolutivity in concertation processes. This analysis will enable us to place the landscape project approach carried out in a particular context within the approaches to projects carried out around the geographical environment, characteristic of the history of landscape approaches (Berdoulay and Soubeyran, 2002; Magnaghi, 2014; Callens, 2023).

This reflexive analysis of a professional practice aims to discuss and contribute to an emerging field of reflection on the links between biodiversity, health and landscape (Les carnets du paysage n°37, 2020), from the angle of project methodologies, at the service of planning professionals.

Text

1.1 Reinventing outdoor spaces in healthcare facilities

Accelerated environmental changes, and more specifically the sixth mass extinction of biodiversity, call for large-scale action focusing on urban ecosystems and the multifunctionality of open spaces for human and non-human life (Clergeau 2013). The European Landscape Convention explains that the living environment, which includes open spaces, plays a vital role in the health of residents. For example, proximity to nature or green spaces promotes physical activity and well-being among residents.

This concept of the relationship between health and the environment is also conceptualized through the notion of social determinants of health defined by the WHO as "the personal, social, economic and environmental factors that determine the health status of individuals or populations". More broadly, the "One health" approach proposes a contemporary, broad and holistic definition of health that includes humans in the same way as other living species. For the WHO, the health of each ecosystem component is closely linked to that of the others.

Hospital modernization often considers outdoor spaces in purely utilitarian terms (parking, logistics, technical facilities), whereas the place of nature (Blanc, 2021) in hospital design from the Middle Ages to the mid-20th century went far beyond landscaping or amenity. Gardens were considered an integral part of patient care. Just think of the cloister gardens in hospitals designed for convalescence.

Although this aspect has been forgotten in modern hospital design, and little space is given to the maintenance and use of nature in hospital projects in France, scientific literature, mainly Anglo-Saxon, recognizes that the natural environment has a direct influence on the clinical condition of patients and on the well-being of the hospital community. One striking example is biophilia, a term coined by biologist EO Wilson following the work of Dr. Ulrich, who scientifically demonstrated that after surgery, hospital patients with rooms overlooking trees heal faster and require less pain medication.

Hospital facilities therefore have a strong responsibility to create and maintain a healthy living environment for patients, hospital staff, local residents, and biodiversity. Taking into account the environment around the site makes it possible to preserve its qualities and subsequently protect users from risks (air, noise, and visual pollution). Hospitals are also public facilities that must contribute to the structuring of the territorial green and blue network by integrating landscaped areas into open spaces and biodiversity corridors.

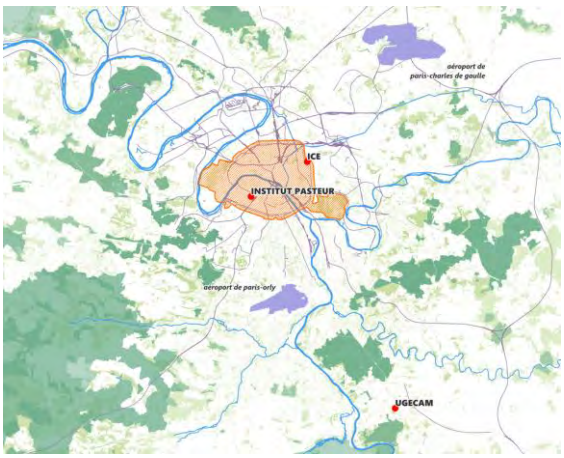


Figure 1: Localization map of the projects in Paris metropolitan area

Through three projects developed by the architects and landscape designers at AIA Lifedesigners in the Paris metropolitan area, we will highlight the structuring role of open spaces associated with architectural projects for healthcare facilities connected to ecological networks. These projects are: the UGECAM rehabilitation center in Lieusaint, the Pasteur Institute campus in Paris, and the Children's Brain Institute at Robert Debré Hospital in Paris.
These landscaping projects incorporate both the therapeutic and social uses of natural spaces and health determinants. Taking these

different elements into account leads to a renewed approach of landscape design for healthcare facilities.

1.2 A therapeutic park based on active design guidelines

The first example developed in this publication reflects these concerns. It highlights a space that is integrated into its environment and conducive to physical activity and patient well-being.



Figure 2: Localisation map

The UGECAM hospital is a medical care and rehabilitation center under construction in the south-east of Carré Sénart in the municipality of Lieusaint. Carré Sénart is a unique 200-hectare landscape with a strictly grid-like layout designed by François Tirot, director of the EPA Senart, to contain urbanization in the agricultural plain.

The UGECAM hospital has been designed to support patient rehabilitation. Backing onto a large "green frame", the plot opens out to the south onto the picking plots of a market-garden farm. This opulent planted setting, and the proximity of diversified landscape entities, makes it possible to imagine recreating a landscape between urbanity and rurality, characteristic of this portion of territory in the south of the Ile-de-France region.

The building's volume plays on a composition of stability and balance, evoking the physical and mental journey of patients. The compact structure maximizes outdoor space while ensuring a fluid and intuitive interior layout, which is essential in an intensive care setting for both caregivers and patients. From inside the building, the park is always visible, enhancing emotional well-being and cognitive performance. (Bolon et al., 2018).

The landscaping project is designed around two axes, interconnected with the building: a welcoming axis that generates porosities on the wider landscape and a therapeutic axis that extends rehabilitation possibilities.

The therapeutic park is a key feature of the program. Tree-lined to the south, with its varied layers of vegetation, it offers immersive spaces for relaxation and rehabilitation, enriching the care pathways. The compositional axes guide users from the entrance to the gardens, creating visual openings onto landscape.

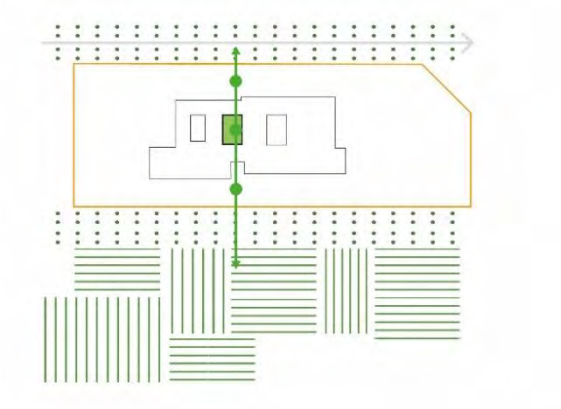


Figure 3: Schematic plan of the reception axis

Several co-design sessions with the project owner and caregivers were necessary to better identify their needs and integrate coherent arrangements for patient progress. The garden paths thus become outdoor rehabilitation aids (Rudaz, Kallumkal, 2024). Loops with different levels of difficulty help to limit frustration during the sometimes long and difficult recovery process. For example, markings on the ground starting inside the building indicate the distances covered so that everyone can measure their progress on their own. The direction of traffic always points forward, highlighting the patients' progress.

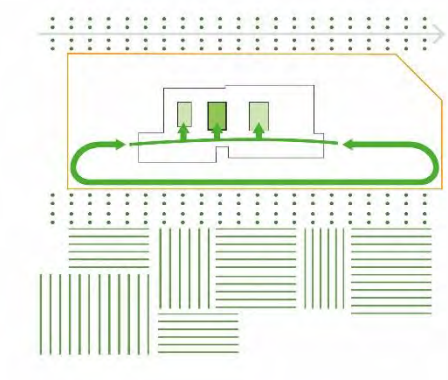


Figure 4 : Schematic plan of the therapeutic path

Dialogue with medical staff also made possible to incorporate features that can be reconfigured to address difficulties encountered in public spaces. In 2020, 57% of people with disabilities reported frequently encountering accessibility difficulties when traveling (IFOP/APF France Handicap survey, 2020). The project therefore includes, at their request, a mound with two large staircases and ramps that are not considered accessible to people with disabilities. A variety of materials are also available in the park.



Figure 5 : Drawing of the park

The programmatic elements tend to form a new landscape on the "carré Sénart", in the image of its history, before the creation of a gridded and anthropic environment. Adapted to the care process of patients and the well-being of caregivers, more flexible and natural forms give way to a free landscape structure.

1.3 Intertwined landscapes and shared care

The site of the future Institut du Cerveau de l'Enfant (Children's Brain Institute), both day hospital and research center, is located on the northern slope of the Robert-Debré Hospital site, in an area that is already heavily urbanized.



Figure 6 : Localisation map

The institute is located on the embankment linking the hospital, the Paris ring road and the Lilas water reservoir, one of the capital's main freshwater reserves. This context imposes multiple constraints: proximity to an active hospital facility, the presence of a major thoroughfare and a secure site of national interest.



Figure 7: Perspective of the Institut du Cerveau de l'Enfant

At the heart of the project is the existing wooded slope, a key ecological element in the Parisian green belt. The main thrusts of the approach are to preserve it as far as possible, compensate for the impacted areas, and recreate habitats for local fauna such as titmice and tree bats. The woodland also acts as a filter, limiting the noise and air pollution generated by the ring road, in line with scientific recommendations on the preservation of urban ecological corridors.

The project is part of an assertive bioclimatic approach, consistent with the City of Paris' bioclimatic PLU and the requirements of HQE biodiversity certification. The architecture and landscape are designed to optimize user comfort and the site's environmental performance. A structuring element of the project is the garden roof, with over 50 cm of topsoil, 80 cm in places, hosting a wide variety of native perennials and shrubs, selected for their resilience to climate change, as well as a number of habitats for entomofauna. This roof, designed as a refuge for biodiversity, is based on recent studies demonstrating the benefits of green spaces in hospitals, both in terms of air quality and the mental and physical health of users (Manusset, 2012).

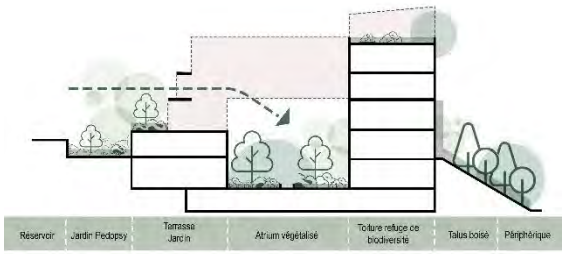


Figure 8 : Cut on the intertwined gardens

A major health issue has also guided the design: the rapid rise in pollen allergies in urban areas, which now affects over 30% of the population compared with just 6% forty years ago. Research shows that rising CO2 and urban particulate pollution favor pollen production and aggressiveness, prolonging the pollen season and aggravating allergic symptoms (ANSES, 2014). To limit these risks, the plant palette was rigorously selected with the support of ecologists and environmentalists: species with high allergenic potential (levels 4-5) were excluded, and the presence of moderately allergenic plants was severely limited, in favor of low-allergenic species. This choice, dictated by the need to preserve local biodiversity, illustrates the delicate balance between public health and maintaining functional ecosystems, as recommended by the "One Health" approach.

In this context, the almost exclusive use of indigenous plants from local botanical strains and regional nurseries has become a necessity, in order to maximize the establishment of non-sterile species capable of reproducing and therefore producing pollen. This balance between reducing health risks and enhancing urban biodiversity reflects the complexity of contemporary trade-offs in landscape architecture.

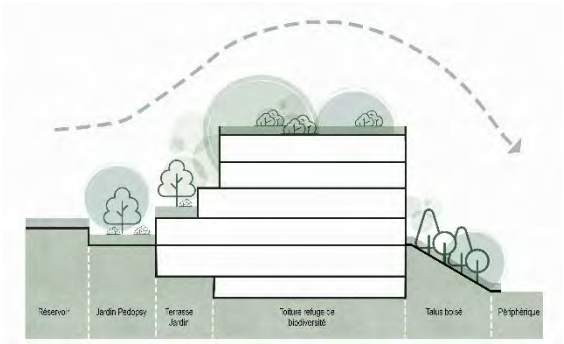


Figure 9 : Cut on the intertwined gardens

The project also gives a central place to the therapeutic dimension of landscape (Manusset, 2012), notably through the gardens designed for child psychiatry (Perret, 2020). These spaces, designed for children of different ages with various cognitive and psychological disorders, emphasize legibility, simplicity and sensory stimulation. The seasonal nature of the flowers and foliage, and the diversity of textures and atmospheres, offer young patients an evolving environment, conducive to both contemplation and awakening. Recent studies on therapeutic gardens confirm the positive impact of these environments on well-being, stress reduction and the quality of caregiver-caregiver interactions (Rudaz, Kallumkal, 2024). The adaptability of the spaces, designed in consultationwith the medical teams, guarantees the safety and relevance of uses, avoiding any risk factors or blockages.

In this constraint urban context, the attention paid to plant species in this project aims to provide users with a high-quality environment (in terms of pollution, pollen, etc.) and a sense of security for patients. It reflects the renewed role of landscape architects especially in the design of healthcare facilities.

1.4 A lively and vibrant landscape

Working on healthcare spaces also means creating meeting places that promote the social well-being of different users. These spaces are essential to provide a setting conducive to social interaction and a more peaceful working environment for healthcare professionals.



Figure 10 : Localisation map

An international biomedical research center located in the 15th arrondissement of Paris, The Institut Pasteur's historic campus must continually adapt to support research excellence. In line with the City of Paris' objectives for a low-carbon, bioclimatic and resilient city, the Institut has adopted an ambitious 20-year Urban and Landscape Master Plan, led by AIA Territoires and carried out in close collaboration with site users. The site's users (researchers, administrative staff, logistics staff, etc.) are attached to it because of its historical configuration: it isa small enclave in the city, set between two facing blocks that houses a collection of scientific architecture, including Louis Pasteur's home, which is now a museum.

The spirit of community also encourages the appropriation of outdoor spaces. The project to renovate these spaces was designed with the "Pasteurians", represented by the Green Team. The users, who are sensitive to the issue of biodiversity in the city and some of whom are members of the LPO (the bird protection league), enthusiastically welcomed the proposals in favor of welcoming wildlife, and the methods of implementation were further developed through the enlightened observation carried out by the Green Team.

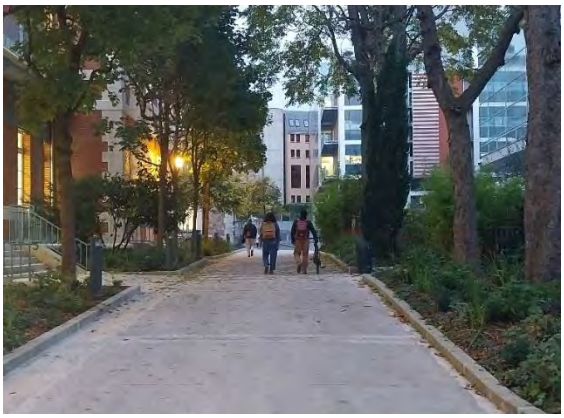


Figure 11: Photo of the linear garden

The landscaping project for the exterior spaces will enable the renaturation of a large part of the site, while allowing for gentle densification to accommodate new research space requirements, and optimize logistical devices and flows with strong impacts on the exterior spaces.

Numerous interventions are aimed at a potential reduction in air temperature of around 2°C between the existing and projected situation in the targeted areas, and will also benefit the residents of this dense urban district: soil desoiling, diversification and densification of plant strata, attention paid to the albedo of pavements, greening of certain roofs... Wherever possible, trees have been planted, in line with the prescriptions of the Paris Bioclimatic PLU, and this clear increase in tree cover has enabled the Institute to become the first healthcare facility to sign the City of Paris Tree Charter, at the end of the first phase of work.

The renaturation project, in this densely built-up area where some 3,000 users pass each other, made it possible to improve user comfort, by restoring a safe place for pedestrians, with pathways and meeting places that bring people into contact with living things.

The physical and mental health of this particular public had to be taken fully into consideration, as working conditions can be testing (confined, aseptic laboratories, basements, etc.).

We felt that reclaiming the site for the living world was the best way to soothe and offer a refreshing break for a better quality of life at work. The planted areas are not designed as decorative spaces, but are accessible: you can touch them, smell them, pick them...



Figure 12: Photo of the comestible garden

On part of the Campus, we have developed a living, nourishing landscape around an "edible street". It extends and encourages the initiative of a group of "Pasteurians" who took advantage of open spaces to plant edible plants. The project, led by AIA Territoires, aimed to reduce the logistical nature of this sector of the campus, to make pedestrian movements safer and to de-silting the surrounding area, in favor of planting edibles (fruit trees, berry bushes, aromatic plants...).

We have also designed the outdoor spaces as meeting places for users and visitors alike. At the heart of the site, the Jardin de la Serre is a shared space, central to campus life (photo illustration). Inclusivity is taken into account, with all spaces accessible to people with reduced mobility, and the multiplicity of outdoor stopping points enabling users to choose the one that best suits their needs, away from or in contact with the major axis formed by the "Traverse jardin", a linear garden, linking the two entities of the site.



Figure 13: Photo of the greenhouse garden

Spatial anchoring is an important notion in everyday life. In fact, the way in which people find their way around, the fluidity of routes, meeting points and familiarity with the site through a hierarchy of spaces are all elements that have been reinforced by the project to enable full appropriation of the site.
The Institut Pasteur's landscape, as a cultural entity, plays a social role: the notion of historical anchorage is very important at the Institut Pasteur, and the witnesses of the past, the great historical architectural compositions, are particularly highlighted. To reinforce this heritage, this feeling of stability, in-depth views and gardens enhance and showcase them.

1.5 Designing welcoming landscapes

These three projects illustrate a new generation of hospital landscapes, where ecological issues, public health, and the sensory experience of users are brought together in an integrated approach based on state-of-the-art science. They demonstrate the ability of landscape architecture to respond to contemporary urban challenges by combining biodiversity, quality of life, and health in a single design gesture. The holistic vision, particularly of the One Health approach, encourages the design of spaces that consider all components of the territory. It leads to a comprehensive reflection on how to develop open spaces. Indeed, these projects develop an ecosystemic

approach both for biodiversity in urban areas and for the different uses by users.

This health-based approach requires us to de-standardize the concept of the user by taking into account all social situations and physical conditions, particularly the needs of vulnerable people. To do this, we need to get down to the granular level of the city and talk to patients, doctors, and caregivers to understand living conditions and consider the consequences of the environment on mental and physical health.

Working on the role of landscape in the health of residents and users also means working on the health of the landscape. We want to go further by questioning the process of design from the perspective of landscape health. This comes into play at every stage of the project, from the initial commission to completion (constraints relating to the plant palette, the environment, the timing of projects, protection/preservation of existing features, etc.). All of these factors influence landscape health, which in turn influences the health of users and residents.

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IFLA 2025
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Short papers

TOPIC 1
Guiding cities through what is alive: Soil management

RESEARCH BY DESIGN: OPEN GROUND, DEPAVING URBAN SURFACES

TOPIC: Soil management

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Keywords: Desealing, soil, landscape design, circularity, research by design

Abstract
European cities are increasingly faced with the redevelopment of small and scattered urban areas, which commonly present sealed surfaces such as parking lots, infrastructure cutouts, or decommissioned warehouses. These spaces constitute both a resource of space and an opportunity for design, as well as a management challenge. Design operations are still limited in the field of depaving, yet they are growing. The Open Ground IDEA League International Summer School took place in the decommissioned area in the Porto di Mare, Milan, and aimed to investigate creative forms and processes of de-paving and material reuse from a design perspective. The outcomes of the Summer School reflected and enhanced the disciplinary backgrounds of the participants – MSc and PhD students from Politecnico di Milano, TUDelft, ETH, Aachen University, and Chalmers, ranging from architecture, landscape design, and urban planning to engineering, physics, and computer science. This contribution aims to briefly present the Summer School, its preliminary insights, inspirations and proposed work programme. First, it presents some internationally designed landscapes dealing with soil desealing. Secondly, it presents the methodology adopted and the proposed projects by the students that focus on both creative desealing and material reuse.

1.1 The Open Ground IDEA League Summer School in Milan as a testing ground for design experimentations on depaving

After decades of large-scale brownfield redevelopment – beginning in the 1980s with the transformation of former industrial zones and railway yards, which also led to important landscape architecture projects – European cities are now increasingly faced with the challenge of reusing smaller, more dispersed areas. These include fragments of infrastructure cutouts, small/medium scale warehouse areas, and oversized parking facilities. These spaces collectively represent both a resource and a challenge in terms of management [1]. These residual areas are gaining recognition for their spatial or ecological potential and are being progressively integrated into urban climate strategies. However, efforts to rehabilitate these sites often run up against the absence of dedicated funding, including for environmental remediation.

We decided to organize a Summer School engaging with the topic of soil desealing from a design perspective, on a case study located in the southeastern periphery of Milan, Italy. The site is representative of the above-mentioned decommissioned sites in the city. Located in the Porto di Mare (*Sea Port*) area, this decommissioned site lies within a larger zone of small-scale manufacturing. It is publicly owned and under regeneration. The site has recently been entrusted to the environmental organization Italia Nostra, which has initiated clean-up and maintenance operations. The site presented spontaneous vegetation taking over both paved and unpaved

areas to different degrees, and accumulations of waste materials, divided according to their types, which were later removed. Close to the area, there is a seasonal wetland and a former landfill site today converted into a park.

The Open Ground Summer School was funded by IDEA League and hosted by the Politecnico di Milano in July 2024. It was jointly organized by researchers from Politecnico di Milano (authors of this paper, Andrea Bortolotti, Chiara Geroldi) and TUDelft (Cecilia Furlan), in collaboration with: Latitude Platform, Italia Nostra Centre for Urban Forestation, and the research projects National Biodiversity Future Center (NBFC) and Nati00ns. The MSc and PhD students participating belonged to the Schools of the IDEA League alliance: Politecnico di Milano, TUDelft, ETH, Aachen University, and Chalmers. Their background ranged from architecture, landscape design, and urban planning to engineering, physics, and computer science and permitted them to explore the topic from a variety of perspectives.

We chose to name the Summer School "Open ground", which is derived from the French term *la plaine terre* (natural soil). Contemporary soil science tends to adopt the concept of an "open soil gradient" [2]. We propose an understanding of "openness" in a broader sense, as opposed to sealed soils. Here, openness refers to the soil's capacity to facilitate interactions among the atmosphere, subsoil, and groundwater [1]. Moreover, we looked at approaches aimed at reusing materials removed during desealing and their integration into new projects. This research-by-design initiative tested and experimented with representation methods and spatial compositions to trigger new aesthetics and ecological processes. It also allowed to engage with field experimentations, such as breaking, coring, and cutting the concrete pavement in the area to implement small-scale tests. A forthcoming publication collects reflections on the topic, the area, and the projects by the students [1].

1.2 International landscape design cases: desealing and reusing debris

Desealing is often seen and performed as a technical operation, whereas it can instead open up valuable design opportunities. A key issue is the possible presence of contaminated soil beneath sealed surfaces, especially in brownfield sites. Reusing materials like concrete and debris on site is another challenge, and often dependent on national regulations.

Desealing is an interesting topic for the field of landscape architecture. Several international projects showcase interesting results from a variety of perspectives. The review of these cases allows us to highlight some common challenges and opportunities, and a set of design strategies that can be inspiring for other projects dealing with desealing. Examples include projects by D.I.R.T. Studio, Wagon Landscaping, GTL Landschaftsarchitektur, and Openfabric.

D.I.R.T. Studio's Urban Outfitters Headquarters in Philadelphia (USA) showcases the reuse of concrete slab pieces as paving elements and the use of construction rubble. In Courtrai, Belgium, Wagon Landscaping's [Park]ing project implements geometric incisions with a precise design in asphalt surfaces to accommodate new planting. Projects like Jardin Joyeux – La Maladrerie in Aubervilliers (France) by Wagon Landscaping and the Bonames Airfield conversion in Frankfurt am Main (Germany) by GTL Landschaftsarchitektur adopt a more untamed aesthetic, fracturing paved surfaces to allow for the spontaneous growth of vegetation [1]. In Mantua, Italy, Openfabric's Via Amadei Garden depaves an urban road and creates a new public space, by choosing species already present in private gardens of the area. Milan-based Gisto's Frantoio Sociale and experimental works by the collective Hypereden explore the use of crushed construction materials to create urban furniture in a participatory way and expand the potential of reusing debris in public space design [1].

1.3 The Open Ground Summer School methodology

In order to prepare the Summer School, we conducted a brief review of the site and project theme by engaging in conversations with a variety of experts and practitioners. Moreover, we gained knowledge about the future plans for the area, the environmental remediation challenges, the existing vegetation on site, and the opportunities and challenges for reusing aggregates.

After this preliminary study, we proposed to the students three lenses for analyzing and interpreting the area within the short time available for the Summer School: materials, soil, and ecosystems. As core disciplines, we focused on landscape architecture and urbanism, representing the

researchers involved in the Summer School, giving account of both spatial qualities and metabolic understanding of the flows of materials.

Each group of students was organized in a way to mix different disciplinary backgrounds and to ensure the presence of one/a few designers for each group. They developed critical maps of the area according to the given lenses of analysis, sections, and a metabolic scheme giving account of existing resources on site, stakeholders and habitats. A site visit was organised with the students guided by a botanist and the representative of Italia Nostra managing the areas. The students got the opportunity to gain information on the site and future plans for its regeneration, including soil desealing. Moreover, they could observe the vegetation on site, including the species growing within the cracks of the concrete slabs, those gaining space on construction debris accumulations, and those present in the seasonal wetland. The students worked in a structure of the Politecnico di Milano called Off Campus Cascina Nosedo located close to the site, thus having the possibility to visit the site and its surroundings several times.

We also organized an international research seminar with invited experts: designers, pedologists, botanists and civil engineers working on soil remediation, demolition and production of recycled aggregates. This provided the students with inspiring and multiple perspectives on desealing.

Ultimately, the students developed design concepts for the site, plans, metabolic schemes and collages by paying attention to both issues of circularity and material reuse and spatial qualities.

A key feature of the Summer School was the possibility for the students to implement small-scale experiments showing the main design concepts. These small interventions were based on students' ideas/groups' work and performed by a geologist. They included cutting, coring, and crushing the concrete to reflect on some of the challenges of the operation and assess reuse potential.

The work was reviewed during the week by the teaching teams and by guests. It was presented at the end of the Summer School to invited academics, Italia Nostra, and local stakeholders. The students thus also had the opportunity to receive feedback from those involved in the regeneration of the area.



Figure 1. A geologist performing the small test experimentations envisioned by the students. Picture by T. Mola Meregalli



Figure 2. Planting cracks. Picture by T. Mola Meregalli



Figure 3. Precise cuts and design with rubbles. Picture by T. Mola Meregalli



Figure 5. Cuts and fills for habitat creation. Picture by T. Mola Meregalli



Figure 4. Cut and fill: ground to mound. Picture by T. Mola Meregalli



Figure 6. Precise cuts. Experimenting with coring. Picture by T. Mola Meregalli

1.4 The Open Ground projects

The Summer School explored desealing through three lenses: "designing with materials," which emphasized assessing the reuse potential of onsite materials; "designing with soil," which considered topography and the need to engage with cut and fill operations; and "designing with ecosystems," which encouraged multispecies design approaches and creating habitats through reused materials. The students developed five projects according to the main themes. The five above-mentioned on-site experimentations represented their project concepts.

Within the theme "design with materials", the project "Cuts and Cracks" imagines the site as both a material storage area and a temporary park. It experiments with accelerated surface degradation by working with existing cracks, previously investigated with advanced monitoring systems. This project primarily focuses on enhancing the existing ecological succession processes in the area, and it keeps the area sealed while waiting for environmental reclamation. "Circul(Art)" proposes instead a waste material inventory to guide artistic reuses of the materials on site. Selective cuts in concrete define open "rooms" for installations, while other waste materials are reused for furniture and installations in the site.

In the category "design with soil", the project "Ground to Mound" proposes full desealing of the area and experiments with landform design constructed with the debris. The landforms provide an accessible area, while the rest of the site is addressed through bio-phytoremediation techniques and is kept not accessible to the public during the reclamation process. This project engages with the potential to construct landforms with discarded materials, a growing attitude in landscape design [3].

For "designing with ecosystems", the project "Eco-Dwellings" designs micro-habitats for wildlife by exploiting accumulations and assemblages of certain discarded materials. Elevated paths allow human access while protecting areas for small animals, with a long-term ecological vision. The seasonal wetland area is also involved by the project. Finally, the project "Watering Sensorscape" creates an educational garden engaging with desealing by exploiting surface cuts, circular holes for tree plantings, and wild forest. The design works with both precise geometries and a wild aesthetic, thus testing different design potentialities. Sensors monitor soil health, and AI supports adaptive watering strategies.

The projects show several possibilities to act in the field: the strategy to keep an area sealed and to work with the existing cracks, having a temporary park before future reclamation and regeneration of the site; the ones to exploit discarded materials for art uses or habitat creation also via cut and fill operations; the construction of new landforms embodying discarded fill; and the one of creating an area for experimentation with didactical value exploiting both precise cuts and more wild aesthetic.

The Summer School emphasized that desealing is not just a technical operation but an opportunity for design. It highlighted the need for an early-stage collaboration across different disciplines, given the complexity of the issues at stake, involving soil ecology, reclamation issues, and design. The experience allows one to gain knowledge on both the challenges and opportunities of the field by discussing with several experts. It encouraged students to reflect both on processes and forms by engaging with metabolic strategies for material reuse and proposing projects for improving biodiversity and creating new spatial qualities. The experience also highlighted that the "cut" – the way in which depaving is performed – is already an integral part of the project, underlying the need for an early involvement of designers in the process. The projects developed by the students engaged with issues of design, forms, aesthetics, and processes, and they can be inspiring for other projects engaging with depaving. The Summer School enabled them to gain knowledge in this relevant field of action, on which there is increasing attention from administrations and policies and which can be an important field of design for the future.

Acknowledgments
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NBFC
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URBAN WASTE USE FOR URBAN EDIBLE LANDCAPES

TOPIC: Guiding cities through what is alive : Soil management

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Keywords: Edible landscape, Urban agriculture, Circular economy, Urban waste, Substrates

Abstract

The creation of natural spaces in the city, and urban agriculture in particular, often involves the use of materials taken from outside the urban system, such as agricultural land, to create agronomical support for plants. At the same time, large urban centers are facing major challenges in terms of waste management (ADEME, 2015). One of the solutions is urban metabolism (Barles, 2005), where urban waste is then considered as a resource. Although a functional soil or technosol can be recreated from urban residues (Grard & Al., 2015 & 2018), questions remain about the real robustness of agronomic functions and their durability, as well as their potential contamination with heavy metals. Based on these issues, ASTREDHOR, the French Agricultural Technical Institute of Horticulture, has developed a research program funded by the Ministry of Agriculture: the CasDar Techn'AU. Trials were set up at the ASTREDHOR experimental station in Saint-Germain-en-Laye (78) in 2017 and 2018. Cropping systems have been evaluated to produce aromatic and vegetable plants (cherry tomatoes and basil). A system in large volume 36 l containers with 14 substrate modalities composed of combinations of organic residues (green and/or food waste), allowing the nutrition of the plant by degradation, and mineral residues, from the building sector (granite and aerated concrete), providing structure to these supports. All the materials and products tested were subjected to a sanitary safety analysis by the Analytical Chemistry Laboratory at AgroParisTech. Results the formulated mixtures all had characteristics that were relatively far from horticultural standards: high density, greater air availability, reduced water reserves, higher pH levels and organic nitrogen. Depending on the materials used and their proportions, productivity levels may have varied greatly. For example, the use of green waste compost in large quantities has led to fertility problems (nitrogen hunger), resulting in low yields. On the other hand, mixtures combining 80% bio-waste compost (green waste and food waste) with 20% aerated concrete gave the best productivity results, thanks to food waste containing higher nitrogen reserves, and more quickly mineralized than the green waste compost used. The results of experiments on urban waste products for the creation of growing media confirm the ability of edible landscape to recover these residues. Some aspects of societal acceptability still raise questions. A more in-depth inventory of reusable materials and a global economic analysis are to be developed soon.

I.Introduction

Urban agriculture in heavily artificial environments requires reconstructing an ecosystem capable of providing plants with the essentials for survival: anchorage, water, air and nutrients. Although water and air are plentiful in western urban environments, fertile substrates and appropriate rooting media are comparatively scarce. Low-tech urban farming systems are often built from reclaimed or recycled materials. Self-produced composts are an important resource, whether to improve existing soils or to create growing media (Daniel, 2017). However, the quality and stability of these products are not always guaranteed and the volumes generated are sometimes insufficient.

Consequently, when a new green space is established, or on sites without composters, fertile matter is often lacking. Greening city centres therefore relies on products such as topsoil or commercial potting mixes. These materials are extracted or formulated outside urban areas and their extraction often degrades extra-urban ecosystems. Their use conflicts with the notions of proximity and sustainability that are fundamental to urban agriculture.

Stakeholders in the sector are actively seeking tailored, more sustainable alternatives. Which products can green the city more sustainably? Urban centres continuously generate "waste" rich in organic matter that could be of interest for plant production: biowaste (food waste and green waste). Composting, an inexpensive treatment that valorises this waste, has re-emerged in our cities over the past few decades. It takes various forms, from large composting platforms on the outskirts of urban centres to small composters at the foot of apartment blocks. More recently, at an intermediate scale, small composting units have been developed to collect and process urban biowaste within the city itself. They mainly process kitchen scraps from catering services and unsold produce from grocery stores, producing local biowaste composts for urban markets. These products, which comply with standard NFU 44051 (AFNOR, 2009), are organic amendments.

II.Materials and method

II.I Plant material

Two cropping systems were evaluated to produce aromatic and vegetable plants (cherry tomato and basil).
Cherry Tomato : Solanum lycopersicum 'Donna F1'
Basil : Ocimum basilicum L. 'Grand Vert'

II.II Growing conditions

Two trials were conducted at the ASTREDHOR Seine-Manche experimental station in Saint-Germain-en-Laye (France) in 2017 and 2018. Large 36 L containers were filled with eight substrate variants made from combinations of organic residues (green and/or food waste), which supply nutrients through degradation, and mineral residues from the construction sector, which provide structure. The whole system was compared with a horticultural growing medium.

II.III. Growing media

All mixtures studied are presented in Table 1

Table 1. Table of mixtures studied

Name	Material combination
C1S1	60 % green-waste compost + 20 % spent mushroom substrate + 20 % aerated concrete
C2S1	80 % intra-urban biowaste compost + 20 % aerated concrete
C3S1	80 % urban biowaste compost + 20 % aerated concrete
LC3S1	80 % urban biowaste vermicompost + 20 % aerated concrete
LC1S1	80 % manure vermicompost + 20 % aerated concrete
T	Commercial Klasmann W913 substrate + slow-release fertiliser (Osmocote Exact Hi-End 8/9 m)
C3	100 % urban biowaste compost
C3S2	| 80 % urban biowaste compost + 20 % wood chips
C1S1	60% compost from green waste + 20% mushroom farm residues + 20% aerated concrete

II.II Social perception / acceptability

During a workshop, 17 participants were asked about the mixtures studied in 2018. Samples placed in 2 L pots and petri dishes were anonymised; they could be looked at, handled and smelled. The respondents were people interested in urban agriculture, mostly for professional reasons. Average age: 28 years.

II.III Measurement of Maximum Water Capacity (MWC)

The MWC corresponds to the volume of water (L m^{-2} roof) retained by the materials constituting the growing complex after 24 h saturation followed by 2 h drainage (ADIVET, 2018). The AUREA Agrosciences laboratory performed the analyses (ADIVET method) on substrate samples taken after one growing season (12 Dec 2018): one composite sample per treatment, analysed in triplicate.

III.Results

The formulated mixtures all exhibited properties that deviated considerably from horticultural standards: high bulk density, greater air availability, reduced water-holding capacity and higher pH.

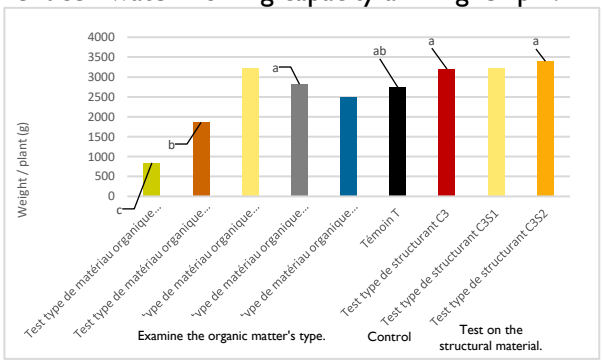


Figure 1- Yields obtained for cherry tomatoes on the potted device, according to the 8 substrate modalities tested in 2018, over 5 months of cultivation (8 harvests).

Nonetheless, depending on the materials used and their proportions, productivity levels varied greatly. For example, the use of green-waste compost in large quantities led to fertility problems (nitrogen hunger), resulting in low yields (C1S1).
Conversely, mixtures combining 80 % biowaste compost (green waste + food waste) with 20 % aerated concrete (C3S1) achieved the highest productivity (3.4 kg cherry tomatoes per plant), thanks to the higher nitrogen reserves in food waste, which mineralise more rapidly than those in green-waste compost.

Accumulation of points awarded

Several of the mixtures tested showed high initial salinity, resulting in significant nutrient losses through leaching during the first irrigations.
Over two years, substrates containing an organic structuring agent (wood) collapsed much more than those with mineral materials (crushed paving). For one treatment containing green-waste compost, spent mushroom substrate and shredded wood, cherry-tomato production was four times higher in the second year, thanks to the gradual mineralisation and stabilisation of the organic matter supplied.

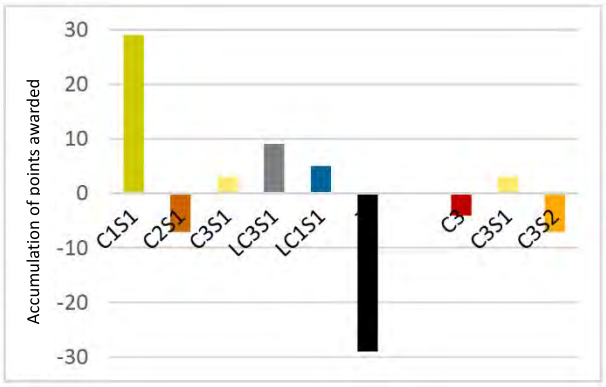


Figure II - Results of a sensory test on substrates tested in 2018. Assessment of the quality of the mixtures according to a score of -3 to 3. 17 respondents.

Sensory perception of the mixtures:
The C1S1 blend, composed of three materials with different colors and textures, was considered the most visually appealing. Mixtures C2S1 and C3S2, which contained coarser elements, were less appreciated. The control substrate, which was very fibrous, was not recognized by participants as a growing medium; some described it as mulch.

Table 1. Tableau des mélanges

Density at WHC kg/m3 (on fresh samples)	
C3S2	945,5 ± 10,2
LC1S1	1095,9 ± 23,0
C3S1	1097,6± 33,5
C2S1	1098,8 ± 25,8
LC3S1	1113,4 ± 32,1
C1S1	1116,4 ± 38,0

The water holding capacity at field capacity (WHC) data allows for a comparison of substrates without considering plant growth. All values obtained were relatively similar. Notably, using wood as a structural component reduced the WHC compared to aerated concrete. Overall, the recorded values are close to the upper limits set for standard commercial substrates designed for intensive green roofs or rooftop gardens.

As a comparison: URBA1200, by Florentaise, for rooftop garden on slab: WHC ≤ 1200 kg/m³; Urban Soil, Optigreen, for rooftop or balcony vegetable gardens: WHC max. = 1650 kg/m³
In conclusion, the formulated mixtures appear to be suitable for rooftop garden applications

The WHC data allows for a comparison of substrates without considering plant growth. All values obtained were relatively similar. Notably, using wood as a structural component reduced the WHC compared to aerated concrete. Overall, the recorded values are close to the upper limits set for standard commercial substrates designed for intensive green roofs or rooftop gardens.

IV. Discussion

From a technical point of view, this study evaluated the agronomic performance and behaviour of two types of urban residues organic and mineral to produce vegetable plants in large containers (36 L). It analysed various ways of combining these 'wastes' and observed the behaviour of these mixtures over several growing seasons.
The findings indicate that homogenous blends composed of roughly 80 % organic matter and 20 % mineral components can be highly suitable for growing vegetable and aromatic crops—provided the ingredients are chosen with care.
Regarding organic materials, the experiments revealed variable fertility levels among the different composts and vermicomposts tested, depending on whether their composition originated from plant (green waste), food or animal sources.
The good productivity obtained with biowaste composts containing about one-third food waste demonstrate the value of these 'wastes' and call for the generalisation of their composting at all scales.
The study also highlighted the role of compost structure in the fertility of the resulting blends and the importance of irrigation management adapted to this parameter.
As for construction-sector materials, the trials show that well-selected residues can be of real interest for structuring organic materials and improving the physical fertility of mixtures (aerated

concrete was identified for its lightness and porosity).

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VI. Conclusion and perspectives

The results of these experiments confirm the multifunctionality of urban agriculture through its capacity to recycle urban residual products to create growing substrates.

Certain health, regulatory and societal acceptability aspects still need to be addressed.

Understanding the mechanisms of organic-matter mineralisation and the addition of supplementary fertilisation remain open research areas.

A more detailed inventory of reusable materials and a comprehensive economic analysis must be developed soon.

More generally, this study opens the question of structuring a sector dedicated to the recovery of urban waste products.

On the one hand, there is a strong demand from users for locally sourced products, and on the other hand, players in the waste treatment sector are increasingly interested in various forms of urban agriculture. They see the greening of the city as an interesting opportunity to recycle their waste locally.

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Acknowledgments

Thanks to the collaborators, suppliers, technical support and other partners who made this project possible.

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Reclaiming Post-Mining Landscapes: An Integrated Approach to Ecological Restoration and Sustainable Design

TOPIC: Guiding cities through what is alive: Soil management

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Keywords: Post-mining reclamation, Ecological restoration, Adaptive reuse, Sustainable landscape design, Urban resilience

Abstract
Urban expansion and industrial activities on the areas which are damaged by man are a widely documented effect on landscape organization. Each year, hectares of land directly disturbed by only mining activities besides agricultural use, roads and transport. This study explores innovative approach to landscape reclamation and community engagement to transform the post- mining areas into multifunctional landscapes while understanding how abandoned open pit areas affect the landscape system.
In addition, to reach the successful reclaim work and to see clearly framework, these questions will be examined "What is the planning process for open mining lands? ", "How can be reduce the disturbance on land?" if many times, land can provide more than just one use. This project is formed by researches of nature, landscape, environment, mine engineering authorities to answer these questions while searching physical effects of mining activities on landscape in parallel with climate, soil, and biotope.
As a case study, information directed remediation of land that is abandoned after mining activities and existing conditions of the Istanbul, Turkey are evaluated to clarify concretely the effects of mine activities on nature. This study provides an evaluation of north mining areas in Istanbul and its landscape transformation over the past 25 years within the context of its changing urban landscape.

1. Introduction

What are the ways to the understanding of the disturbance of surface mining activities on landscape system and how can it be reclaimed? Since the early days of reclaiming, the various aspects are posited in different disciplines as ecology, engineering, architecture. The natural value of the land and its ecology are more considered by ecologists, on the other side mine engineers debate mostly increasing of the product efficiency. In this study, cooperation of the different principles will be considered for the developing of reclaiming plan to be able to live off the land.

Specifically, the study intends to:

1) Understand the present situation of mining lands carried out in Istanbul having a scientific and technical basis for damage assessment/restoration/reclamation planning;

2) Create a landscape assessment analysis based on the detailed data from the scientific studies carried out in Istanbul by mine engineers and municipalities and past and present variables in the study area.

3) Recommend reclamation plan considerations to be incorporated in mining sector of Istanbul City including land use plan and restoration/ design regulation.

What are the ways to the understanding of the disturbance of surface mining activities on landscape system and how can it be reclaimed? Since the early days of reclaiming, the various aspects are posited in different disciplines as ecology, engineering, architecture. The natural value of the land and its ecology are more considered by ecologists, on the other side mine engineers debate mostly increasing of the product efficiency. In this study, cooperation

of the different principles will be considered for the developing of reclaiming plan to be able to live off the land.

As Berger, A. (2009) says "As with any new cross-disciplinary approach, the primary objective is the formations of knowledge that can redirect our current ways of thinking about reclamation - to allow for the mining world to begin a new discourse with the design world."

1.1. Human Impact on land: Open Pit Mines

The study starts theoretically with a literature survey mainly focusing on the open mining activity, its ecological disturbance and reclamation plan of disused mining areas. In the first part of study are examined reasons of changing landscape by human and the effects of this changing on nature and human. The reason of focusing to mining lands as abandoned and temporary use land will be mentioned.

Meanwhile, the time dimension, that is to say the period required to ameliorate any damage to the productivity of the land, is crucial factor in land degradations. In most case, no matter how severe a degradation process is, given enough time, natural processes will repair the damage without human assistance.

Besides nature no longer is an external force, separated from human culture. It is increasingly incorporated into the matrix of human experience and action (Bennett 1976).

Moreover, human impact is not only on nature. In the short term, at the individual or institutional level, polluting and destroying resources often seems economically logical, but in the long term, actions create side effects such as social, economic and cultural effects on many lands, apart from ecological effects.

1.2. Regulatory and Executive Network

Land conservation, reclamation planning, environmental laws and related regulations and public and private co-operations are described and on reclamation projects, importance of their relations and integrations are pointed out to open-pit mines.

Today, in some countries that have a strong environmental lobby, when even with good planning the environmental consequences are deemed too costly to society, mineral extraction may be prevented. Such has been the case in some areas of Alaska, California, and coastal New England where, to date, exploitation of potential offshore petroleum has been prevented. But the overall reality from the worldwide perspective is that, in most cases, the short –term economic benefits of mineral extraction are all powerful and they are actively mined. To ensure that the deleterious aspects of mining operations are minimized requires, in almost all cases, conservation strategies that would increase the overall cost of the mineral extraction. Worldwide, prices of most mined minerals usually reflect only the direct immediate costs such as fuel, equipment, a labor. Rarely have permissions been made to include the costs of destroyed landscapes in the price determination of minerals.

To prevent land degradation from occurring, mining operations usually need to be controlled by strong legislation. This is because, in general, higher costs are associated with the extraction of the mineral if environmental damage is to be prevented. Since mineral resources are where you find them, not where you would like to find them, prevention of deleterious effects associated with their removal must be planned around, not planned for;

As Flawn, Peter T., (1970) *pointed out* "*That is, mining operations must take place in the locations where the minerals are located. They cannot be assigned to areas that satisfy the whims of society.* "

Moreover "For whom should be reclaimed? Good for what? For whom?", "Who is the real owner of land? Nature or man?", "Should the damage of land take ignore to make profit from mining? On that point we examine the role of public and private corporations dealing with mining sector to answer the questions (Table 1).

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Table 1. Role of the Actors in Planning (Dulek, D. 2010)

1.3. Case Study: Istanbul Mining Region from 2000-2025

North coastline of European side in Istanbul is examined to understand the conflict of open- mined area with its effects. The reason for choosing this area as a case study area are its positioning in the city and its disused. And most importantly, the value of the land for future is remarkable, when we considered the 3rd bridge and 3rd airport project planning in future in 2010.

It is placed in the greenest place and ecologically valuable region of Istanbul which covers a narrow range of recreational activities, has a dynamic character with diverse meanings changing according to the user groups, and way of uses, diverse characters of area changing during the time because of the structural character of land. In this study area, present situation is examined profoundly in terms of soil conditions, structure types, morphology, plantation types and climatic factors. Furthermore, the proposal reclamation plan will be developed for coal district of İstanbul and the questions as "What former time period will the site be restored? And her should one cope with the unpredictable environmental changes that impact site?" according to Berger, A. (2009).

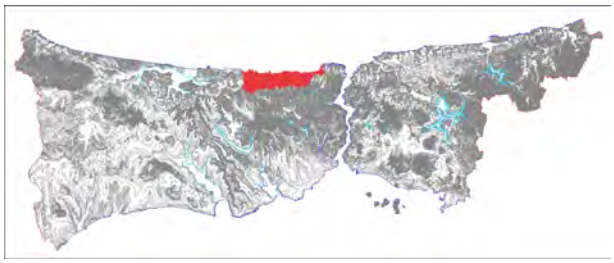


Figure 1. Position of the Coal Mined Region in İstanbul.



Figure 2. Neighborhood of the Coal

Region (Dulek, D. 2010)

Sustainable recreational plan is developed on the coal mined regions of Istanbul where are located near North Sea coast of European Side because of concentration of abandoned mine lands on the area where has the greenest dense and ecological value of the city. The data gathered from various institutions and organizations are analyzed to give a general framework about the situation in the project area. The recreational use and some land solutions are proposed to reclaim the land for nature, public use and green future of the city.

The case study area is located in the north of Yukarı Ağaçlı Village and Çiftalan Village. It is also near estimated 3d Bosporus Bridge so this area would have major position in future. In the point where estimated 3rd Bosporus Bridge Road comes close to operation boundary, the altitudes of overburden material and road are in the approximately same level. Therefore, during the coal production activities in the future, any remediation work can be discussed in the south of area for road connection requirement to mines. (Dogan,T., Kahriman, A.,2008)

1.3.1 Changing Landscapes in the Region

- Changing of coast line
- Land use change with mining
- Creation ponds
- Changing in contour line of land
- Soil degradation
- The lack of biotope diversity

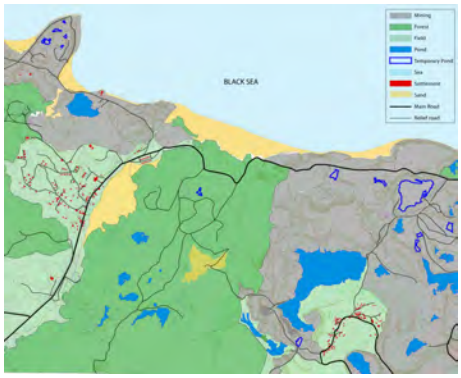


Figure 3. Land usage situation till 2000

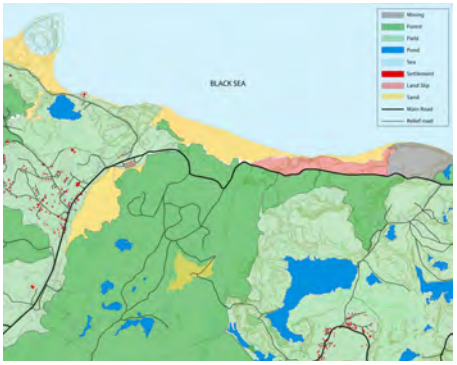


Figure 4. Land usage situation till 2020 (Dulek, D. 2010)

1.3.2. Impacts of Open-pit mines in the Region

The environmental impacts of quarries were discussed in the research of Dogan, T., Kahriman, A., 2008. As shown in Figure 5, considering the changes in the coastal area and land use, it is proven that these impacts are still relevant in 2025.

- Water quality is damaged by the mining sector.
- Destroyed forest land is influenced by seasonal rainfall. Valuable and productive soil layer is terminated in the sea.
- Coastal and seabed topography and fauna and flora of sea and forest are largely destroyed by coal mining.
- Decreasing of fish population and the fishing activity becomes more difficult.

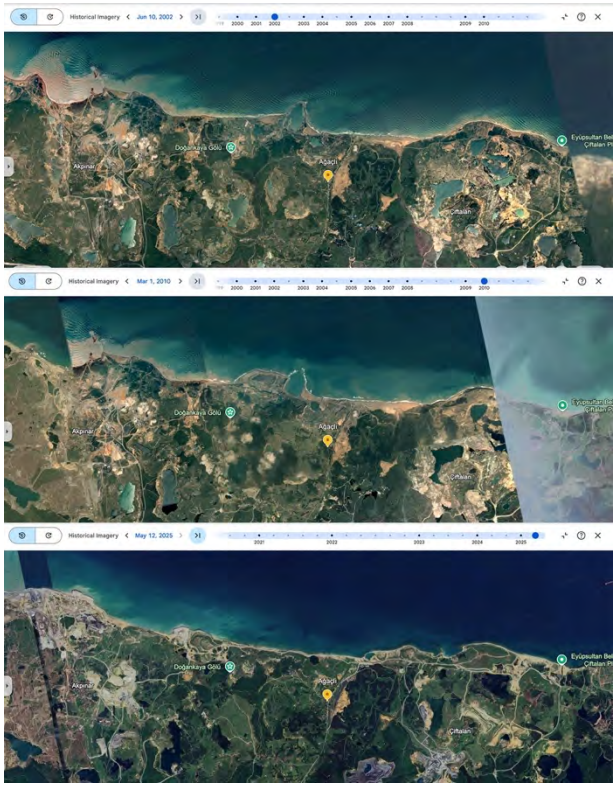


Figure 5. Satellite views between 2002-2025

Google. (2002-2025)

The data's gathered from various institutions and organizations are analyzed to give a general framework about the situation in the project area. The recreational use and some land solutions are proposed to reclaim the land for nature, public use and green future of the city.

As a case study, reclamation proposal is developed for whole Ağaçlı Region and communication strategy is offered to change the recreational habit of residents in Istanbul.

The design proposal is developed in order to physical/natural conditions of region and behavior of residents of Istanbul. North European Side is one of the most visited natural areas for recreational use and escaping from the city environment in İstanbul. The Black Sea is also preferred coastline for swimming because of the clean sea and Belgrad Forest is one of the big recreational forests to public use but it usually comes to demand for picnic. Various recreational uses are recommended according to the natural circumstance and mining history.

In Ağaçlı Region new center of population such as Kemer Country and Zekeriyaköy are dominant center in term of their residents. We can also offer these recreational uses on the area, as we consider resident of these neighbors for daily use and residents who live in the Istanbul mostly for weekend use.

Recreational activities can classify into two groups; 1) land-based activities, 2) facility-based activities;

- Land based activities:

Sand rally, fishing, boating, canoeing, picnicking, horseback riding, camping, caravanning, kite flying, hiking, bird watching, bicycle riding, boardsailing, kayaking Water skiing, space exploration, climbing, sightseeing, nature/wildlife observation, outdoor photography

- Facility based activities;

Visiting cultural/historical sites, golf, basketball, soccer, swimming, volleyball, music festivals, agricultural activities, gardening.

Recreational use should be thought in the plantation plan or its' surround and north sides of remediation area should be under controlled in order to protect remediation area. In order to this, some areas are determined and designed as forest area to protect the parks and recreational areas from mined areas. The forestation plan is developed around the lands which are proposed for recreational use in Ağaçlı and Ciftalan Coastline.

According to Kara, F., Demirci, A. (2009), generally, the parks include sports fields, campgrounds, playfields, winter sports, trail systems (hiking, bridle, bicycling, and vehicle), nature study area, nature center, food and lodging, water recreation (swimming,

boating, and water skiing), large picnic areas. Istanbul should consider these qualities as standards when they establish a community, district or regional park. Designing these parks while restoration of the damaged lands is very important for cities, especially big cities like Istanbul.

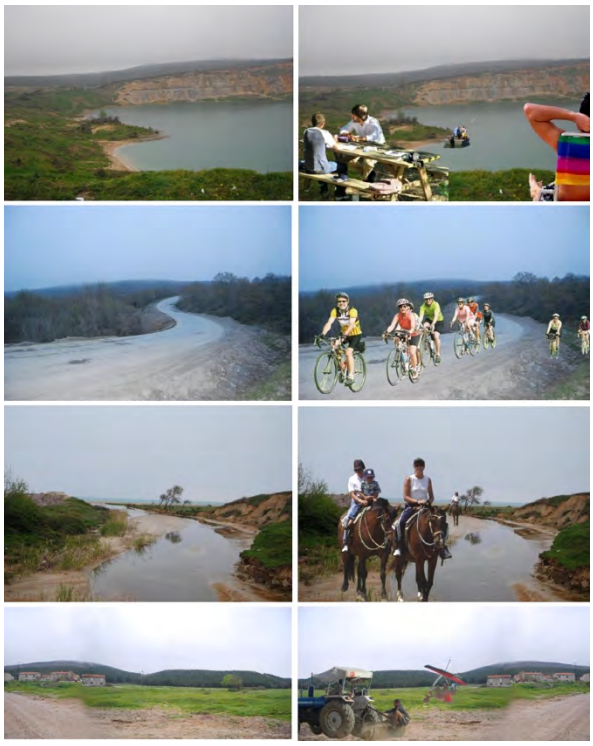


Figure 6. Illustration of proposed recreational activities (Dulek, D. 2010)

2. Conclusion

The landscape management and planning should take into consideration before and during the mine operation. Before the operation, the environmental conditions should be evaluated and operation should be planned according to these conditions. During the extraction process, the land layer should be hoard for sustainable and restoration of the site. Meanwhile, the products to be quarried, how to use is unavoidable, environmental problems as a result of this mining, should consider and minimize.

Planning of the operation has significant role sustainability of landscape. In addition, landscape management provide easy and efficient recycling to land and reduce the cost of the process.

Current structure and recommended reclamation study of Coal Region of İstanbul shows a rarely faced special case. Comparing the thesis study area with the other examples in the world we can see the thesis area needs reclamation under a proper program.

Some land usage alternatives are proposed to increase proportion of the green recreational areas and to bring back to nature in disused mining areas in the district;

- The materials that are obtained from the excavations should be ported to the lands that were cleaned from coal before.
- The land should be afforested and the upper soil that is going to be cleaned from coal should be used in casting zones with the purpose of greening.
- The perpendicular slopes through the sea should be decreased.
- State has to prevent the crooked utilization on developing the new zones, the result of the construction of 3rd bridge and the airport.
- Every operator who holds the license should define their plans with indicating the time period and place along with the maps, and therefore, the rehabilitation of the deformed zones should be guaranteed in all conditions.
- Process water and land biodiversity should be protected. To protect process water and land biodiversity. There need minimize the environmental hazards which occur during mining because of the erroneous processes.
- To create interaction between actors and residents. Communication and consultation should be provided among all parties, includes citizen liaison committees about benefits of reclamation projects.

The development of population and especially pressure of bridge which is planning to construct, presumably will affect green areas of İstanbul. This estimated also changings should be considered to preserve the green open spaces, habitat and wildlife when the abandoned mine lands are re-claimed.

Understanding, the importance of landscape plan in terms of nature and human, on reusing mined sites requires multi- disciplinary thinking with pub-lic policy, ecology, political activism, planning and design fields. The relation between mining process and reclamation by considering the team work and aims to strengthen this process. A landscape architect, designing a general decisional framework shows the possible ways to embed the landscape management plans of these lands into more organized planning system.

Finally, it is prominently aimed to provide an integrated framework to involve cross-disciplinary approach. In addition, this study wants to make people aware about the existing of these temporary lands according to the assessment of Istanbul's open mining pits.

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DESERTIFICATION IN MEDITERRANEAN URBAN PERIPHERIES:

TOPIC: A new field of climate intervention for urban resilience

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Keywords: Peripheries desertification, Hydromorfological restoration, Ecological Regeneration, Nature-based solutions, Cultural landscape

Abstract
The project is part of the strategic action of the **Metropolitan Forest of Madrid**, a key initiative for the city's climate adaptation. Covering 14,200 hectares and with a 75 km perimeter, it aims to strengthen green infrastructure by completing the existing network of green spaces and linking them with nearby natural areas. It contributes to the Sustainable Development Goals of the 2030 Agenda, promoting resilience, biodiversity, and territorial integration.

In its southern sector, The Southern River Parks, lies the Manzanares River and its tributary, **the La Gavia Stream**, which crosses gypsicolous hills. This area, once agricultural and pastoral, was transformed into extractive land due to gypsum quarrying and later used for inert waste. Fragmentation caused by urban infrastructures disconnected the stream and the Colada del Santísimo cattle track, leading to informal settlements and illegal dumping. The stream was reduced to a runoff ditch between polluted lands.

Desertification in Mediterranean regions and intense human activity around Madrid have further disconnected historic cattle tracks and city access routes, degraded soil, reduced fertility, caused erosion, altered sub-basins, and led to habitat loss.

The regeneration aims to restore degraded soils, recover the seasonal watercourse, and revive the area's cultural value. The goal is to **restore the stream as an ecological, hydraulic, and social backbone**, reconnecting residents with nature via the Manzanares floodplain and banks.

Given the area's size and budget constraints, the focus is on optimizing local resources and applying strategies to recover a fertile, resilient territory. **Nature-based solutions** are used to slow runoff, enhance infiltration, and reduce erosion, directing rainwater to the stream. The result: a mosaic of moisture levels that restore habitats like reed beds, poplar groves, willow stands, and tamarisk thickets. Delaying the WWTP's regenerated water discharge is also considered to boost temporary flow.

To improve soil, the plan includes organic amendments, herbaceous cover, and regenerative agriculture. Reforestation is key to restoring ecological balance.

This **regenerative approach** revitalizes the landscape, boosts biodiversity, and socially reactivates the space by restoring historic paths into pedestrian and cycling routes, creating gathering areas, and reconnecting people with their cultural and environmental heritage.

Text

1. Desertification in Mediterranean urban peripheries: A new field of climate intervention

In recent decades, Mediterranean cities have expanded outward, absorbing fragile and historically neglected territories without proper planning. These peripheries—once fertile farmlands, pastoral routes, or river corridors—have become fragmented and degraded, losing much of their ecological and functional structure. Climate change, coupled with institutional neglect of these urban edges, has accelerated a silent yet profound process of **erosion and urban desertification** that has scarcely been addressed from a systematic perspective.

In Spain, desertification has been primarily documented in rural areas, where agricultural intensification, overexploitation of aquifers, and abandonment of traditional farming have disrupted ecological balance. In urban and peri-urban contexts, this phenomenon manifests through different yet equally degrading dynamics. The urban fringe has been treated as a **utilitarian and disposable** space: hillsides turned into quarries, valley floors occupied by infrastructure, and runoff areas converted into landfills. These alterations erase territorial memory, hinder regeneration, and compromise the capacity of these areas to provide environmental and functional support to the cities that created them.

Today, however, these territories are more strategic than ever. New urban developments surround or incorporate them, social demand for nearby green spaces is increasing, and environmental commitments are strengthening. These degraded peripheries are now being seen as **opportunities for ecological, social, and climate regeneration**. Within this new framework, green infrastructure ceases to be merely decorative and assumes a functional role in reconfiguring hydrological processes, restoring ecosystems essential for resilience, and ultimately improving urban health.

One of the key strategies for such regeneration is **hydrological–forestry recovery**. Restoring the role of ephemeral watersheds and streams—now altered or buried—can reactivate natural dynamics that sustainably manage water, reduce erosion, and facilitate the formation of new **biological corridors**. Though often absent from urban plans, these intermittent watercourses historically structured land use, vegetation, and settlements—and they can do so again.

This type of intervention is gaining ground in various Mediterranean cities: in Barcelona, the renaturalization of the Vallbona–Besòs axis seeks to reestablish ecological continuity between Collserola and the sea, integrating the Besòs watershed as a key structure (Ajuntament de Barcelona, 2023); in Marseille, adaptation plans in the Quartiers Nord are restoring peri-urban hillsides as a barrier to urban sprawl and a mitigation strategy (Agence d'Urbanisme de l'Agglomération Marseillaise, 2022); in Rome, efforts to reactivate the Agro Romano involve the recovery of historic ditches and irrigation channels redesigned as green infrastructure (Vallerani & Trusiani, 2019); and Lisbon has consolidated the Monsanto Green Corridor as a strategic axis to restore eroded soils and connect peripheral areas with urban ecological systems (Câmara Municipal de Lisboa, 2021).

These strategies represent a paradigm shift from traditional urbanization or restoration models, as they do not seek to impose a new order but rather to **activate the site's latent potential**. Instead of erasing past traces or importing external solutions, they recognize the ecological, topographic, and cultural value of what already exists: eroded slopes, stream traces, resilient species, or spontaneous patterns of use. The goal is not to reconstruct an idealized landscape but to accompany its transformation based on principles of **minimal intervention, resource efficiency, and continuity with the surroundings**.

The recovery techniques are grounded **in soft, adaptive processes** that are sensitive to the fragility of the territory. **Low-impact interventions** are prioritized: minimal soil disturbance, superficial and selective clearing, use of local materials to stabilize slopes, and revegetation with native species. Hydrological and geomorphological design is essential for reactivating natural runoff, reconnecting the territory with its fluvial dynamics, and restoring basic ecological functions.

This new approach acknowledges the value of **time as a design material—not only as an ecological agent but also as a vehicle for cultural and territorial transformation**. Time

that shapes the land and sediments memory. Time that allows a plant to germinate, a watershed to stabilize, a soil to regenerate. Designing with time—rather than against it—means intervening with intelligence, respect, and a long-term vision. Beyond its environmental aspects, these interventions carry powerful symbolic value: they transform marginal spaces into new nodes of urban and environmental resilience, where what was once a quarry or landfill can, without denying its history, become a park, forest, or climate corridor.



Figure 1. Current state of La Gavia stream and dry hills on Madrid's peripheries

2. Case study: Regeneration of La Gavia — A green infrastructure model within Madrid's Metropolitan Forest

2.1.1 Madrid: Environmental Challenges in a dense and fragmented city

The **climate crisis** is accelerating aridification processes across the Mediterranean region, posing unprecedented challenges for cities like **Madrid**, located on a plateau with sub-humid to semi-arid conditions. With 7 million inhabitants, Madrid follows a compact and highly impervious urban model that has eliminated green infrastructure, historic drainage systems, and natural habitats. Its urban edges—once fertile and functional—have been exploited, filled in, and abandoned, resulting in eroded peripheral landscapes with altered water networks and limited ecological connectivity. Increasing urban pressure, resource depletion, and growing demand for green spaces highlight the urgent need for territorial infrastructures capable of mitigating climate impacts, restoring ecosystem functions, and reinforcing socio-environmental cohesion.

2.1.2 The Metropolitan Forest of Madrid: Strategy and scope

In response, the Madrid City Council, through the Directorate General for Strategic Planning, launched the **Metropolitan Forest of Madrid (BMM)** strategy in 2020. This project envisions the creation of a 75 km peri-urban green belt covering 32,000 ha, integrating reforestation, soil regeneration, sustainable water management, soft mobility, and the recovery of historic corridors. It aligns with **the "Horizon 2030" goals and the Paris Agreement**, articulating a dual strategy: CO_2 capture through reforestation, and emission reduction from motorized mobility via a network of **slow mobility pathways that foster social reconnection through the landscape**.

In a region marked by high aridity (average annual precipitation ~460 mm) and an Aridity Index (AI) between 0.20–0.50, restoring ecological connectivity and reactivating seasonal hydrological cycles emerge as key axes for reestablishing the functionality of degraded systems.

2.1.3 Lot4: Location, challenges, and a multidimensional approach

The Metropolitan Forest is structured into five lots, the result of an international and interdisciplinary competition. Lot 4, developed by **aldayjover architecture and landscape**, spans 1,250 ha in the southernmost part of Madrid, traversed by the **Manzanares River** and its tributary, **La Gavia Stream**.

This area represents a paradigmatic case of **degraded peri-urban landscape**: former gypsum hills exploited as quarries, later converted into landfills, fragmented by infrastructure, and disconnected from the urban system. Despite this, significant geographical traces remain (such as the stream and livestock trails), and the site occupies a strategic location for linking established neighborhoods with future developments.



Figure 2. Lot 4 in the Metropolitan Forest of Madrid.

The intervention approach combines **environmental restoration, social regeneration, and landscape design guided by principles of sustainability and circularity**.

2.2. Territorial and historical context

The La Gavia area is located on the southern periphery of Madrid, within the lower sub-basin of the Manzanares River and near the boundary with the municipality of Getafe. Since the Iron Age, as evidenced by the remains of the **Carpetani settlement**, the territory has been associated with extensive agricultural and livestock use, shaped by its location among gypsum-bearing hills. However, in the mid-20th century, intensive exploitation began: the hills were turned into **gypsum quarries** and, after being closed, were progressively filled with **inert waste**, fragmenting soil profiles and degrading their capacity for water and nutrient retention.

The route of the historic **Colada del Santísimo**, a livestock trail used by sheep and goats, was largely dismantled and occupied by informal and vulnerable settlements.

La Gavia Stream, originally a seasonal watercourse, was progressively degraded into an artificial ditch, flowing through eroded soils with accumulated waste and **a heavily reduced riparian vegetation**, now limited to small, isolated gullies with no ecological continuity.

The deployment of metropolitan-scale urban infrastructure—such as the M-45 highway, railway lines, substations, wastewater treatment plants, and landfills—has **severely fragmented the landscape**, undermining both ecological and social connectivity. Currently, neither wildlife nor residents can move continuously through the peri-urban corridor, disrupting historical links between neighborhoods. This issue will become even more pronounced with the upcoming urban developments in southern Madrid (51,656 new housing units), reinforcing the need for green infrastructure and regenerated public space.

The territorial evolution of La Gavia reflects a trajectory of exploitation, abandonment, and environmental degradation, but it also represents a **strategic opportunity to reconfigure its ecological and social dynamics** through nature-based solutions, attention to existing geography, and the activation of its landscape potential.

2.3. Current environmental diagnosis

In an ecosystem **deeply altered** by anthropogenic processes, neglect, and accelerated urban transformation, environmental degradation is evident in **soils, water systems, and biodiversity**. This diagnosis is complemented by climatic variables and other critical conditions, providing a rigorous foundation for identifying the territory's real challenges and guiding adaptive and resilient interventions.

2.3.1 Soils: compaction, erosion, and loss of fertility

The hilltop soils are characterized by a strong presence of gypsum, with highly saline materials, low water retention, and poor fertility. These conditions limit the formation of stable soil structures and restrict plant diversity, favoring specialized gypsophilous communities adapted to extreme environments. Added to this is intense anthropogenic degradation: compacted soils, low porosity, minimal organic matter, and high vulnerability to erosion—all of which **hinder ecological regeneration processes**.

In the streambed area, the topography facilitated the establishment of informal settlements that polluted and compacted the ground. Later, the area

was transformed into an uncontrolled landfill. Natural processes persist only in spots where moisture accumulates, forming **temporary microhabitats** within a broader context of soil degradation and ecological dysfunction.



Figure 3. Current state of the stream and artificial hills.

2.3.2 Hydrology: cycle disruption and fluvial disconnection

The watershed's hydrological cycle is severely disrupted. La Gavia Stream has lost its seasonal functionality, becoming a degraded channel with low ecological value. Linear infrastructure interferes with its natural course, obstructs its connection with the Manzanares River, and impedes infiltration and aquifer recharge processes. Increasing urban impermeabilization and the artificial management of stormwater through detention tanks have produced abrupt runoff events. This dynamic raises **flood risks** and hampers the restoration of riparian habitats, which are now exposed to frequent and intense **hydrological disturbances**.

2.3.3 Biodiversity: fragmentation and species loss

Habitat fragmentation has drastically reduced native flora and facilitated the spread of **exotic and ruderalized species**. The degradation of gypsiferous areas and the disappearance of species adapted to gypsum soils are clear indicators of environmental decline.

The former ecological corridor, once known for its high biodiversity, has become an ecologically **imbalanced environment** dominated by unbalanced populations, losing its functionality to support stable faunal communities.

2.3.4 Climate, emerging issues, and social demands

Southern Europe's increasing **vulnerability to climate change**—evident in rising temperatures, declining precipitation, growing water stress, and the increased frequency of extreme weather events such as prolonged heatwaves or the Filomena storm in Madrid—highlights the urgent need to develop resilient territorial structures.

Compounding this scenario is the high presence of buried waste and diffuse emissions from wastewater treatment plants, further aggravating soil and air pollution. Expansive urbanization, characterized by high impermeability and minimal vegetation cover, intensifies the urban heat island effect, increases energy demand, and inhibits urban **renaturalization** processes.

At the same time, the local population is demanding more safe and ecologically valuable green spaces, reflecting a historical debt in urban policy, which has allowed environmental deterioration without ensuring equitable **access to urban nature**.

2.4. Ecological regeneration strategy

In response to environmental degradation, the project adopts a systemic vision that integrates principles from **landscape ecology, functional restoration, and multi-institutional collaboration**. The intervention is conceived as an opportunity to repair degraded natural processes and activate **long-term regeneration** dynamics, structured around three fundamental ecological axes: soil recovery, hydrological system restoration, and restructuring of vegetation adapted to edaphic and hydrological gradients. This regeneration is approached from a **multiscalar and multifunctional logic**, aimed at both **ecological processes and public use**.

2.4.1 Soil restoration and regenerative agriculture

The strategy begins with a detailed geomorphological and soil analysis of the area. Three main soil units are identified: compacted anthropogenic fill, eroded gypsiferous soils, and degraded alluvial plains. Their recovery involves **surface soil restoration techniques** with minimal ground disturbance, localized application of organic amendments, management of fill layers, and

erosion control through **bioengineering** and vegetative cover.

In areas with agricultural potential, regenerative farming techniques are introduced, such as cover cropping and controlled rotations, avoiding agrochemicals and promoting **spontaneous ecological regeneration**.

2.4.2 Hydrological renaturalization

The functional and hydromorphological recovery of the stream is one of the intervention's central pillars. **Nature-based solutions (NBS)** are proposed to recreate former fluvial dynamics through small dikes, excavated channels, green filters, and runoff buffer zones. Sustainable urban drainage systems (SUDS) are also integrated, redirecting rainwater to areas for infiltration, retention, and temporary storage, thereby reducing erosion and promoting groundwater recharge.

The **microtopographical design** alternates temporarily flooded zones, gentle slopes, and infiltration areas to recreate environments such as tamarisk groves, willow stands, reedbeds, and riparian forests. This diversity increases ecological value by **maximizing biodiversity and enhancing resilience** to extreme climate scenarios.



Figure 4. Rainwater collection and drainage system.

A key territorial stakeholder is also engaged: **Canal de Isabel II**, operator of the **La Gavia wastewater treatment plant (WWTP)**. Instead of discharging all regenerated water directly into the Manzanares River, the project proposes diverting a portion upstream into La Gavia Stream, boosting its temporary flow and enabling the establishment of aquatic habitats. This intervention, which poses minimal hydrological impact on the Manzanares due to the low volume and frequency involved, would significantly enhance the ecological functionality of the stream and its immediate surroundings.

2.4.3 Vegetation restoration and landscape typologies

Vegetation restoration is tailored to the area's diverse soil and water conditions, guided by ecological functionality, climate resilience, and landscape continuity. **Eight vegetation typologies** are defined:



Figure 5. Main habitats and their evolution.

- **Riparian forest**: a combination of seasonal halophytic tamarisk stands and open forests with poplars, ashes, and willows, arranged on fluvial terraces to create bioclimatic refuges.
- **Seasonal reedbed wetlands**: shrubby and herbaceous riparian vegetation on gravel pits, with varied flow systems to diversify microhabitats.
- **Gypsiferous shrubland and forest**: gypsophilous communities such as albardine, ontina, and gypsum thyme, forming unique high-biodiversity habitats.
- **Mediterranean broadleaf forest**: a successional mosaic over hills, featuring sclerophyll species and dehesa-like areas at higher elevations.

- **Transitional conifer forest**: a stone pine forest with structural gradients, serving as an ecological corridor and buffer against infrastructure.
- **Regenerative agricultural park**: a mix of rainfed fruit trees, legumes, and fallow plots, with integrated beekeeping.
- **Naturalized meadows**: wild herbaceous species with diverse flowering, used in public areas and as stabilizing covers on slopes.
- **Urban transition parks**: coniferous and urban vegetation along edges, connecting the urban landscape with the metropolitan forest system.

The model does not aim for uniform intensive afforestation but instead seeks to **establish resilient ecological systems** that are spatially distributed, functionally connected, and capable of autonomous evolution. **Ecological succession** is prioritized through gradual naturalization strategies, minimizing mechanical interventions. This approach aims to configure a dynamic ecological mosaic that enhances **biodiversity, strengthens connectivity, and provides a complex landscape structure** with high ecosystem and educational value.

2.5. Landscape and social intervention

The ecological regeneration of La Gavia goes beyond biophysical restoration, incorporating a social dimension that establishes it as a **metropolitan public space**. The intervention recovers intangible heritage, activates territorial memory, and redefines the landscape as a **cultural and community infrastructure**.

2.5.1. Recovery of the Colada del Santísimo as the Forest Avenue

The transformation of the **Colada del Santísimo** into a backbone for sustainable mobility—as part of the 75 km-long future **Forest Avenue of the Metropolitan Forest**—constitutes the structural axis of the intervention. This former livestock trail, now converted into a pedestrian and cycling corridor, connects neighborhoods with their agricultural and natural surroundings, linking key territorial spaces through a network equipped with urban furniture and interpretive signage. It thus becomes a **narrative infrastructure** that restores the memory of the place while promoting green accessibility.

Along this axis and in its surroundings, educational trails, wildlife observation areas, and recreational, sports, and cultural spaces are laid out to meet the needs of both current neighboring communities and future developments.

The landscape regeneration not only enhances the environmental functionality of the area but also activates its social dimension by restoring the broken ties between city and nature, between residents and territory, between landscape and identity.



Figure 6. Recovery of the Colada del Santísimo cattletrack.

2.5.2. Sustainable design and circular economy

The intervention prioritizes a multifunctional, permeable, and low-maintenance green infrastructure based on **passive solutions and local materials** (recycled wood, native stone, native vegetation). **Circular economy** principles are applied, minimizing the carbon footprint and demonstrating that ecological restoration can optimize material and energy flows.

2.6. Expected Outcomes

The intervention in La Gavia, conceived as a comprehensive **strategy for ecological restoration and social reconnection**, anticipates both environmental (soil, water, vegetation, biodiversity) and social (quality of life, territorial memory, neighborhood cohesion) impacts. To ensure its **long-term effectiveness**, monitoring indicators and continuous evaluation mechanisms will be implemented.

2.6.1. Environmental impact: Soil, water, vegetation, and biodiversity

Progressive improvement in soil quality is expected, with increased infiltration and water retention capacity, along with the recovery of the hydrological cycle of the seasonal stream. Soil and vege-

tation actions will foster **microbiological regeneration processes**, mitigating the erosion and desertification observed in recent decades.

Restoration of hydrological connectivity will reactivate key ecosystem functions: aquifer recharge, nutrient retention, and thermal regulation. Increased vegetation cover and diversification of riparian habitats will enhance local biodiversity, while also **improving air quality and reducing the urban heat** island effect in adjacent urban areas.

2.6.2. Social impact: Reconnection, health, and territorial memory

Beyond ecological improvement, the regeneration of La Gavia restores the landscape's role as a support for **identity and community cohesion**. Formerly degraded or inaccessible spaces are transformed into areas for movement, gathering, and community use, where nature becomes an active part of daily life. The recovery of the livestock trail network and the creation of accessible routes reestablish historical connections between neighborhoods, foster a sense of belonging, and reactivate emotional bonds with the territory.

This renewed connection with the landscape encourages healthy habits, sustainable mobility, and direct contact with biodiversity, strengthening residents' ties to their surroundings. The new space promotes **well-being and neighborhood cohesion** through the activation of social, educational, and cultural dynamics.

2.6.3. Monitoring indicators and tools

To ensure the effectiveness of the interventions, both **ecological indicators** (vegetation dynamics, soil and water parameters, bioindicator species) and **social indicators** (space usage, public perception, mobility) have been established. Monitoring will combine digital tools with citizen participation mechanisms to guarantee transparency and adaptability.

2.7. Conclusions

The regeneration of La Gavia area represents a **strategic intervention** within Madrid's Metropolitan Forest, aimed at transforming a degraded territory into a resilient landscape that integrates ecological restoration, territorial memory, and social activation. The recovery of the ephemeral stream and its surroundings provides **long-term environmental, social, and climate solutions**.

The project demonstrates the potential of **nature-based solutions and water management** as tools for urban adaptation, incorporating techniques such as Sustainable Urban Drainage Systems (SUDS), reforestation, and regenerative agriculture. It also functions as a key node within the metropolitan vision of a more **connected and livable city**.

Thanks to its integrative approach, La Gavia is presented as a replicable model for other Mediterranean urban edges facing similar challenges, offering an adaptable framework for action grounded in principles of **ecological restoration, territorial justice, and sustainability**.



Figure 7. La Gavia stream and dry hills regeneration project

Acknowledgments
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We also extend our recognition to the teams responsible for the other sections of the project for their rigorous work and collaboration.
Finally, we thank the organizers and the expert committee of the IFLA 2025 World Congress for selecting this proposal to be part of the congress, giving us the opportunity to share this model of ecological and territorial regeneration.

25 SAMPLES TURN UP AS PARADISE

TOPIC: Guiding cities through what is alive : Soil management

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Keywords: EARTH, TURN UP, PARADISE, SAMPLES, 25

Abstract

Doing landscape needs patience. Doing something for the earth needs even more patience. This year, Laurence ROBERT and I, Sébastien ARGANT, celebrated our company's existence LA TERRE FERME. We have spent the last 25 years patiently treating a morceaux of landscape, a morceaux of earth close to Nantes, the Loire river, the region and sometimes further away. This exhibition will show you samples of 25 project concepts implemented from 2000 (when we created LA TERRE FERME, in the same year as the Florence convention) till 2025. Those 25 projects concepts show different strategies that give more attention to the earth in landscape. A possibility to cultivate the earth to turn up as paradise.

25 samples turn up as paradise.

1. Introduction

This year, Laurence ROBERT and I, Sébastien ARGANT, celebrated our company's 25 years in existence LA TERRE FERME.

At the beginning of our cursus, Laurence ROBERT followed an artistic path by attending the Olivier de SERRES school in Paris, and I followed the horticultural path by attending school in Roville-aux Chênes in the East of France. We both attended the National Landscape School of Versailles, in the King's garden, where we met and later built our company LA TERRE FERME.
Our ambition is to work on all types of emerging landscapes found on earth, in its géographical sense. "The dry land" or "land ahoy" as we say in english.

My incredible first job happened at Disneyland Paris in 2000, soon after the big storm of 1999. Keeping Disney's dream alive was my goal. My job was to oversee the restoring of fallen trees to its upright position. Afterwards we decided to move to the countryside, for more space, more fresh air, and for more dreams to come true. Not in the East, in my rural native country in Lorraine, but in the far West of France, close to Nantes.

2001, was the space odyssey for us.

We found a place in blue stone country which met all our criteria :
- an old house in blue stones
- a garden
- a woods
- a land
- a field
- farm house and barn in blue stone

The place to be !

Doing landscape needs patience.

Doing something for the earth needs even more patience.

We have spent the last 25 years patiently treating a morceaux of landscape, a morceaux of earth close to Nantes, the Loire river, the region and sometimes further away.

Our exhibition (Figure 4) will show you samples of 25 project concepts implemented from 2000 (when we created LA TERRE FERME, in the same year as the first european landscape convention in Florence) till 2025.

These 25 project concepts show different strategies that give more attention to the earth in landscape.

A demonstration of how to cultivate the earth to turn up as paradise.

25 samples turn up as paradise.

2. The exibition in a few words

2.1. 25 Samples

We decided to make our exibition with samples of 25 projects for every year of the company's existence. Every sample is but a specimen. It is significant and key to each project. It links earth and geography [1]. For each project, we use two kinds of samples: firstly, square pictures before (Figure 1) and after (Figure 2), as forest workers use visuals to explain how they reforest the montain in the 19th century [2]. Secondly, 25 small sketches in the shape of my IPhone 13 mini becomes IDream 25 mini landscapes (Figure 5), (scale to H0), with little people, as a call to dream, like a child about landscape all over the world [3].

2.2. Turn up as paradise

Our experience in landscaping allows us to enlarge any part of the earth and keeping it alive. We specify how we decide what to do between open spaces and covered spaces [4]. A rolling stone gathers no moss [5,6], therefore, we use plateforms [7], and straight lines [8], to keep stone, moss and all the players in the theater of life on the landscape stage.
Every part of earth could become paradise in every part of the geographical plane [9].

We just need to do every thing together, patiently, caring for life, using and re-using, to cultivate and transform the landscape into paradise.

2.3. 25 Samples Turn up as Paradise

All pictures, before and after, all small sketches, show 25 projects concepts, an opportunity to celebrate together the 25 years of LA TERRE FERME, land turns up as paradise (Figure 5) :

01 - THE LONG HIGHWAY
Rouans (44) / 4750 m3 of embankment to do a pathway and spare the landscape

02 - THE JUNGLE
Nantes (44) / Rebuild a garden as a jungle with a patio into the wild.

03 - A CHICKEN ON A WALL
Fégréac (44) / Title inspired by a French nursery rhyme. A school garden around an orchard enclosed by henhouse.

04- SLIPWAY-DOCKS
Port-Saint-Père (44) / Access to the water in a submersible camping.

05 - THE PALM TREE PATIO
Pornic (44) / Private garden.

06 - FREED EARTH
Saint-Nazaire (44) / Social housing.

07 - SEA BREEZE
Saint-Michel-Chef-Chef (44) / Hostelling with handicapped conditions.

08 - LITTLE HAPPINESS (Figure 1,2,3)
Bouvron (44) / School playground.

09 - BLUE ATLAS CEDAR & TARMAC
Saint-Nazaire (44) / Social housing.

10 - ISLANDS, HIS OR HERS ?
Étel (56) / Private garden.

11 - LOIRE VIEWPOINT
Le Pelerin (44) / School playground.

12 - MAKING PUBLIC SPACE
Plouguenast (22) / Public space.

13 - BEL AIR
Saint-Nazaire (44) / Social housing.

14 - HERE COMES THE SUN
Questembert (56) / School playground.

15 - THE LIGHTHOUSE
Saint-Nazaire (44) / Social housing.

16 - GARDENS OF BABYLONE
Saint-Nazaire (44) / Social housing.

17 - THE ALLOTMENTS SOLARIS
Saint-Nazaire (44) / Social housing.

18 - A PODIUM IN THE POND
Saffré (44) / Rural public space.

19 - NATURE'S PLATFORM
Plouguenast (22) / Rural public space.

20 - GAZEBO IN THE JUNGLE
Vertou (44) / Private garden.

21 - 110M LONG HEDGE
Saffré (44) / Rural public space.

22 - BEACH UNDER TARMAC
Donges (44) / School playground.

23 - BOSQUET'BALL
Avrillé (49) / Young social housing.

24 - BOSQUET'BALL
Châtillon-Sur-Thouet (79) / Playground.

25 - MELLINET STABLES
Nantes (44) / Cultural public space.



Figure 5. IDREAM 25 MINI LANDSCAPE
9 La place, Vay (44) 19 june 2025, 11h37



Figure 1. LITTLE HAPPINESS BEFORE
Bouvron (44) 16 november 2011, 12h27



Figure 2. LITTLE HAPPINESS AFTER
Bouvron (44) 5 july 2024, 16h28



Figure 3. LITTLE HAPPINESS IDREAM MINI
Bouvron (44) / IDream mini landscape N°08/25



Figure 4. THE EXHIBITION
9 La place, Vay (44) 17 march 2025, 20h24

3. Conclusions

Cultivate the earth to turn up as paradise?
It's possible !
Let us dream the landscape all over the world, within the limits of space left over after planning [10], perhaps soon, across the river, in New-York, in the MoMA PS1, with a "Jersey girl"…

Yes we can !

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All our teachers in the National School of Landscape in Versailles, and all of them in my first Horticultural School of Roville-aux-Chênes.
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Lucile JOUSSELIN, student in Landscaping in Lille, for her 25 pictures.
Loris MENANT, student in Landscaping in Bordeaux, for his finishing touches to our 25 years exhibition.
Grace ARYEE-FOUCAUD, for the translation.
Special thanks to my father. Let's take a walk on the left side, in our beeches cathedral, in the low woods, pick some girolles mushrooms, eat them with a glass of white wine across the pond, play cards, sleep, smell the air, fish, observe. 21 june 2025, 9h39.

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FULLY CONSIDERING SOILS IN THE URBAN PLANNING AND DEVELOPMENT PROCESSES – REPLICABLE EXAMPLES FROM NANTES METROPOLIS (FRANCE)

TOPIC: Guiding cities through what is alive: Soil management

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Keywords: soils, resources, risks, methods, tools

Abstract

Soils are an essential component of landscape. Being part of the ecosystem, they represent a vital resource encompassing many ecological functions (water infiltration and storage, carbon sequestration, reservoir of biodiversity, physical support of vegetation, etc). In this frame, soils contribute to eg. regulate the climate and the water cycle. They also allow the production of biomass. In the urban environment, they are mainly considered as a support of infrastructure. They may also be considered from a risk perspective (pollution, geotechnics). This is particularly the case in redevelopment projects. The objective of this paper is to present some soil instruments (knowledge, methods and tools) and results that can help landscape architects to fully consider all aspects of soils in their planning and design activities. Most examples relate to Nantes Metropolis territory and were developed in the frame of applied R&D projects.

The presented instruments and feedbacks cover various aspects of soils inclusion in planning and (re)development at territorial to site scale: i) Soil multifunctionality to identify some good or patrimonial soils needing preservation or restoration; ii) Pollution pressure linked to industrial and service activities, anthropogenic deposits, agricultural activities like market gardening to anticipate the soil contamination hazard; iii) Potential of soil for desealing; iv) Excavated soils management on a risk-resource based approach; v) Solutions (including nature based solutions NBS) to deal with moderately contaminated soils used for gardening or to deseal soils. The latest development in progress deals with a webtool aiming to help the users (including landscape architects) to find the right soil instrument to answer their needs in the planning, development and/or design process. It is essential indeed that planning and (re)development processes consider both the opportunities and constraints linked to soils, whatever the scale of approach.

1. Introduction

Soil is an essential component of landscape. In this frame, territorial diagnoses for spatial planning produce pedo-landscape maps. In addition, vegetation development is very much linked to soil types and to climate, leading to the consideration of pedo-climatic zones. Knowledge on soils is therefore essential for landscape architects.
Being part of the ecosystem, soils represent a vital resource. They are indeed a major source of biodiversity (in and above). They also sink carbon, store and infiltrate water, transform organic matter and nutriments. In this frame, in addition to supporting human activities, soils contribute to eg. regulate the climate and the water cycle, support the production of biomass. Soils may nevertheless present some constraints. In the urban environment, they are often impacted by contamination. Redevelopment projects consider

even soils from a hazard perspective (pollution, geotechnics). The objective of this paper is to present some soil instruments (knowledge, methods and tools) and results that can serve landscape architects in their planning and design activities. Most examples relate to Nantes Metropolis territory and were developed in the frame of applied R&D projects.

2. Better knowing soils to adapt planning strategies and redevelopment projects

Better knowing soils allows adapting planning strategies and redevelopment projects. In this frame, soil must be considered in 3D (Blanchard *et al.,* 2018 [1]), not only as a surface for infrastructure implementation. In this frame, soil ecological multifunctionality is a way to approach soil health. The MUSE method (Branchu *et al.*, 2021 [2]) considers four estimated indicators of soil ecological functions (carbon storage, biodiversity storage, infiltration capacity, agronomic potential) at territorial scale, individually and combined together. The maps can be used to preserve some good or patrimonial soils or anticipate soil restoration needs. Nantes Metropolis planning department confronted its urban planning zoning to the ecological multifunctionality maps modelled with an adapted version of the MUSE method (Figure 1). It conducted to propose some updates in the zoning. The scale of validity of such maps is, however, limited by the scale of the soil map, and the availability of data. In France, regional soil maps are available on the whole territory at 1:250 000. They can be downscaled at about 1:50 000. This downscaling associated to additional adaptations of the MUSE method on Rennes Metropolis (Le Guern *et al.,* 2025 [3]) allows gaining precision at territorial scale. This soil multifunctionality scoring crossed with the land use scoring is used by Rennes Metropolis to test planning scenarios. The scoring system allows working on no net land take and land neutral degradation objectives together by considering qualitative and quantitative aspects of soils (soil ecological multifunctionality + land use).

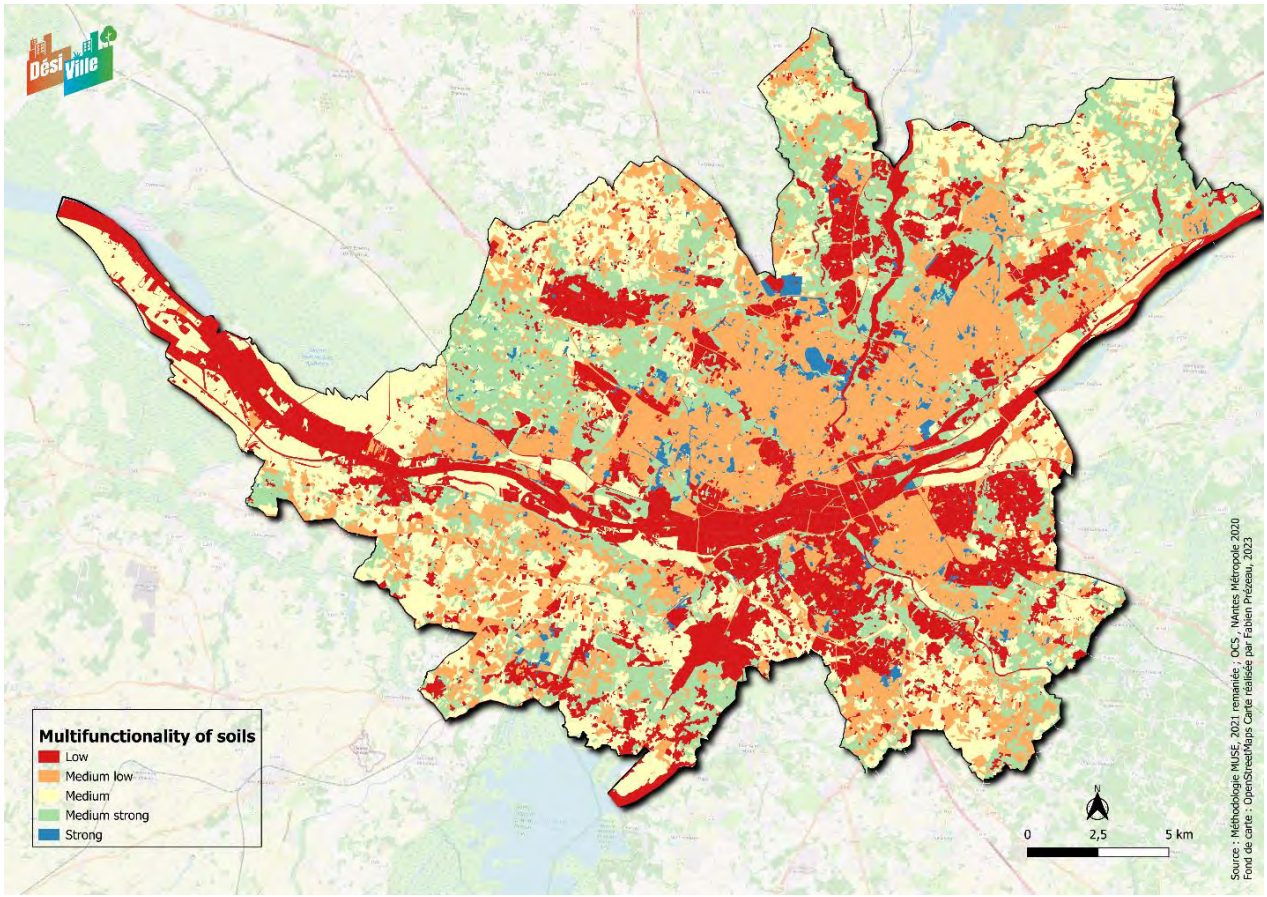


Figure 1. Ecological multifunctionality soil maps of Nantes Metropolis modelled thanks to an adapted version of the MUSE method (Prezeau *et al.,* 2024)[15]

However, the global soil maps are not precise enough to work at the scale of a redevelopment project. In this frame, the new method proposed to map urban soil types developed by Ducommun *et al.,* 2024 [4] on a district of Nantes, allows producing much more precise soils maps (1:5 000

to 1: 10 000). The indicators used in the MUSE method can be used to characterize the soil types. This was carried out on Ris-Orangis to work on the no net land take objective. Other sets of soil indicators (eg SUPRA by Séré *et al.*, 2024 [5], IndiQuaSol by Cousin *et al.,* 2024 [6]) could be used to refine the evaluation of the soil ecological functions. A consensus is now needed on the most adapted indicators to be used according to the type of soil use. The DESTISOL tool (Séré *et al.*, 2024 [7], which models soil ecosystem services (rather than soil functions) by scoring soil characteristics (from observations and measurements *in situ* or at lab) allows comparing land use scenarios to adjust the redevelopment project to maximize soil use. It pushes to preserve best soils, which would rather serve for green areas, and artificialize the most degraded soils (eg. for buildings or parking places).

3. Soil pollution, a real need of anticipation

Soil contamination is very frequent in the urban environment (Binner et al. 2023 [8]). The most frequent contaminants are lead (Pb) and polycyclic aromatic hydrocarbons (PAH). There are many other types of contaminants. These contaminants may pose health risk for humans and the environment. Human may be exposed through soil ingestion, contact with soil as well as inhalation (of air and dust). Gardeners and young children are very much concerned. That is why soil contamination must be checked systematically before opening urban allotment gardens (Bodenan *et al.,* 2022 [9]), or even before carrying out desealing operations with regreening, especially in schoolyards, nurseries or playgrounds. According to a review in progress within the frame of the PERMEPOLIS R&D project, this does absolutely not seem systematic. Water and biodiversity may be also affected by contamination. Indeed, contaminant may transfer from soils to groundwater and surficial water as well as toward living organisms. Again, this must be anticipated when infiltrating rainwater, desealing or renaturing.

Soils keep the memory of all the contaminants they have been exposed to. Many contaminant sources exist (Le Guern, 2017 [10]). Lots of point-source soil contamination come from former industrial and service activities. In this frame, urban historical inventories map the former sites potentially source of soil pollution and can guide on associated potential pollutants (Le Guern *et al.,* 2016 [11]). An example on Nantes Métropolis is given in Figure 2. Anthropogenic deposits may also be a source of pollutants, according to the nature of materials they contain. Le Guern *et al.* (2018a [12]) proposed a typology of anthropogenic deposits according to their intrinsic pollution potential. Figure 3 illustrate the application of this typology on a district of Nantes. The maps are derived from a 3D geological model developed with the GDM modelling software and a simple geostatistical approach (Le Guern *et al.*, 2018a [12]). Further research efforts are in progress within the GSEU and PERMEPOLIS projects to harmonize the vocabulary used to describe anthropogenic deposits at European scale and to develop methods to map and model (3D) such deposits in a refined way thanks to non-destructive investigation methods and geostatistics. Agriculture, like market gardening, and green spaces maintenance may have generated diffuse soil contamination with pesticides (Bouzouidja et al., 2020 [13]).

Combining the various potential sources of contamination serves to map soil pollution hazard maps. An example is given in Figure 4. Considering the memory of soils, pollution hazard needs to be checked before any project. In this frame, the high demand for urban gardening as well as the regreening of cities' soils appears as a real challenge needing a careful check of soil quality.

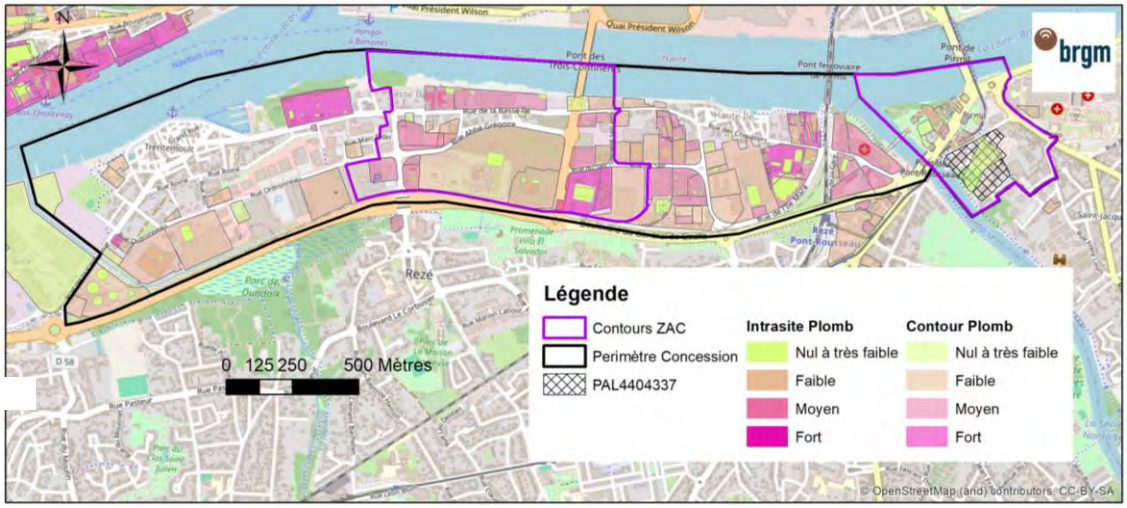
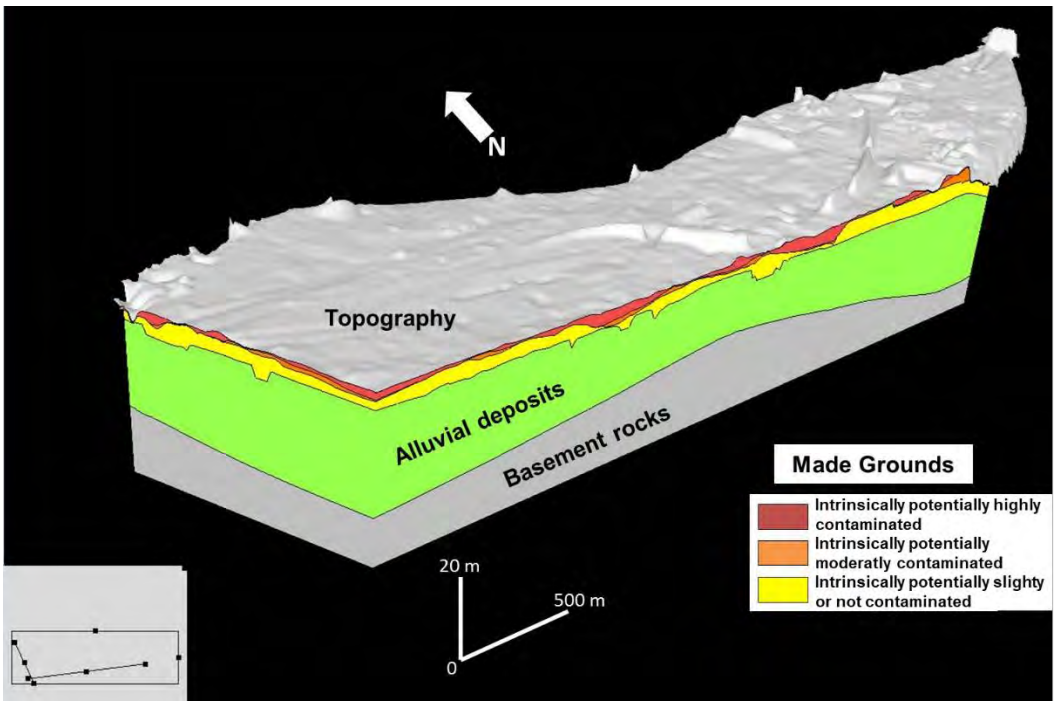


Figure 2: Soil pollution hazard linked to former industrial and service activities in a district of Nantes Métropolis – Example of lead (Le Guern et al., 2023 [14]).



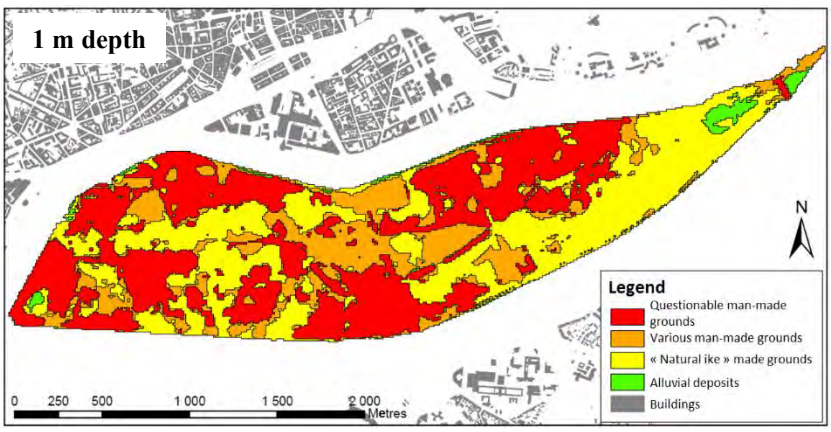


Figure 3. Mapping and modelling anthropogenic deposits based on their Intrinsic pollution potential. Example on a district of Nantes Métropolis (Le Guern et al., 2016 [11]).

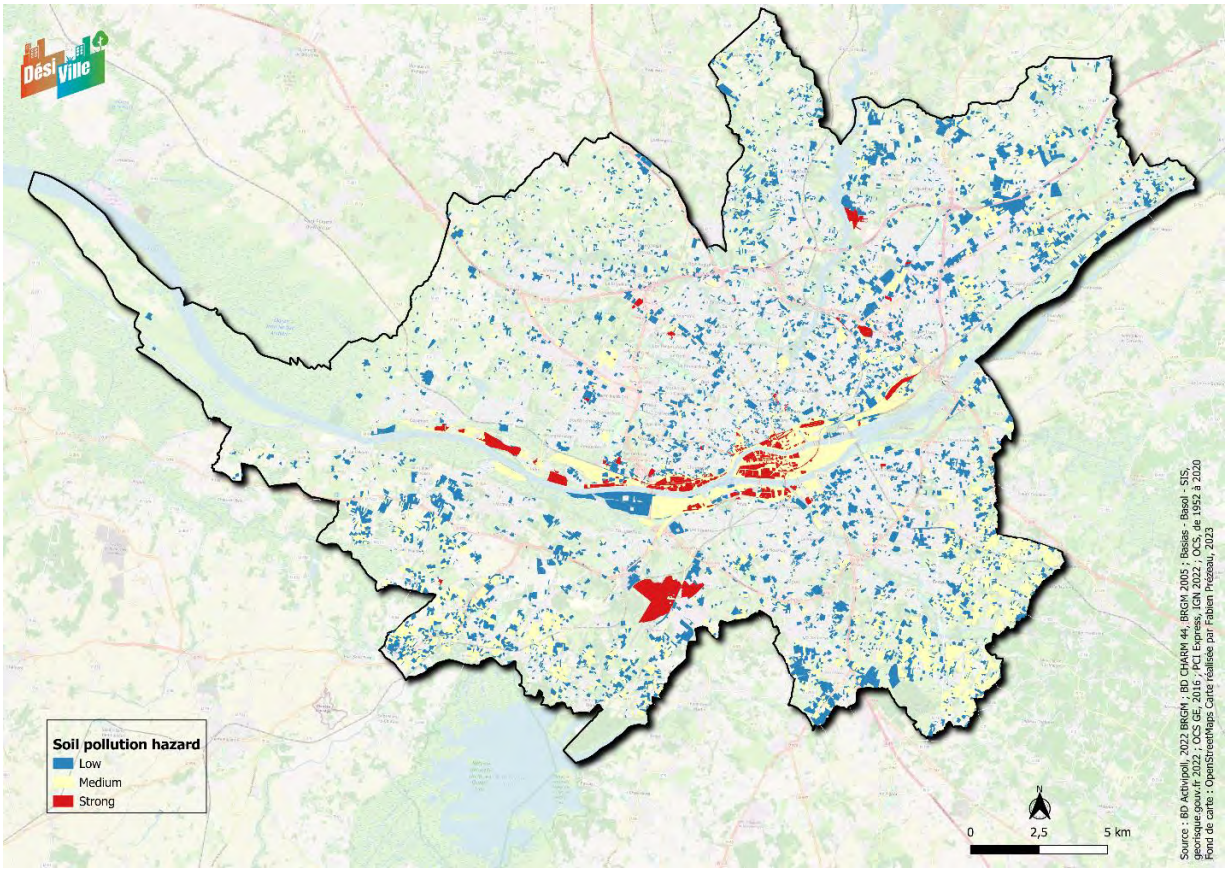


Figure 4. Soil pollution hazard map obtained by crossing several sources of contamination. Example on Nantes Métropolis (Prezeau et al., 2024 [15]).

Modelling pollution pressure helps to alert on the potential presence of contaminants in soils. This must lead to checking their effective presence or not. Because anthropogenic deposits are poorly known, a point of attention is needed even in zones out of the pollution hazard zoning. Le Guern *et al.* (2018a [12]) indicates some artefacts possibly contaminating soils that should serve as an *in-situ* alert when observing soils. The chemical analyses of soil contaminants are not always easy to interpret. The pedogeochemical background serves as a referential for such interpretation. In the urban environment, it allows getting information on diffuse contamination of soils, which superimposes itself to their natural usual content. The framework proposed by Demetriades and Birke (2015 [16]) has been applied on several European cities. In France, no dedicated investigations get financed at city scale. To compensate this, the BDSolU database aims to gather/capitalize soil chemical analyses and descriptions to produce pedo-geochemical backgrounds and make them available to any user. Mapping the pedo-geochemical background is in progress on Nantes Métropolis within the NEO-SOLocAI project.

The question then arises of what to do in case of contaminated soils. To deal with point-source pollution, managing the source of pollution is a priority. Actions on transfers to media (eg air, water, soil) and targets (eg humans, water resources) may also be necessary. The exact way to decide on management actions varies from one country to another. Some countries propose threshold values for soils, other ones like France propose a risk-based approach, by considering the type of use of the soil. This latter refers to the pedo-geochemical background or at least to a 'local control environment'. In France, a detailed framework to manage contaminated sites is proposed in a national guide, together with normalized actions and a certification process for companies involved in the process. In the case of gardens used for cropping in Nantes, various management solutions came out of a co-building process (Le Guern *et al.*, 2018b [17]) including classical and nature-based solutions (NBS) such as phytoremediation for low concentrated contamination. In some cases, a change of use was necessary.

Dealing with diffuse pollution may be more difficult, as it covers large areas. In this frame, the anthropic pedogeochemical background may possibly reveal

areas with health risks. There is no choice than living with such contaminated soils but some actions are nevertheless encouraged. Implementing long-term nature-based solutions (NBS) appears as an option. Phytomanagement to extract or stabilize contaminants are common solutions in development. The combination of cropping and phytoremediation together tested in a participatory experiment by Bouquet *et al.* (2017 [18]) on allotment garden soils in Nantes proved interesting, although caution was needed when gardening. A characterization of the bioaccessible fraction of contaminants present in soil is developing quickly since normalized tests are available. This knowledge helps to assess the real risk associated to soil ingestion. Indeed, the total concentration of contaminants does not transfer to plants or humans. The ongoing pedo-geochimical background study on Nantes metropolis within the NEO-SOLocAl project considers this bioaccessible fraction in the zones where the usual contents are higher than the national baseline assessed on agricultural soils.

4. Excavated soils, a reusable material

Redevelopment projects produce large amounts of excavated soils (Hale *et al.*, 2021 [19]) that must be considered as a resource. They can be reused on site, from one site to another or through a valorization platform. The French TERRASS numerical tool helps to put producers and receivers (users) in contacts and to fulfil the traceability obligations. In case of low to moderate contamination, which is frequent in the urban environment, the local geochemical background serves in France to establish threshold values to facilitate the reuse of excavated materials at district to territorial scale. Table 1 gives an example on a district of Nantes Metropolis. Soil refunctionalisation or construction (Damas and Coulon, 2015 [20]) can also be operated, using eg. excavated soils and organic waste. This can compensate for the scarcity of topsoil.
In case of contamination, attention must of course be paid to the associated health and environmental risks.

(mg/kg_MS)	As	Ba	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Zn
Level 2 - Threshold 2	70		0.7		110			170	4.1	
Level 2- Threshold 1	50	340	0.6			0.2		75	3.4	190
National baseline for excavated soil reuse	25	100	0.4	90	40	0.1	60	50	1	150

Table 1. Threshold values based on the pedo-geochemical background (mg/kg_MS) produced on a district of Nantes Métropolis to drive the reuse of excavated soils (Le Guern et al., 2023[14]). Contents in red may get lowered after health risk assessment

5. Fully considering soils in planning strategies and (re)development projects

Soils (including resource and risk) are fully considered in the DésiVille method aiming to map their potential for desealing at territorial to district scale (Prezeau *et al.,* 2024 [15]).
It considers four thematics to map the land potential of desealing: i) the properties of the sealed surfaces, ii) the infiltrabilty of soils and shallow subsurface, iii) the environmental constraints and iv) the benefits of desealing. Environmental constraints include the soil pollution hazard, as well as the geotechnical hazard linked to swelling-shrinking clays in soils. The benefits include the improvement of soil multifunctionality. The criteria come from a literature review and exchanges with experts on soils, hydrology and urban microclimate, as well as with stakeholders in land development and urban planning. A multicriteria analysis coupled with GIS allows crossing the criteria per thematic. The obtained thematic maps are then crossed, using the weight sum method as well, to map the potential for soil desealing at territorial scale and district scale. Such map can serve as a decision support tool to build territorial desealing strategies.
Additional developments are in progress within the PERMEPOLIS project to take into account the point of views of stakeholder including the associated discrepancies as well as the uncertainties on the knowledge on soils and other criteria.

Many tools and methods exist to plan and design with soils. The webtool in progress within the SPADES project (https://www.spades4soils.eu/) aims to help the users (including landscape architects) to find the right soil concept/methods/tool to answer their needs. It

should offer various other inspiring examples at national to EU scale, including renaturing examples.

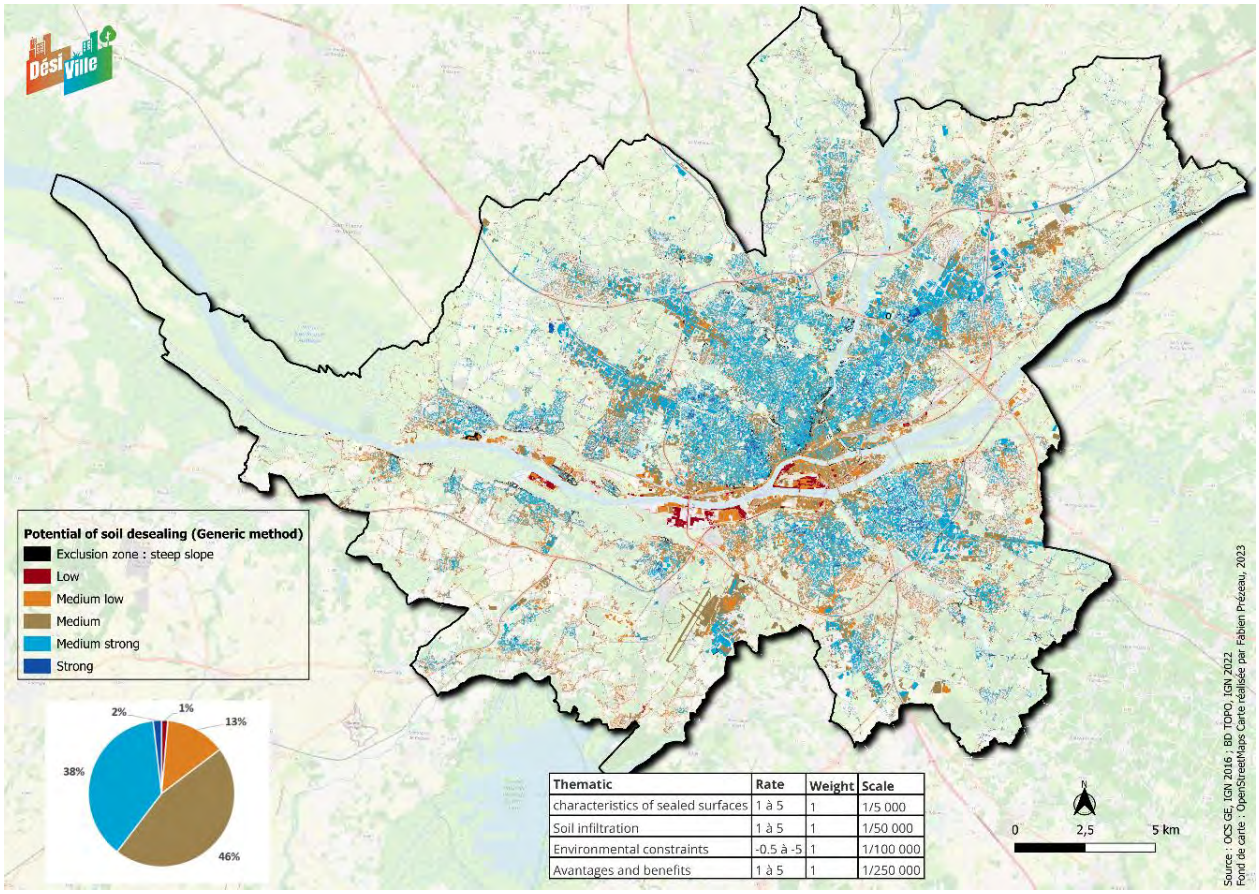


Figure 5. Soil desealing potential map obtained on Nantes Métropolis with the DesiVille method (Prezeau et al., 2024[15]).

Conclusions and perspectives

Being a major resource, soils need to be considered as a common good. Longly considered only as a support of infrastructures, they need to be fully considered in 3D in planning and (re)development processes. Adapting land use and vegetation choice to the soil health and characteristics is becoming evidence to optimise the soil resource.

As part of the stakeholders involved in territorial planning and design, landscape architects must be aware of the opportunities and risks linked to soils, whatever the scale of approach. Soil science needs thus to be fully part of their training.

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Short papers

TOPIC 1
Guiding cities through what is alive: Rainwater and water landscapes

OSLO HYDROPOLIS: ENVISIONING WATERSHED URBANITY

TOPIC: Guiding cities through what is alive: Rainwater and water landscapes

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Keywords: Watersheds, Urbanity, Water management and regeneration, Oslo

Abstract

Contemporary cities grapple with detachment from their hydrological environments, exemplified by the Oslo region, which faces challenges of water excess and scarcity amid climate extremes. The Oslo Hydropolis project has emerged to explore regenerative water management in relation to urban life over nearly a decade. Hydropolis aims to complement contemporary urban planning and design with an approach termed "Watershed Urbanity," which views catchments as socio-ecological units. This concept seeks to reintegrate the social and cultural significance of water, moving beyond the perception of water as a mere risk or resource.

The project's outcomes reveal the potential to reimagine the Oslo region through the lens of its watersheds. Here, the dynamics of water flows—both qualitative and quantitative— land management and daily practices are inextricably linked. By promoting water as an active agent to shape social practices and vice versa, the vision pioneers a participative and bodily outdoor urbanity in already developed areas and advocates for regenerative frameworks in development sites. Examples include daylighting small streams to promote bodily experiences of bathing, enhancing rural water through run-off filter spaces for day-out activities, and establishing decentralized water supply systems that create communal spaces around water sources and ensure public access to the fjord. Additionally, the project creatively engages with elements of landscape heritage, such as ice ponds, rehabilitating them into pools and bogs that include outdoor spaces fostering multicultural community interactions. Furthermore, the project promotes the role of low-density communities as stewards of well-moistened soils, and positions logistic parks as facilitators for groundwater replenishment. Although the project's speculative nature may limit immediate applications, its compelling visual outcomes underscore the relationships between territory, water, and social interactions. Hydropolis aspires to ignite discussions about incorporating watershed logic into urban design, and more so propels a regional urbanity as a driver towards water regeneration, offering adaptable methodologies for other metropolitan areas.

1. Introduction

Urban life remains disconnected from its hydrological environments. This is despite the presence of 'Sponge City' and 'Blue-green infrastructure' concepts in municipal planning. Oslo is a forerunner in river openings and urban water management. Nevertheless, the region, with its profound historical connection to water, exemplifies this drawback, especially as it increasingly confronts floods and droughts that imperil the functionality of its urban and cultural landscapes. These challenges are exacerbated by growing urbanisation and the associated pressure on drinking water and wastewater systems.

Efforts to transform the way we manage water remain isolated and do not gain momentum in comparison to the prevailing planning model based on compact cities around transportation nodes. A deeper reason for this dilemma lies in the concept of 'modern water', which treats water merely as a 'resource', devoid of cultural, social, political, and ethical connotations [1]. This perception emerged in the 20th century as the dominant paradigm for understanding water. As Jamie Linton articulates, modern water is reduced to a mere chemical compound, H_2O, reflecting modern society's aversion for "mud, muck, and swamps of all kinds" [2]. Moreover, the abstraction of water as a universal commodity has resulted in a perception of water that is placeless and disconnected from its environmental origins.

In response to the limitations of the modern water paradigm, recent scholarly work has sought to reintegrate social contexts into our understanding of water through the lens of the 'hydrosocial cycle' [3][2]. This framework emphasizes the interdependence of hydrological processes and social relations. By deliberately reinvesting water with social content, researchers advocate for a re-evaluation of how water is perceived, valued, and managed, thereby addressing the crisis born from its abstraction [4]. Overcoming the hegemony of modern water and the isolation of engineering strategies, necessitates a transformative shift in our understanding and representation of water—one that recognizes the intricate interplay between water, place and human experiences.

This is where the Oslo Hydropolis project, developed over a decade in a series of landscape architecture master design-studios at the Oslo School of Architecture and Design, enters. Through artistic methodologies the project advances the imaginary of "Watershed Urbanity". At its core, Hydropolis seeks to re-territorialise water within the socio-ecological context of catchment planning and design, framing it as integral to urban social and cultural life. As 'water is what we make of it', its transformation must come from altered descriptions. As pointed out by Ian Thompson [5], societies are grounded in basic conceptions of the world, and these social imaginaries shape structures and practices. The goal of Oslo Hydropolis is to contribute to an evolving imaginary regarding the role of water in society.

2. Methods - Coupling Urban and Water questions

Oslo Hydropolis employs a trans-scalar, trans-disciplinary and multi-perspectival approach, integrating analogue and digital artistic representation to explore water management strategies within urban contexts. This methodology aligns with the project's overarching goal of contributing to a cultural imaginary of water as a spatial and socially significant driver of urban life.

A foundational element of the project involves the "scanning" of the catchments in the Oslo region. Each catchment's physical setting is mapped as a three-dimensional waterflow structure (Figure 1), hand-traced as pattern and layered as haptic ground-, water- and vegetative 'scapes', while everyday practices are uncovered through on-site observation and historical photography. These scales, perspectives and techniques allow for the visually rich, interpretive description of watersheds as specific geographic and social contexts of design.



Figure 1. Watershed Model

Coupling urban and water issues is central to the project. Challenges related to urban development and environmental justice in the Oslo region, whether in central, peripheral or rural locations, are intertwined with water-related issues concerning the regeneration of quantities and qualities depending on the location within the watershed, whether upstream or downstream. The project's starting points are urban and agricultural flood mitigation, runoff pollution, pressure on the supply of fresh water, rehydrating soils, replenishing groundwater, the silting of ponds; and urban fragmentation, privatisation of the coast, expansion of urban areas for residential and commercial use, inclusion of diverse cultures, and the pressure to open recreational sites outside urban areas. The aim is to inter-activate the realms of urbanism and water management to interweave structures, programmes and spaces. Media used to explore this include 'territorial laces', intwining paths, roads, channels and forests into one elastic plane. (Figure 2).



Figure 2. 'Territorial Lace'

This paper focuses on aspects of urbanity emerging from the spatial conditions and management arrangements in the design proposals. While urbanism is concerned with the physical planning of cities, urbanity focuses on the lived experiences, cultural practices and social interactions within urban environments. The design scale of projects will be reflected in categories of structures supporting urban life and their effects, such as place-form [6], permeability and centrality, and in social behaviour and cultural practice, such as inclusiveness, communality and sensory engagement.

The outlined methods and questions intertwine the spatial units of watersheds with urbanity. This allows for an exploration of how re-territorialised water can create social opportunities, and of how urban life can drive the necessary transformations in water management.

3. Results

3.1 Watershed spatiality: Re-territorialising water

While 'watershed' and 'catchment' are often used interchangeably, the term watershed often includes the ecological and social context. Therefore, it offers a powerful concept towards re-territorialising water, highlighting the interconnectedness of land, water, and human activities within that area.

A watershed is an area of land where all surface water from precipitation converges and drains, along with sediment and dissolved materials, into a single body of water or outlet. The boundaries of a catchment area are usually formed by geographic barriers or divides, such as areas of higher elevation. This hydrological definition places water in the context of a specific landform. It presents water as a nested configuration that spans from larger river basins to sub-watersheds and tiny tributaries, including brooks, creeks, rills, and runs — a finely meshed, scalar sequence that can be expanded to include the runoff drainage pattern of roads and pavements. This transforms the perception of water from a mere resource into an omnipresent entity that, although not always visible, is interwoven with the territory it traverses. By definition, watersheds include the potentiality of water, which is governed by gravity and thus conceptualises terrain as animated by downward flow.

Watershed ecology provides a further differentiation of this integrated perspective by offering a four-dimensional framework [7], in which environmental factors such as geology, soil characteristics, flora, fauna and climate interrelate. Interactive vectors govern flow longitudinally from headwaters to depositional zones, laterally between the channel, floodplains, riparian areas, and hillslopes extending up-gradient to the watershed boundary, and vertically between groundwater and infiltration capacity hinging water between the geomorphological base, the sky and the climatic regime of evapotranspiration, cloud formation and precipitation. Time accounts for temporary responses and evolutionary changes. The ecological perspective highlights the variety of

water forms and locations, whether flowing, standing or mixed, depending on their position within the three-dimensional context, and renders water 'thick' and spatial in conjunction with environmental and living matter. This shifts the notion of water as blue and fluid towards "other waters", held in soils, plants and air [8].

Additionally, watersheds have a social dimension, as advocated by geologist and geographer John Wesley Powell, who recognized that they are "bounded hydrologic systems, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community". Watersheds foster collective governance over shared water care and use within these essential environmental units. The governance aspect becomes even more critical when working with anthropogenically altered watersheds, where inter-basin water transfers again abstract the provenance of water.

Consequently, watersheds serve as pivotal units for ecosystem management [9,10]. Historical practices have illuminated the interconnectedness based on the vectorial condition of a watershed, as seen in the Veneto region. The realisation that upstream actions impact activities downstream has resulted in forest stewardship laws in the Alps, aimed at mitigating erosion, river flooding, and the sedimentation of the Venice lagoon [11]. Contemporary regenerative practices align with these precedents, advocating for slowing, spreading, and sinking water, with techniques aimed at enhancing soil health and water retention such as infiltration ditches and dams [12]. This approach involves carefully and precisely intertwining water, land and human interventions, when situating points of delay along or across the secondary or tertiary particularities of the relief.

Outlining water in the hydrologic, ecological, geographic, and socio-political contexts of watersheds is a step towards re-territorialisation, as it offers an inherently spatial, four-dimensional, and relational framework – here termed watershed spatiality – for understanding the interdependence of the potentialities of water, land, and communities.

3.2 Oslo Hydropolis: Re-investing Water with Social Content

While watershed spatiality is a way of navigating within the landscape, a rhizomatic agency rather than a pattern to roll out, the re-territorialisation of water and its re-investment with social content must be actualised in a specific physical and cultural setting, to be described for the Oslo region in this section.

3.2.1. The Oslo area comprises many small, prototypical watersheds as depicted in dominant representations found in educational publications [13]. Most of these span from forested, mountainous areas to the Oslofjord. Glacial periods formed valleys with limited surface area in impervious bedrock. These valleys are fertile due to marine deposits, but they also compete with large-scale transportation infrastructure and settlements under pressure to expand. Oslo city's amphitheatre-like setting comprises many small rivers, the majority of which are piped and rush down from the forest, halted by moraine recesses and a myriad of man-made dams. This fine-meshed dendritic flow pattern contrasts with the parallel and trellis patterns of faulted plains along the Inner and Outer Fjord.

Oslo's cultural setting is deeply influenced by the Norwegian concept of 'friluftsliv,' which means 'open-air living' and emphasizes outdoor enjoyment and appreciation of nature. This ethos is supported by Norway's 'Right to Roam' (*Allemannsretten*), allowing public access to uncultivated land for recreational activities like hiking, camping, and berry picking. Additionally, civic participation is a cornerstone of Norwegian life.

3.2.2 In this context, the Hydropolis has generated over 50 designs focused on specific urban and water-related challenges in distinct locations. In the following a selection is presented to highlight which traits of urbanity could emerge from enriching water systems with social content and improving urban life.

Urban Flooding, Urban Fragmentation and a culture of wild bathing. *A Tribute to Alna* demonstrates how urban flooding and runoff pollution can be addressed by simultaneously tackling the fragmentation of the urban fabric.

Situated in Oslo's industrial and suburban Grorud Valley, it proposes a strategy for transforming the underprivileged east of the city. By reopening all streams within the Alna watershed, the capillary rivulet system is figured as the most prominent layer of the territory, generating new connective seams in the patchy urban fabric. The riparian structures of each tributary become park-strips where urban runoff is retained and filtrated using rocks, local flora, wetlands and water mirrors,

before the water is lead into a multitude of pools and baths on its way to the main river that must remain closed. The type of the baths vary, depending on site-specific slope, vegetation and urban structure, ultimately determining if the velocity and volume of water is suitable for an up-stream treadmill or a secluded mud bath. The numerous bathing spots promote decentralized recreational activity near residential areas in contrast to first-row destinations at Oslo's seafront. These small, non-commercial locations foster communality and a spirit of belonging, arising from appropriating and sharing a secluded space. Ultimately, the project promotes wild bathing as a cultural practice, building on bodily joy as part of the everyday.



Figure 3. A Tribute to Alna

Stress on Freshwater Supply, Access to the Fjord and Chitchats. Can countering the quest for ubiquitous tap water connections, even in weekend settlements, be combined with keeping the fjord publicly accessible?

The *Hallangspollen Water Walk* proposes channels to zigzag from the top of the steep hill down to the fjord, harvesting rainwater and bringing it close(r) to the cabins using simply gravity, while simultaneously opening paths for hikers through the highly privatised area. Clearings with small storage dams located in the nooks of the terrain provide not only a resource but places for the inhabitants to gather in, socialise or perform household chores such as washing clothes and rugs. Connected by flow, and separated by changes in elevation, they serve a polycentric community of water-use neighbourhoods. The cooperatively managed water places introduce a sense of communality, born of shared resources and spaces, to the summer cabin culture around the Oslo fjord.

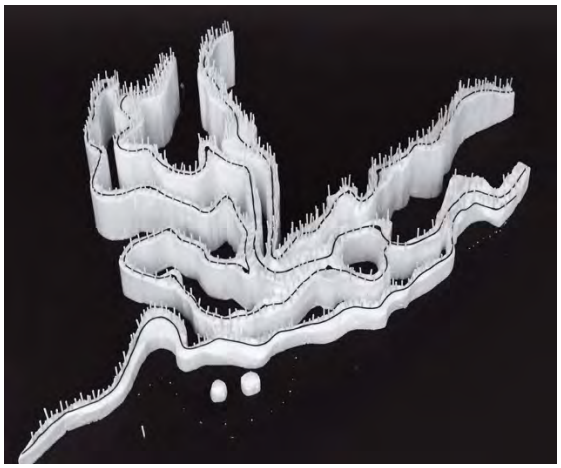


Figure 4. Hallangspollen Water Walk

Low Water Levels, Diversity of Cultures and Heterotopias of other Waters. The low water levels and silting in the dams built for ice production are in fact unrelated to the presence of diverse demographics and subcultures. However, some of the lakes just above the city border have become places of respite for underrepresented groups. This creates an opportunity to strike a balance between rewilding and preserving the landscape's heritage.

Vesletjern Gateway to Marka feeds the lake's small catchment area with runoff channels from neighbouring watersheds, preventing it from drying out. With slopes that are accessible to all, the adjacent paths invite also untrained inhabitants to explore the forest. The nested basins within the lake, built to recreate the historical dam enlargement phases, ensure a stable shallow water level, even during potentially dry periods when Hindu festivals with water ceremonies are taking place. This approach enriches urban life by valuing landscape heritage and encouraging a variety of cultural practices.

Svartkulp Mire Park features a grid of floating islands that absorb excess nutrients and support sub-cultural activities, as well as outdoor childcare. The layout of the islands allows for both interaction and the freedom to avoid it, providing visual and physical separation and enabling people to choose their level of engagement. The resulting urbanity celebrates both cultural diversity and tolerance and promotes a heterotopic space that honours other waters such as the mire.

Agricultural Runoff, Out-door Recreation and Baskets. Mitigating agricultural runoff pollution and meeting the demand for recreational spaces outside urban areas as cities expand may seem unrelated, yet combining the two can contribute to the development of rural destinations. Projects like the *Sageneelva Basket Makery* demonstrate this. Designed to showcase basket-making from willow branches as an integral part of the landscape, the project enhances stream water quality in a farmed valley and improves connectivity across the slope into the forest for wildlife, mushroom hunters and berry pickers alike. A widened riparian corridor with willow fields filters agricultural runoff. Basket-making activities meander in the open spaces amongst the trees. As people venture out to harvest using the baskets, spores and seeds are dispersed, enriching the ecosystem. Once again, a spirit of communality arises from sharing a common departure point and experiences. Eventually, the role of humans as disseminators in an edible landscape is emphasized, promoting craftmanship, hiking and foraging as a way of communing with the environment.



Figure 5. Sageneelva Basket Makery

Soil Hydration, Groundwater Replenishment, Urban Expansion and Stewardship. Commonly, soil hydration and groundwater replenishment are in contradiction to expanding residential areas and industrial zones. Could this conflict be turned around through the concept of stewardship and landscape validation? *Stensrud Cascading Bands* and *Gardamoen Infiltration Strips* offer such optimism.

Cascading Bands creates a system of terraces that cascade with water and nutrients in an upland valley zoned for development, but too beautiful to build on. This place-form, which is layered with a forest edge, retention ponds, a grazing belt, an orchard strip and meadows, has been established firstly to reduce erosion, improve water infiltration and build soil, and secondly to host suburban dwellers. Here, with sectional interconnectivity fostering collaboration, private gardening is elevated to landscape stewardship.

Meanwhile, *Gardamoen Infiltration Strips* deploy forested infiltration ditches to improve groundwater storage, highlighting the micro-topography of Norway's largest glacial fluvial delta. The radial place-form acts as a template for the subdivision of commercial and logistical land use, creating a permeable structure that encourages walking, cycling and staying to strengthen the sense of identification with the working context. Here, urbanity evolves to value the natural and cultural landscape, promoting physical activity as an integral aspect of urban life.

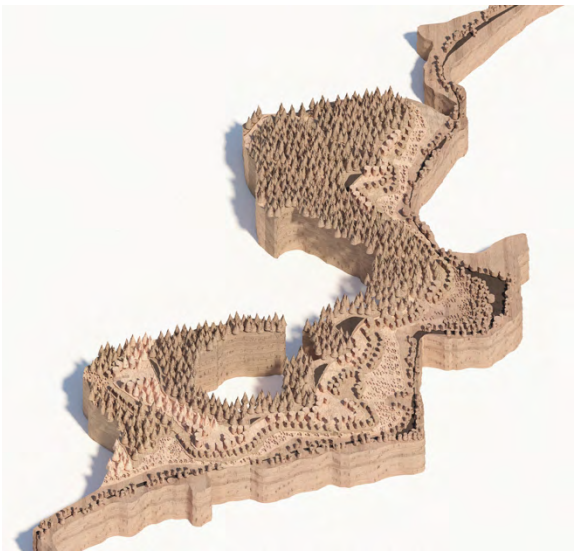


Figure 6. Stensrud Cascading Bands

3.2.2 The projects exemplify urbanity in terms of activity patterns, social behaviour and cultural practices that may emerge and be stimulated by the geometric properties of regenerative water measures and their spatialisation within watersheds. The fine-meshed, riparian structures, "thick" with life, based on the capillary figures of tributaries, drainage pattern or swales of delay inherently offer accessible, connective, permeable networks 'in vicinity' as part of the everyday

residential and work environment. Their diffusion as well as the polycentric situations at confluences, meanders and points of delay potentially foster decentral provision of water, food and craft, and therefore partial autonomy from the central, overburdened infrastructures.

Thread-like, closely-knit positioned between upstream forests and downstream fjords and laterally between banks, floodplains, and slopes, the water structures foster a sense of orientation within the broader landscape. They also nurture a sense of communality around the shared resources and places in reach. Social behaviour characterised by cooperation and responsibility within a bounded environment is strengthened through an understanding of the interconnectedness of places and actions. This awareness arises from the sensory comprehension of relationships and the depth of territory, fuelled by the tangible downward vector of flow.

Cultural diversity, characteristic to contemporary urban life, and tolerance cannot be resolved by spatial arrangement, yet the differentiated and graded places integral to watershed spatiality allow people to unforcefully share environments and choose their level of engagement. A reflection of diversity and openness is the incorporation of other, underrepresented waters, the mires, muds and interfaces between land and water as heterotopic spaces.

By catering to society's disposition for physical and emotional engagement with the land, a culture that affirms the body is sustained. Paths accompanied by potential water following the curves on contour stage spatial sequences in an animating way. They are walkable with their soft inclines, making them inclusive to children, and those impaired or not trained in hiking. Public bathing, the craft of moulding clay and weaving branches, cultivating and foraging are ways to get in touch. In essence, a culture of communing with the environment can be envisaged. This will be a physical and concrete form of relating tied to the specificity of sites and their heritage emerging from the place-form of interconnected micro-localities in an animated terrain. It takes a whole landscape to "produce" balanced and clean water, tasteful food and crafts. To participate in it nurtures a sense of belonging.

Finally, joy! With water regeneration the driving force, spaces are not designated or demarcated as recreational or public but rather emerge as situations to be appropriated. According to Lefebvre [14], if a site of enjoyment exists, it positively appropriates space, producing a collective space in which use-value, life, and the body predominate. This statement encapsulates the concept of watershed urbanity.

4. Discussion and Conclusion: Implications of Envisioning Watershed Urbanity

The imaginary of watershed urbanity presents an opportunity to reconnect urban environments with their hydrological contexts, overcoming the limitations of infrastructural water management approaches. Oslo Hydropolis shows that anchoring water and its potentiality in the spatial context of watersheds and their regenerative refiguration entails the development of fine-grained capillary networks of decentral localities, thick with the messy forms of life and matter. highlighting a landscape's place-form. This rich environment animated by gravitational flow fosters orientation and belonging. Everyday urban life associated with this spatiality nurtures communality around shared places and resources, and fosters a sensorial culture centered around diversity, care and bodily joy.

By focusing on urban life and culture, the concept of watershed urbanity expands on well-established planning concepts such as water urbanism [15] and water centric communities [9] and broadens artistic and participatory approaches to change relationships with the watery world [1] into an imaginary of urban life in a regional context.

While the speculative nature of this academic project presents limitations for immediate application, the visually compelling outcomes have the power to draw out a vision of the intrinsic connections between territory, water, and social interactions. As a vision it contributes towards watersheds becoming a complementary unit in planning and governance – the 'slow lane' in contrast to the 'fast lane' of transportation-based approaches [10], and watershed urbanity becoming a goal in urban design. The proposals are speculative, but not unfeasible due to their anchorage in everyday life.

Developed from the specific context of the Oslo region, watershed urbanity can be adapted by other metropolitan areas seeking to reconnect with their hydrological systems as a necessary step toward climate adaptation. Ultimately, Hydropolis aims to foster a cultural shift, recognising the management of water catchments as the lively foundation of a regional urbanity, in which 'society and water can be understood to make each other'.

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RESTORE THE ROOTS OF SINKING GROUNDS: A WATER-SENSITIVE LANDSCAPE PLAN FOR THE CITY OF MEYCAUAYAN IN BULACAN, PHILIPPINES

TOPIC: Guiding cities through what is alive: rainwater and landscapes

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Keywords: land subsidence, aquifer recharge, Water-sensitive Urban Design (WSUD), landscape planning

Abstract

The rapid population growth in cities has driven urbanization and industrialization, leading to a surge of built infrastructure and a decline in open green spaces. This transformation disrupts natural environmental processes, particularly the hydrological cycle. The increase in impervious surfaces threatens the process of naturally recharging aquifers— one of the primary sources of groundwater. In the City of Meycauayan, Bulacan, Philippines, groundwater extraction poses a significant threat to these resources, exacerbating the occurrence of land subsidence. The city experiences one of the highest rates of subsidence in the country with a record of 5.50 cm to 6.00 cm per year. In this study, the application of landscape architecture emerges through the proposal of a water-sensitive landscape plan focused on recharging aquifers through the Water-sensitive Urban Design (WSUD) approach to mitigate land subsidence. Biotope mapping was done to analyze spatial patterns of potential critical and supporting recharge zones. The data gathered were used to develop three planning scenarios: status quo, regulated extraction, and no extraction. Through a series of computations for recharge rates and assessments, the best water-sensitive landscape plan is chosen as the most suitable option. The study proposes specific interventions and guidelines within the chosen water-sensitive landscape scenario, along with implementation and maintenance guidelines. The study further demonstrates the potential of integrating water management solutions in guiding the planning of a city, addressing its environmental aspect.

1. Introduction

The concept of urbanization is multifaceted as it involves numerous layers explaining the concentration of population and industrialization in urban areas. As cities lean toward urban development, their physical and spatial attributes change. Thus, urbanization impacts different aspects of a city including its landscape.

Impervious surfaces are defined as anthropogenic features that have limited water infiltration capacities (Lu & Weng, 2006). Furthermore, these surfaces associated with urbanization reduce the infiltration capacity of water, thereby altering by which water reaches waterways and reservoirs. Thus, one of the most important metrics for analyzing how urbanization affects the water environment is its imperviousness. As a result of the disruption of water infiltrating into the ground, the surface water runoff increases while the rate at which the water table recharges declines. Prolonged disruption to the water cycle affects the rate of groundwater recharge, exacerbating the occurrence of land subsidence in areas dependent on groundwater as a resource (Guzy & Malinowska, 2020).

1.1. Land Subsidence

It has been identified that one of the main causes of land degradation and the adverse effects on the environment is represented by land subsidence (Radutu & Vlad-Sandru, 2023). Subsidence is the process by which an area of land gradually sinks to a lower level than the land surrounding it. Gambolati and Teatini (2021) elaborated that it leads to a higher risk of flooding, causes damages to infrastructures, and a disruption to water management.

Many cities around the Asia-Pacific region have identified subsidence as a major environmental problem. As cities undergo rapid urbanization and continuous industrialization, the demand for water significantly rises. The heightened demand leads to increased groundwater extraction— a major contributor to land subsidence.

1.2. Land Subsidence in the Philippines

In the Philippines, extensive land subsidence has been recorded specifically in the coastal areas of Metro Manila, Pampanga, and Bulacan, firstly attributing it to the rapid sea-level rise, but eventually recording overuse of groundwater resources as a major contributing factor (Eco et al., 2020). Other areas far from the coast also suffer from land subsidence. Moreover, frequent occurrences of flooding are often pointed towards deforestation, urbanization, improper waste disposal, etc., however, anthropological factors such as the sinking of land, as a result of excessive extraction of groundwater, is also a major contributor (Eco et al., 2020).

Existing laws and policies enacted in the Philippines manage existing water sources. Republic Act No. 6716 mandates the construction of water wells, rainwater collectors, development of springs, and rehabilitation of existing water wells; and Presidential Decree No. 1067 (Water Code of the Philippines) establishes a framework for the "appropriation, conservation, ownership, utilization, exploitation, development, conservation, and protection of water resources." Several news articles, however, show that there have been multiple accounts of unregistered extraction across regions in the Philippines. The National Water Resources Board (NWRB) in 2004 implemented a ban on constructing and extracting groundwater from

deep wells in various regions; including many municipalities in Bulacan, like Meycauayan. Despite this, there has been a lack of acknowledgement in communities regarding its gravity because of its "invisibility."

1.3. Land Subsidence in the the City of Meycauayan, Bulacan

The province of Bulacan was determined to have a maximum subsidence rate of 10.90 cm per year (Sulapas et al., 2024), where Meycauayan experiences one of the highest rates of 5.50 cm to 6.00 cm per year. This high subsidence rate is caused by over-extraction of groundwater to supply the needs of residents and industries.

1.4. Groundwater Extraction and Aquifers

When groundwater is extracted at a faster rate than it can be replenished in the aquifers, it causes land to sink. Multiple occurrences of subsidence as a result of groundwater extraction happen in different cities of the Philippines, recording a depletion of groundwater in aquifers. Stricter groundwater extraction restrictions can help in reducing its impacts as seen from the study of Sulapas et al. (2024), where CAMANAVA and Las Piñas City observed a decrease in subsidence rates after the NWRB set groundwater restrictions.

1.5. Water-sensitive Urban Design (WSUD) Approach

Exploitation of groundwater has been recognized to affect landscapes. The continuous extraction depletes groundwater reservoirs as a result of increasing water demands to support the growing population and development processes. With the inability to replenish the water table and reverse this trend, the city may continue to encounter challenges resulting in sinking lands. The study examines the implications of integrating the WSUD approach. The study gives importance in the creation of a water-sensitive landscape plan that is a living laboratory for the community to understand the role of water management through their environment.

2. Methodology

The process begins by defining the problem, with a focus on the challenges posed by land subsidence in the City of Meycauayan, Bulacan, Philippines.

A comprehensive literature review was conducted to map the existing body of knowledge regarding five concepts: land subsidence, aquifer recharge, the WSUD approach, water management, and related laws and policies.

Using QGIS, a biotope map was created by integrating soil media, landform, and land cover maps of the City of Meycauayan to illustrate the physical characteristics and ecological functions of its landscape. The biotope map was then layered with the location of deep wells obtained from the Local Water Utilities Administration (LWUA) to identify critical areas for groundwater recharge. The biotope map was then evaluated through the ecological network plan.

Land deformation maps were generated using interferograms acquired from the COMET-LiCS Sentinel-1 portal. These datasets consist of time-series interferograms with temporal baselines ranging from 20-30 days or 40-50 days per interferogram. The maps illustrate spatiotemporal trends in ground deformation, highlighting areas of uplift and subsidence over the years of 2014 to 2020.

The groundwater drawdown interpolation map illustrates varying levels of groundwater

decline across different areas in the city. These interpolated drawdown values were crucial in estimating the average groundwater extraction rates within the city.

An initial WSUD guideline was created followed by a key informant interview with the local government representative of the City Urban Planning and Development Office (CUPDO) Meycauayan to gain insights on the planning and development projects, the city's vision, groundwater extraction practices, land subsidence issues, and perspectives on a water-sensitive landscape plan.

From these data, three planning scenarios were formulated. Each planning scenario was assessed using the Darcy's Equation for the quantitative phase and the Water Sensitive City (WSC) Index for the qualitative phase. The scenario with the highest infiltration rate and the highest WSC scoring was chosen to be developed into a water-sensitive landscape plan.

3. Results and Discussion

3.1. Biotope Map

The integration of the soil map, landform map, and land cover map resulted in the development of the biotope map.

The city is primarily composed of Bigaa clay loam, Prensa clay loam, and Prensa silty clay loam (BSWM, n.d.).

The landforms can be classified into three: flatlands, highlands, and lowlands.

The city is categorized into two: Built-up and Semi-natural.

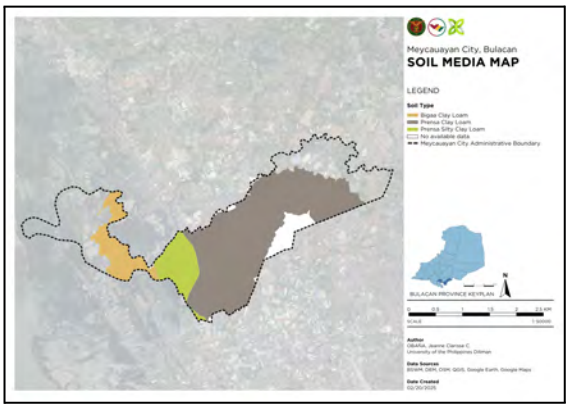


Figure 1. Soil Media Map

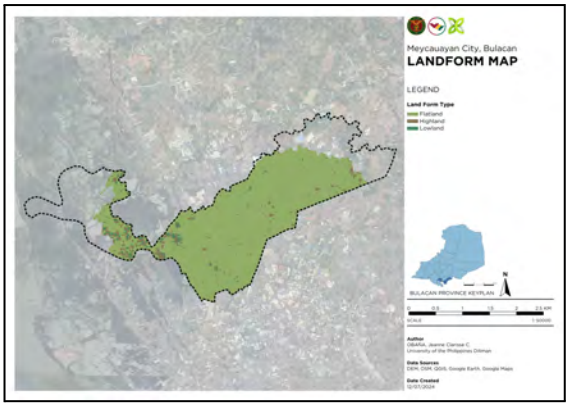


Figure 2. Landform Map

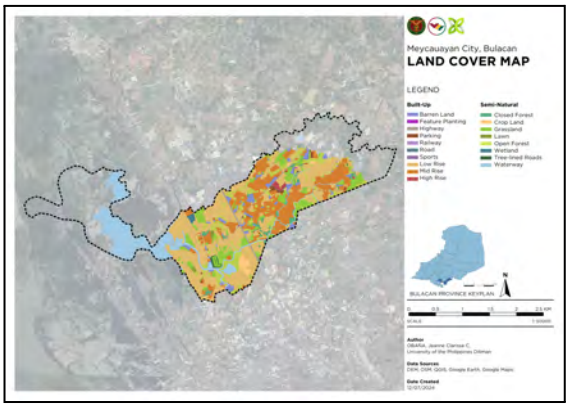


Figure 3. Land Cover Map

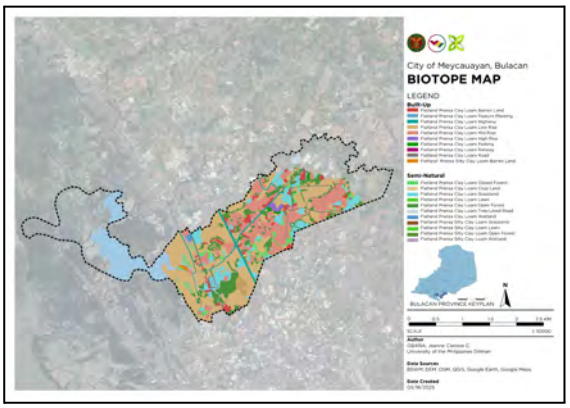


Figure 4. Biotope Map

The biotope map identified 21 biotopes, comprising eleven semi-natural and ten built-up biotopes. It provides a basis to assess urban environments, directly informing strategies to mitigate land subsidence (Jarvis and Young, 2005). The identification of impermeable and low ecological value zones locates areas where the loss of vegetative cover, fragmentation, and decrease in size of open space exacerbate the sinking of land.

3.2. Biotope Map with Well Locations

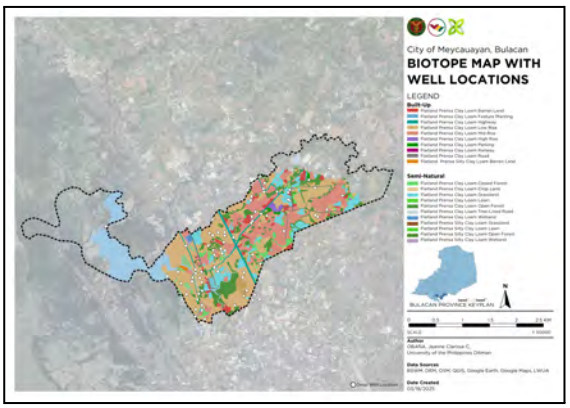


Figure 5. Biotope Map with Location of Wells

The distribution of deep wells reveals a strong reliance on groundwater resources within urban areas. It provides an understanding of how groundwater extraction intersects with the different ecological zones.

3.3. Ecological Value

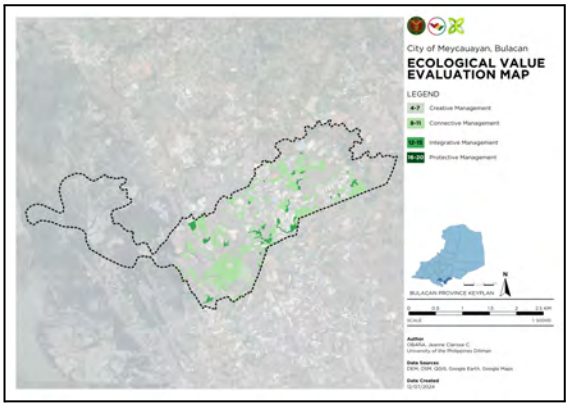


Figure 6. Ecological Value Evaluation Map

Figure 6 indicates that the majority of the semi-natural biotopes require a connective management approach. These biotopes can serve as transitional zones to link fragmented patches of biotopes identified to have integrative management approaches.

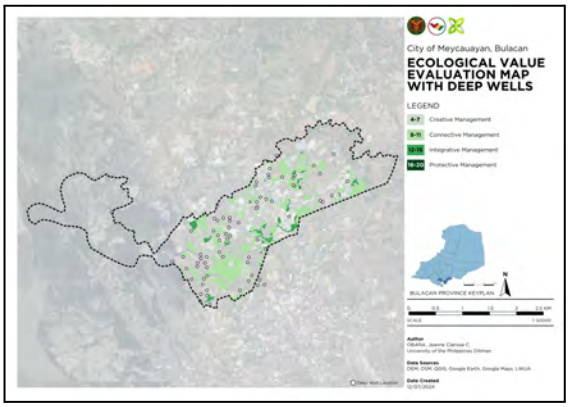


Figure 7. Ecological Value Evaluation with Deep Wells Map

Figure 7 indicates that the majority of deep wells are situated in built-up biotopes, compared to semi-natural biotopes. This distribution presents that built-up areas are

more heavily relied upon for groundwater extraction, while semi-natural biotopes may serve as important recharge points for aquifers.

3.4. Land Deformation Maps

Land deformation maps (LDM) illustrate spatiotemporal trends in ground deformation, highlighting areas of both uplift and subsidence over the years of 2014 to 2020. There are a total of 568 land deformation maps, however, seven maps from the end of each year were selected to show land deformations from 2014 to 2020.

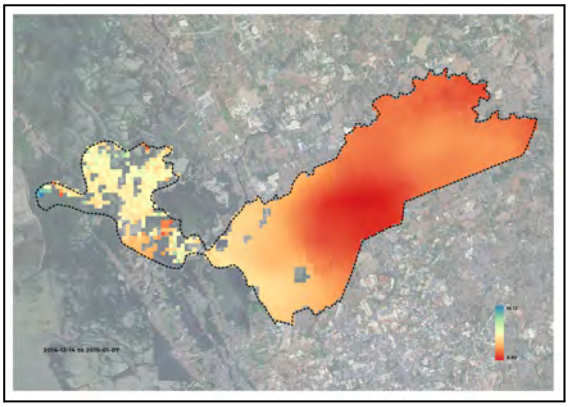


Figure 8. LDM for 2014-12-14 to 2015-01-07

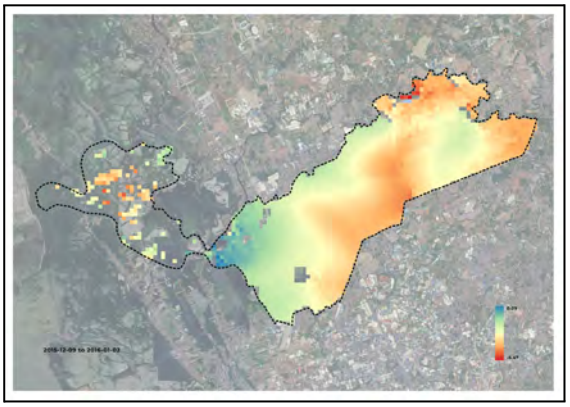


Figure 9. LDM for 2015-12-09 to 2016-01-02

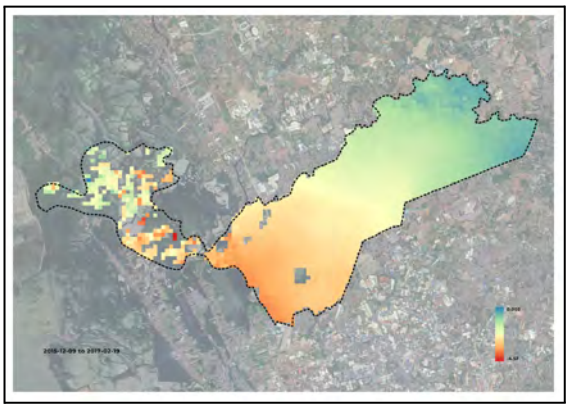


Figure 10. LDM for 2016-12-09 to 2017-02-19

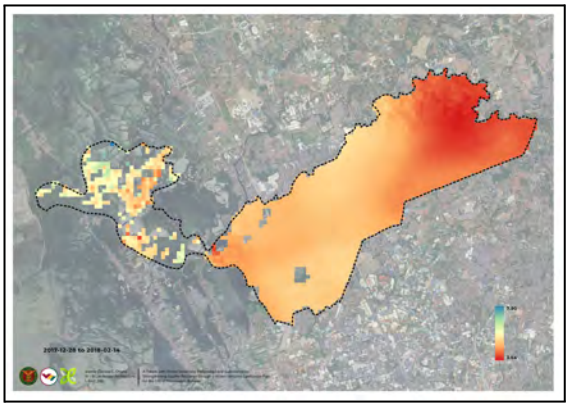


Figure 11. LDM for 2017-12-28 to 2018-02-14

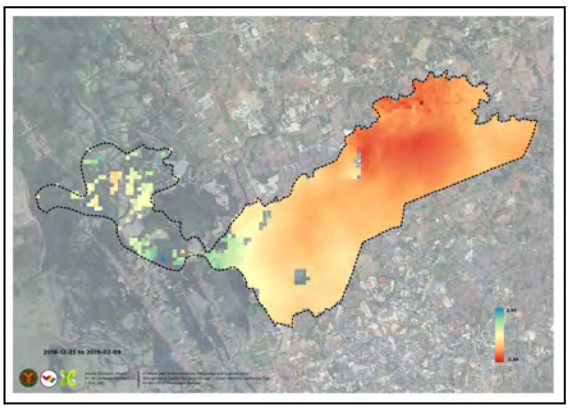


Figure 12. LDM for 2018-12-23 to 2019-02-09

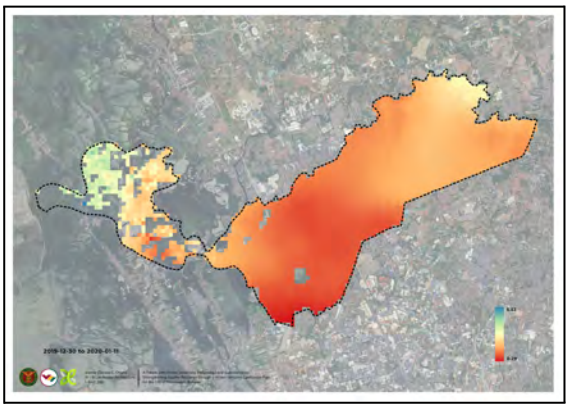


Figure 13. LDM for 2019-12-30 to 2020-01-11

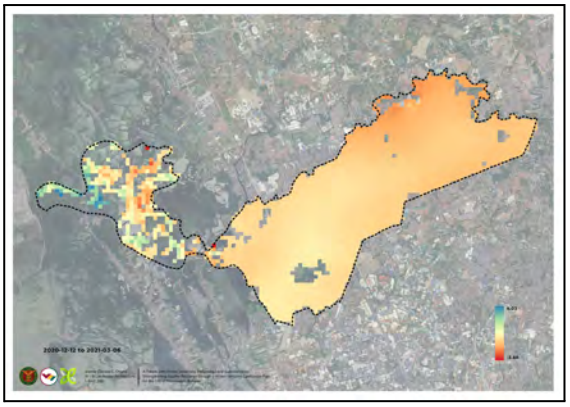


Figure 14. LDM for 2020-12-12 to 2021-03-06

3.5. Interpolated Groundwater Drawdown Map

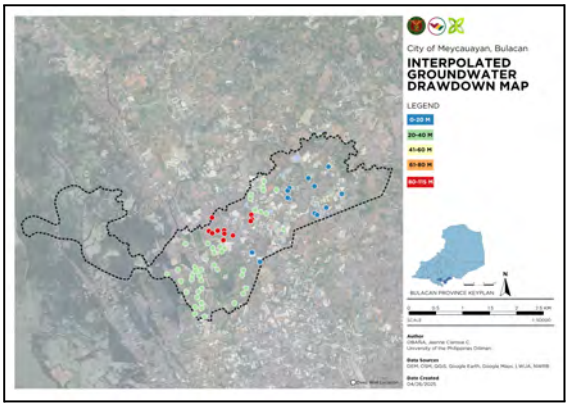


Figure 15. Interpolated Groundwater Drawdown Map

Figure 15 illustrates the varying levels of groundwater decline across different areas of the city. These values were used to estimate the average groundwater extraction rates within the city. Areas with the greatest drawdown may indicate higher extraction activities.

Based on the computation for drawdown values, the average extraction depth across the city is approximately 35.71 meters which exceeds the granted extraction rate in many areas.

3.6. Correlation of Groundwater Extraction and Land Subsidence

Groundwater drawdown generally leads to rapid and visible ground deformation, particularly in densely populated areas (Bagheri-Gavkosh et al., 2021). As a basis for correlating the amount of groundwater extracted and its corresponding ground loss, this study utilizes values from a research conducted in Bangkok, Thailand, wherein for every 1 m^3 of groundwater pumped, approximately 0.10 m^3 of ground is lost at the surface (Phien-Wej et al., 2005).

In the case of the City of Meycauayan, for every 1 m^2 of land, a 6 cm drop means 0.06 m^2 is lost. To calculate for the required recharge, Todd and Mays (2004) used the water balance equation wherein:

$$Required\ Recharge = \frac{0.06\ cbm}{0.10} = 0.6\ cbm$$

The total groundwater recharge needed to offset the 6 cm/year land subsidence in the City of Meycauayan is:

$\frac{0.6\ cbm}{1\ sqm} \times 22,609,000\ sqm = 13,565,400\ cbm$

The daily groundwater recharge needed in a year is 37,165.48 cbm per day.

To facilitate this recharge, the area allocated for recharge must be able to accommodate this amount, maximize infiltration, and limit external human activities to ensure optimal efficiency.

3.7. WSUD Strategies

The WSUD strategies identified for this study are the following: bioretention swale, retention pond, porous pavements, vegetated waterways, bioretention basin, rain garden, sediment basin, sand filter, constructed wetland, and rainwater tank. These strategies have corresponding site parameters and requirements for construction which are adapted from Melbourne Water, 2005.

3.8. Key Informant Interview

The interview with the local government representative of the CUPDO Meycauayan was conducted to gather information about the city. All of the information was synthesized and considered in the study's proposed plans, policies, and recommendations.

4. Assessment

4.1. Planning Scenarios

Three planning scenarios were formulated focusing on groundwater extraction practices and their implications on groundwater recharge. The overall strategy for strengthening aquifer recharge in Meycauayan is based on the analysis of current conditions and leverages the land's capacity to capture and retain as much water as possible.

4.1.1. Scenario 1: Status Quo

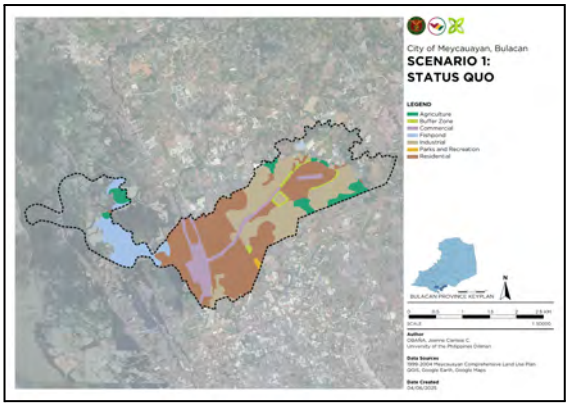


Figure 16. Status Quo Scenario Plan

The Status Quo scenario reflects the existing conditions of the city. It serves as a baseline for evaluating the effectiveness of alternative strategies.

The current land subsidence rate of 5.50 cm to 6.00 cm per year is expected to continue, driven primarily by groundwater extraction, lack of permeable surfaces, and insufficient aquifer recharge.

No WSUD interventions are implemented. Moreover, the water supply of the city continues to rely primarily on groundwater extraction drawn from deep wells.

4.1.2. Scenario 2: Regulated Extraction

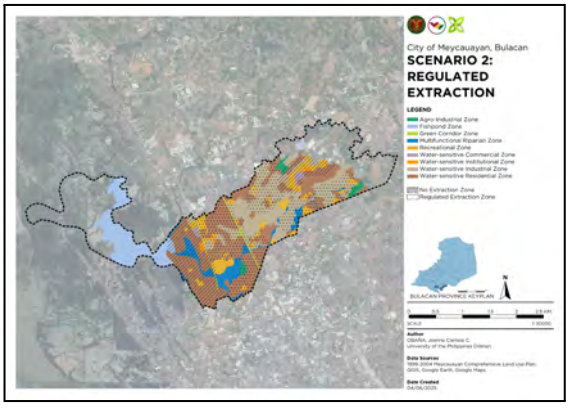


Figure 17. Regulated Extraction Scenario Plan

In the Regulated Extraction scenario, zoning plays a crucial role in identifying areas that can still be developed while ensuring that these developments are complemented by integrating public open spaces. These open spaces are critical components in promoting groundwater recharge.

Through strategic zoning, areas with high groundwater vulnerability can be protected from intensive development, while extraction activities are in areas where the aquifers can be sustainably managed. Based on the groundwater drawdown interpolation map, areas identified as having low risk of groundwater depletion are designated as "Regulated Extraction Zones," where limited and monitored groundwater use is permitted. Conversely, areas identified as having a high risk of groundwater depletion are designated as "No Extraction Zones," where groundwater withdrawal is strictly prohibited. In support of these strategies, the role of WSUD allows for open spaces to capture water and recharge the aquifers.

This scenario presents a transitional approach in water supply by deriving it from a combination of controlled groundwater extraction and alternative surface water sources developed and provided by the local government. Groundwater is extracted only from designated deep wells under strict monitoring and regulatory measures.

4.1.3. Scenario 3: No Extraction

The No Extraction scenario focuses on maximizing the ability of all available open spaces to recharge the aquifer. This scenario prioritizes the discontinuance of groundwater extraction to prevent further depletion and subsidence, shifting the focus toward enhancing the natural hydrological processes through the extensive application of WSUD strategies.

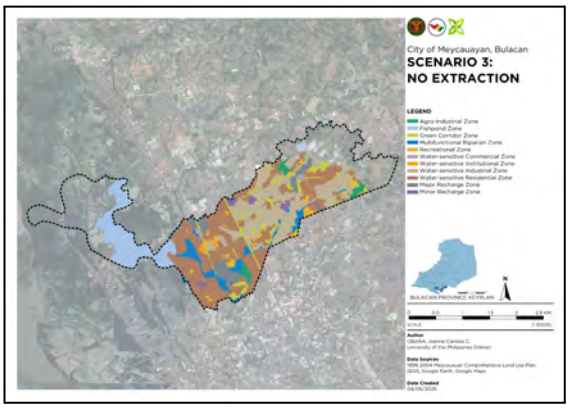


Figure 18. No Extraction Scenario Plan

A key element of this scenario is the water-sensitive park system, identified as critical recharge zones. To strengthen the hydrological connectivity of the landscape, these parks are integrated into a network of green corridors. The role of WSUD is crucial as it introduces a range of nature-based solutions on sustainable water management and aquifer recharge.

With the discontinuation of groundwater use, the major water provider in the province of Bulacan is assumed to supply the city's water demand through a surface water reservoir located upstream of Meycauayan.

4.2. Quantitative Assessment

The computation for infiltration rates determines which scenario offers the highest potential for groundwater recharge. The computation uses the Darcy's Equation multiplied by the area of open spaces. The equation analyzes key factors influencing infiltration including the total area of open spaces (A), soil type, hydraulic conductivity of soil (K), hydraulic head difference (Δh), and length of flow path (L).

$$q = K\frac{\Delta h}{L} \times A$$

Table 1. Infiltration Rate Computation Variables

	Scenario 1	**Scenario 2**	**Scenario 3**
A	166.68 ha	446.51 ha	533.66 ha
Soil Type	Prensa clay loam	Prensa clay loam	Prensa clay loam
K	0.2 m/day	0.2 m/day	0.2 m/day
Δh	0.1 m	0.2 m	0.2 m
L	3 m	3 m	3 m
q	**11,112.26 m^3/day**	**59,534.67 m^3/day**	**71, 544.67 m^3/day**

The computation reveals that Scenario 3 yields the highest rate at 71, 544.67 m^3/day. This is significantly higher than the required daily recharge volume computed. This value covers potential fluctuations in water availability, variations in rainfall, and seasonal changes.

4.3. Qualitative assessment

The qualitative assessment employed the Water Sensitive Cities Index (WSCI), which outlines seven goals that structure the 34 indicators of a water sensitive city (Hammer et al., 2020). Each scenario was assessed using a standardized rating system, wherein scores ranged from zero to three— zero indicating WSC indicator not applicable to the study, one representing minimal impact, and three denoting the highest impact. Only 27 of the 34 WSC indicators were utilized in the assessment of the three scenarios, as the remaining seven indicators were deemed non-applicable.

Table 2. WSC Index Assessment

WSCI Goal	**Scenario 1**	**Scenario 2**	**Scenario 3**
Goal 1	16	14	16
Goal 2	6	12	12
Goal 3	5	9	9
Goal 4	3	8	9
Goal 5	4	9	12
Goal 6	3	8	9
Goal 7	4	11	11
TOTAL	**31**	**71**	**78**

According to Table 2, Scenario 3 received the highest score. As a result, the No Extraction scenario was selected to be developed into a water-sensitive landscape plan.

5. Synthesis

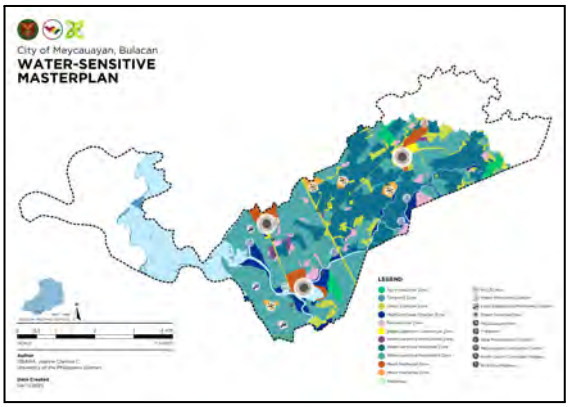


Figure 19. Water-sensitive Masterplan

The water-sensitive masterplan illustrates the proposed zoning and key facilities. The central aspect is the establishment of a water-sensitive

park system, which is emphasized as critical recharge areas. These are connected through green corridors and minor recharge zones, strengthening both ecological and community access.

6. Conclusion

Land subsidence in the City of Meycauayan, Bulacan, is significantly influenced by excessive groundwater extraction. With urbanization, the demand for water intensifies, leading to increased reliance on groundwater. The development of built infrastructure to accommodate urban demands contributes to the reduction of open and permeable spaces. This leaves the city at more risk to subsidence and its adverse effects.

The WSUD approach is crucial for the planning of areas vulnerable to environmental degradation. Driven by its core principles, WSUD enables effective water management, providing a framework for balancing urban developments with the landscape.

Considering the data analyzed from maps, the thematic analysis from the key informant interview, and desk research, three planning scenarios were formulated. This includes Status Quo scenario, Regulated Extraction scenario, and No Extraction scenario. Each has varying groundwater extraction practices and WSUD strategies that promote aquifer recharge. Each scenario was assessed through quantitative and qualitative methods to determine the most suitable scenario for facilitating aquifer recharge. Results revealed that the No Extraction scenario offered the greatest potential for strengthening aquifer recharge. Hence, this scenario was developed into a water-sensitive landscape plan.

The water-sensitive landscape plan emphasizes the importance of discontinuing the reliance on groundwater. Central to it is the integration of the WSUD approach which prioritizes sustainable water management through enhanced infiltration and holistic use of water resources. By considering this alternative for land subsidence mitigation, the proposal aimed to establish a water-sensitive landscape plan that not only addresses the physical cause of sinking grounds, but also promotes ecological health and community well-being. Through proper implementation, the City of Meycauayan could mitigate the risks associated with land subsidence while moving towards their vision of becoming a “highly urbanized green city.”

Acknowledgements
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NEW SUBLIME WATERLANDSCAPES OF THE NETHERLANDS

TOPIC: A reflection on the aesthetic quality of the new designed Dutch river landscapes

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Keywords: Water, Rivers, Flooding, Aesthetics, Sublime

Abstract

The river landscapes of the Netherlands have undergone a major change since a near-flooding event in 1995. That near-disaster showed how vulnerable the civil engineering oriented strategy, of raising dikes, was. A change to a landscape-based solution, of widening the floodplains, was made in the program Room for the River. As a consequence of other biodiversity goals and the new strategy of flood defense, the new wide floodplains were reinstated as natural floodplains, as opposed to mostly agricultural uses before. Many minor and major solutions were planned, designed and executed, the Dutch again making their own landscape; in a very (im)modest way, changing the face of the planet. Given the energy provided by the river flow and the fertile soils, some of these areas developed over time into wild places in the otherwise very tightly managed Dutch landscape.

This paper explores whether the wilder river-landscapes that developed afterwards can be experienced as sublime and how this can be represented in photographs, drawings and paintings. This exploration leads to some philosophical questions. What does it mean for a landscape to be sublime? How can we decide whether a landscape is sublime? Is this not a very personal experience?

Kant states that a sublime landscape must impress us and leave us in awe, either by its scale or dynamics. Often the component of fear is mentioned, but it is mostly an imagined fear, as the situation should still leave room for aesthetic reflection. For the paper I have chosen to follow a theoretical perspective developed by Burke. Burke gives us a list of several components that can contribute to an object being perceived as sublime. With this list in mind I have explored during several visits, a part of the floodplain between Doorwerth and Wageningen and I have tried to document and analyze places and moments of the sublime. Because on a warm summer day the floodplain is simply a beautiful place. But as Wordsworth has noted an object can be both beautiful and sublime, but not at the same moment. And there are, as I will try to show in this paper, also plenty of places and moments that the floodplain is a mysterious, dark and awe inspiring place. Especially when the floodwaters come and take their grip on the floodplain, the sublime character of the landscape shines through.

Through documentation in descriptions, photographs and subsequent reworking in drawings and paintings, the Dutch river landscape can be shown to match most, if not all of the qualities as given by Burke as specific for the Sublime. My place as inhabitant of these landscapes, landscape architecture academic, philosopher, and landscape artist provides a privileged view into the folds of the tightly organized Dutch landscape, where wildness can still play out and sublime experienced can be had. It offers a glimpse of how nature restoration and flood protection can combine to shape aesthetically interesting places offering sublime experiences, contributing to creating trivalent places that are functional, sustainable and aesthetical.

1. Introduction

A near disastrous flooding in 1995 in the Netherlands made clear that flood protection by building ever higher dikes along the rivers, was a failing strategy. Landscape architects proposed a new solution, in the project room for the river, in which enlarged floodplains of the rivers were adapted to accommodate more water and to turn them from intensively used meadowland into natural swamps and softwood riparian forests. By taking accumulated sediments out of the floodplain, they were deepened, and sometimes widened. These new floodplains could spread out the floodwaters and thus lower water levels in the river.

In the Netherlands there is no Nature with a capital N, as in: unspoilt pristine areas of wilderness, untouched by the human hand. Every square centimeter has been touched, turned over and rearranged. We have cut down the last remaining original forest in 1871 and what is today called nature in the Netherlands are remnants of the agricultural landscape that have been taken out of the primary production process, which nonetheless can be ecologically very rich. Nature is the remains of grasslands used for grazing animals, heather lands as remains of overgrazed forests and coppice woods, hunting forest and many 20th century tree plantations. In 1990 the development of the EHS (a national nature network) was agreed upon which consolidated the protection of existing natural areas, but also proposed the development of new nature areas. For this purpose agriculturally used land was taken out of production, reshaped and the allowed to develop mostly in accordance with natural processes. In the newly shaped floodplains many species of plants and animals could profit from the new, more varied physical circumstances along the river and improved connectivity of natural areas along the river. To avoid the blocking of the floodwaters by quick-growing forests, many of the floodplains are managed by extensively grazing by half wild horses and cows. In this way nature development and solutions for river management were combined in the room for the river project.

In terms of policy the room for the river project was unique in that it had a dual quantitative water management goal and qualitative goal in terms of improvement of spatial quality. The latter meant that a quality team would also check the new plans for their contributions to functional, sustainable and aesthetic goals. This looming check by the quality committee at the end meant that often the project leaders hired landscape architects to be involved and to deal with that aspect. New landscapes came into being along the rivers as a result of the designs. Beyond the prose of solving a quantitative water issue, landscape architects have created the poetry of new interesting landscapes, opening up the floodplains for aesthetic experiences. The topic of this paper is to explore the character of the aesthetic experiences offered by these new landscapes.

2. Research question

The second policy goal for the river improvement plan "room for the river" was to improve spatial quality which includes besides a functional and sustainability component, an aesthetical dimension [1]. Some sites have definitely become more beautiful, as was explored in an evaluation of the room for the river program [2], but it is worthwhile to explore whether perhaps the new wildness of parts of the floodplain has also diversified the aesthetic palette with the sublime. My research question for this paper is to explore in how far these new floodplain landscapes can be experienced as being partly sublime in character. I say partly sublime because as Wordsworth has noted a landscape can be both beautiful and sublime, but not at the same moment. [3] A visitor in the warm summer months would for sure experience these landscapes as beautiful and or picturesque, but perhaps also sublime experiences can be had in these new landscapes.

3. Research method

In the exploration of the landscape I have gone beyond the visual experience [4]. These experiences are gathered in a practice of engagement, as described by Berleant [5], as a basis of exploring the aesthetic quality of a landscape in a multisensory and environmental experiential manner, as described by Carlson [6], not for one of the "monuments" of room for the river, but for a rather mundane everyday environment close to home in accordance with points made on everyday aesthetics by Saito [7].

I describe the experience of a 6 kilometer stretch of river and associated floodplain along the river Rhine between Doorwerth and Wageningen in the Netherlands. I am an inhabitant of the river landscape, a walker of floodplains, a kayaker on the river and a landscape artist; painting/drawing the floodplain and the river.

When it comes to evaluative judgements like whether something is sublime I hold the postmodern position of Bourassa [8] that grounds aesthetics judgements in general human sensory experiences , cultural conceptions and the individual experiences of a particular person. That means that these aesthetic evaluations can vary between people (but do not necessarily do so). By clearly describing the experiences that lead to the evaluation, differentiated along different characteristic of the sublime at least it can be made plausible that the sublime can be found in the floodplain landscapes.

In a step to narrow down the research question, I propose the following: Does the target landscape exhibit the characteristics of the sublime as described by Burke? Because Burke [9] provides us with a list of characteristics that can make things sublime. They are: astonishment, fear and terror, obscurity, power, privations: vacuity, darkness, solitude and silence, vastness and infinity, succession and uniformity, magnitude, difficulty, magnificence, light, loudness, suddenness, cries of animals, bitters and stenches and pain.

To research the landscape of the floodplain I devised the following method grounded in phenomenology: to walk and kayak in the floodplain stringing places into a landscape, observing my experiences without explanation taking photographs and making sketches without trying to explain them, followed by reflecting on the experiences and the process of experiencing, and lastly followed by reflecting on the dependence on the singular character of the observations through imaginative variation. Describing the experiences in the field very explicitly opens the findings to intersubjective validation. Other could do the walk and kayak the river, report their findings and discuss parallels or differences in experience.

4 Results

First a caveat, the sublime in the Netherlands is a value by contrast; in the land where the word for beauty is linked to cleanliness, in the land of sand and mud without mountains and rocks, the river place is wild. Compared to sublime landscapes of the arctic nnorth, the jungles of the equatorial regions or the desert landscapes of the world, this place is pretty tame. But in the context of a flat, well raked, Mondriaan-style organized landscape of a stamp-size country and its tulip and cow collection, with its 18 million people, this is as wild as it gets. So what are some of the experiences of this place:

Astonishment
You walk though rough grassland surrounded by shrubs and trees, the vegetation breaks, and a river appears suddenly there are lines of sight kilometers away. Walking along the dike and in the floodplain, suddenly light breaks through the clouds and draws your attention to elements at the horizon. I stop and am amazed.



Figure 1. Astonishment at the light on the water.

Walking up the ice-pushed ridges next to Wageningen, (singular heights in a flat landscape) one can look across the landscape of the river. In a crowded country this openness to the sky with light reflected upwards from the water shows an astonishing set of nuances of blue and grey.



Figure 2. A painting of the view across the river.

Fear and terror
You walk into the floodplain and are enclosed by it; water slowly builds and floods the area; paths are

cut off and you need to retrace your steps. I get anxious about whether I will be able to safely retrace my path.



Figure 3. The river entering the floodplain.

Kayaking along the river, large trees loom close-by on the banks throwing shade in the fading light of the evening. Their looming presence fills me with awe.



Figure 4. A painting of looming trees.

Obscurity
While you walk the path, (or was it an animal track?) it disappears in vegetation, you end up in a dark enclosure unsure about where to go next, signs and markers may have washed away, the landscape once familiar, has changed since the last flood.



Figure 5. Lost in the floodplain.

Trees have toppled and regrown, forming unusual patterns, broken and regrown. I am intrigued by the strange shapes.
Masses of branches and reeds find a way with the floodwater; blocking routes and gathering around stems of trees.



Figure 6. a painting of floodplain chaos.

Privations: Vacuity, Darkness, Solitude and Silence
In a kayak on the river; you enter this hole in the landscape, you are away from the people, the voices of the shoreline; you insert ourselves into a world of solitude and silence. With the darkness the wind falls away, the water takes and oily appearance, purples and pinks floating on top of darkness. I am amazed at the colors that appear in the absence of the bright light of the day.

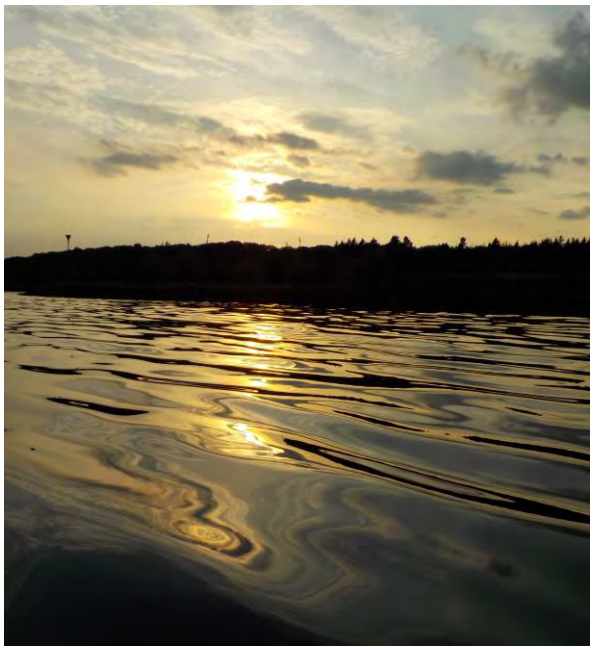


Figure 7. The color of the water at dusk.

Darkness falls and trees turn into shapes growing from the darkness, morphing into blots of wild darkness.



Figure 8. a painting of willows at dusks.

Vastness and Infinity
The sky is mirrored in the water on a dark evening; the horizon fades and darkness envelops us and the kayaks seem to float in nothingness, vertigo grips me, whilst I am centimeters above the water.

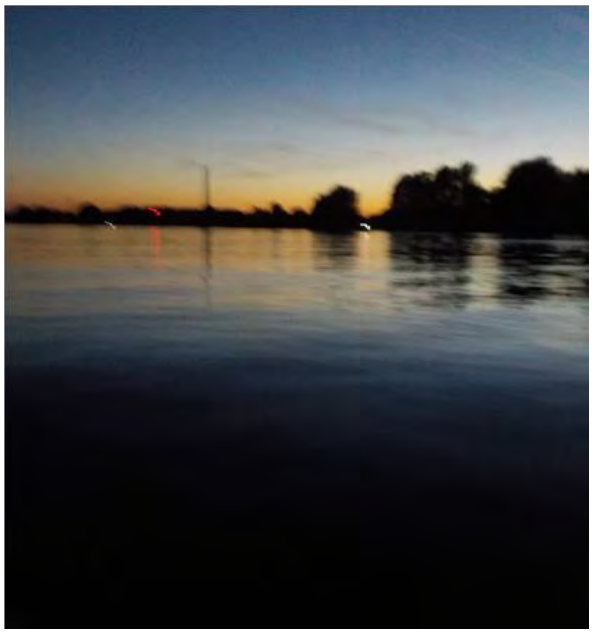


Figure 9. Floating in vastness.

If we let go, the river will bring us to the sea and wash us away..



Figure 10. The vastness of the river.

Succession and uniformity
The river keeps flowing, bringing always new waters as a link in the endless chain of the water cycle, grinding down other countries, building our land. It is bigger than us, I feel small and insignificant in its presence.

Magnitude
As a walker the other side of the river is miles of walking away, the river flows unhindered, not broken, but just punctuated by bridges; when flooding, the river expands to a magnitude beyond our reconning, the kayak brings us suddenly into unknown corners of the landscape that were hidden in the folds of the flat land; I am surprised by the vastness of this place.

Difficulty
Entry is easy in summer when the ground is dry, though the dried mud may still echo footsteps impressed in wet mud and form ridges and holes that can trip you. Most of the time the mud is serious business, slippery and sucking at your footwear, offering no grip for progress. I wonder what I am doing in this inhospitable place.



Figure 11. Sliding through mud.

Plants grow high and wild and without plan, stringing your legs, anchoring thorns and needles in your flesh. Gullies and ditches close off paths. I feel unwelcome even threatened by plants, like I am invading their space, they let me know I have no rights here.



Figure 12. A painting of vegetation.

Magnificence
Clouds in all their majestic beauty flowing by, the river glistening, this landscape is magnificent.
The sun is setting behind disused brickworks and their large chimneys, one signifying our homebase for the kayaking club

Light
When we travel west in the evening, we squint, etching wrinkles in my face. The light, reflected by the water, unhindered by shading vegetation is blinding, forcing me to focus on what is near and a close to the boat.



Figure 13. Light behind the clouds.

In the evening the light fades away in spectacular colors illuminating trees. Old factories stand out as silhouettes against the sky.



Figure 14. A painting of last light.

Loudness
Loudness is mostly rare, except when the wind blows and roars in your ears, shakes the trees and uses the trees and the water surface as an instrument to be played.

Suddenness
In a matter of days, the water will rise from its normal level to the summer banks and then can quickly spread beyond that.
In some places the river widens autonomously, in some places via locks and gates, which will only be opened when the pressure is on. And then the water roars into the floodplain, filling it in hours.

Cries of animals
Herons flying by and shrieking, Geese overhead squawk about autumn and winter.

Bitters and Stenches
Bitters come from the willow bark omnipresent in the floodplain, saving people's lives as traditional medicine. There is a smell of mud and river water, the smell of dead fish and of plants being crushed underfoot; exhaust fumes of boats and ferries. Formerly exhausts of brick factories lined the landscapes, now taken over by companies in recycling. I am afraid it is not always clean stuff they are burning.



Figure 15. Smoking chimney.

Pain
People do drown in the river, mostly foreigners unfortunately, inexperienced swimmers unfamiliar with the force of the Rhine beneath its clam surface. When the flood comes, the official "no swimming" signs are lost in the river; dangerous swimming seems an understatement.



Figure 16. no swimming sign.

5 Discussion

Many of these experiences in the floodplain and the emotions they cause seem to be intersubjective. Feelings of being small and a fear of getting lost and forces that could potentially threaten us, are generalizable for many. Perhaps if people come from a real wilderness background they might not so easily be impressed. The experiences are perhaps also not shared by everyone that visits this landscape. Simply because they stay away in the winter period or do not have the ability and skills to kayak the river. But if they would, they would experience the same as me. The characteristics of the sublime seem to reside in the objective landscape and even though they rely on a subject to be experienced, it does not seem dependent on any specific person to be experienced. Others might be excluded from these experiences altogether, as they do not share, or feel they share, my male privileges of moving freely through the landscape.
Experience accumulated over time does help me to see the river landscape in all its aspects. As a researcher I am slowly learning how to photograph this and to represent this in the drawings.

It seems to me however as though this landscapes displays all or at least many of the characteristics as described by Burke, and if we accept his list of characteristics, that could be a strong indication of the opportunity to experience the sublime in this landscape. As a side line it is worthwhile wondering whether to be sublime a landscape needs to display all the features mentioned by Burke, or whether it is sufficient to have a few.

But perhaps the landscape is just picturesque? There is a roughness to these landscapes and as seen, it lends itself to be represented in pictures. But there are also aspects that are truly sublime in terms of size and openness to the sky, this landscape is sharply contrasted with normal landscapes in the Netherlands. The raw green vegetative power of the fertile floodplain and the wildness of vegetation springing from its fertile soils is impressive and fear inducing. The slow but substantive power of the flood and the unpredictability of flows, and the wetter circumstances that offer more chances for willows and wild growing trees and shrubs to spread across the landscape in combination with less agriculture, more spontaneity and more animals more randomness, also causing a differentiation in smells paired with different engagement because there is more access, and opportunities for free roaming, make that there is a serious side to the terror induced by these landscapes that goes beyond mere picturesqueness. It is a slow, insidious kind of terror however, that you only find by engagement and prolonged observation.

6 Conclusion

In the room for the river project Dutch Landscape architects have developed some room for wildness and the sublime, in the cracks of the landscape, in the liminal zone between river and land. Though the floodplains are not without control and management, they are feral, wilder places in the tame Dutch landscape. The characteristics of the river and it's uncontrollable waxing and waning and the fertility of the floodplain with the productive power in softwood vegetation certainly contributes to this wild feel of the place.

When the water rises and the extent of water grows from 450 to 2000 meters wide, rising up to 4 meters above normal, swallowing ledges, hedges, pushing trees to the crown in water and the mass of water, comes flowing in, pushing through locks and gates, extending into grasslands, and the river is flowing, whirling, billowing moving branches reeds and mud and its erosive power are released, sand and mud are moved, and a new landscape appears after the flood; this to my mind constitutes a sublime landscape within the context of the Netherlands.

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THE PARC DU VALLON IN METZ : WATER SHAPES THE LANDSCAPE

Guiding cities through what is alive: Rainwater and water landscapes

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Keywords: hub, park, corridor, ponds, groundlevelling



Figure 1. More than just a park : a corridor for wildlife

Metz Technopole has been growing rapidly since 1984. More than three hundred firms and multiple teaching hubs have settled in the direct area.
Along that formidable development, the mission of this site states the same: to become a pioneer hub, dedicated to environmental innovation. **Arpentère** studio drew plans to integrate this new district into the surrounding urban fabric, with the ongoing challenge of making it an example of a technological, ecological and sustainable neighborhood. Among other things, a housing zone and the development of service sector areas are planned.

A strong choice has been made: to promote nature in the city. Hence a major public space will be created. A twelve hectares park, which will be called the Vallon, will take place in direct proximity with the buildings. Composed with three successive soils, from the wettest to the driest, it will be crossed by a web of paths that let pedestrians enjoy a continuity of agricultural landscape. Reed beds, meadows and pastures, orchards and gardens, will cover the floor and form an ecological corridor. All of it will respect and develop the conclusions of the fauna-floral study that was delivered on site in 2017. Along with sports trail, some observation points will be disseminated around the park, so that visitors can have a discreet and respectful look at the lively environment that flourish around water.

Water management is quite original here. We decided to collect and pool all the upstream water from the district to create a system of basins, ditches and reed beds that form the heart of the Parc du Vallon. This solid network has been created in the remnants of an existing and imperfect landscape. Indeed this area had already been utterly damaged by archeological excavation: in the middle of this former farmland lying fallow, a Roman villa was found. Hence, ground levels were uneven, offering a range of different levels. We used this specificity as an asset, and developed these horizons to connect the park to the rest of the district.

This network of waterways will let the flood from the city reach retention ponds, created in soil crevices. These ponds are thought to stay emerged all year long so that a decantation can occur. All of them will lead to the reed breeds, whose role is to purify the air thanks to the phytoremediation of plants. Reeds and marsh iris will be perfect refuges for tree frogs, salamanders, dragonflies and ducks. There's absolutely no doubt they'll rapidly settle in the environment.
Another keyspace of this project is the brand new Grigy plaza. Located in between the already inhabited hamlet and the new district, it will constitute a visual eye-catcher that acts as a graft. Floors, lights and trees have been used as tools to

develop a frugal space with multiple possible uses, and one everlasting purpose: being a welcoming place.



Figure 2. Three successive types of soil coexist within the park



Figure 3. A system of ponds and reed breeds helps phytoremediation



Figure 4. A large web of trails enables pedestrians to enjoy the fullest of the park

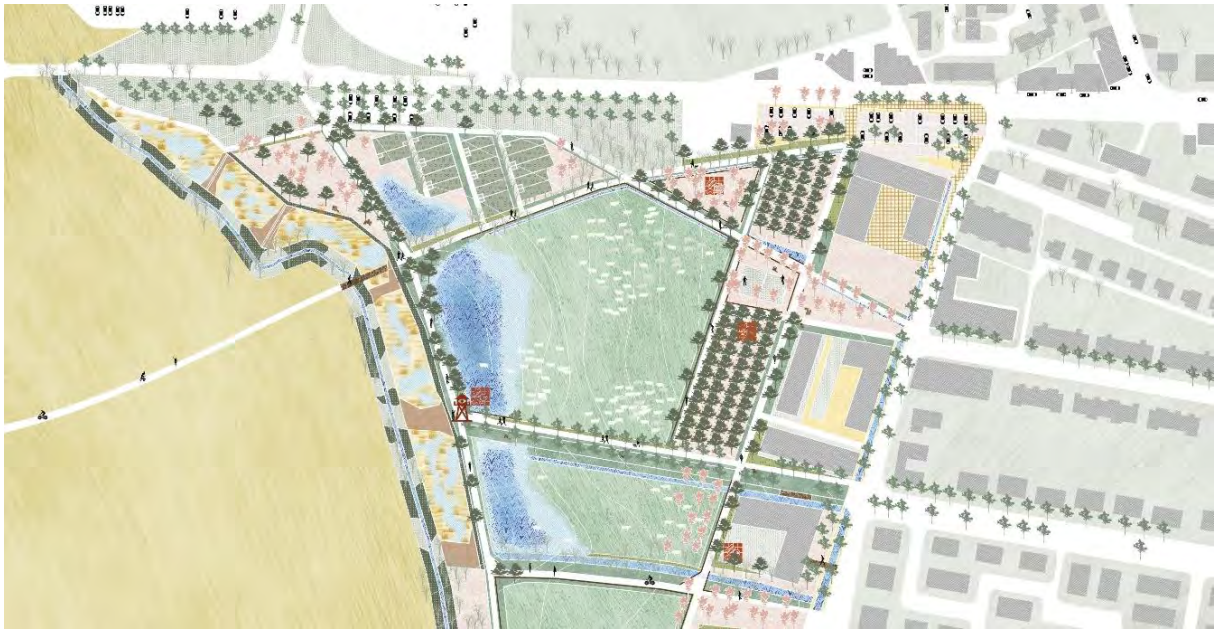


Figure 5. Straddling the city and the countryside, the parc du Vallon is an ecological hub

Acknowledgments
SAREMM 57, Atelier Choiseul, Ingerop photos © Karolina Samborska

URBAN-LAKE SYMBIOSIS: UNDERSTAND THE SUSTAINABILITY AND RESILIENCE OF SOUTH CHINA'S HISTORIC MUNICIPAL LANDSCAPE THROUGH A HISTORICAL POLITICAL ECOLOGY LENS

TOPIC: Guiding cities through what is alive: rainwater and water landscapes

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Keywords: history, disaster resilience, sustainability, political ecology, landscape management

Abstract
Human-nature harmony has been deeply rooted in China's culture. As reflected in the "*shan-shui* (mountains and waters) city" concept, the natural environment context is significant for urban sustainability. China has a history of thousands of years in shaping and managing the landscapes around metropolitan areas. In recent years, an increasing number of studies have shifted from designing small-scale exquisite gardens to managing large-scale urban landscapes, through which Chinese traditional knowledge has been continuously revealed. The southern region of China, covering the modern Chinese subdivisions of Guangdong, Guangxi, Hainan, Hong Kong, and Macau, was called "Lingnan" in history. In this region, over 2000 years of Chinese cities' development have represented the synergy of the urban areas and their surrounding landscapes. Lingnan is in the subtropical zone, characterized by a hot and humid summer with copious rainfall and frequent typhoons, causing tough drought and flood events for human settlements. *Zhou-fu* areas, known as the administrative divisions in Chinese history, were economically and socially well-developed. They are normally adjacent to river intersections, making them vulnerable to flooding. Therefore, it was crucial for *Zhou-fu* authorities to manage the water systems, which was the key motivation for shaping and managing Lingnan Municipal (or *Zhou-fu*) Landscape (LML). It suggests that studying LML is valuable in revealing Chinese traditional wisdom for sustainable and resilient urban development.

The objective of this paper is to answer two research questions. (1) As an important green infrastructure, what functions did LML offer from the perspectives of environment, economic, and social (the three pillars of sustainability), and disaster resilience? (2) From the political ecology perspective, how did local authorities' management support the multifunctionality of LML? This paper conducted a diachronic analysis of typical cases of LML through a historical literature review. These cases include Chaozhou West Lake, Huizhou West Lake, Zhaoqing Star Lake and Leizhou West Lake in Guangdong Province, and Guilin West Lake in Guangxi Province, covering most subdivisions in the Lingnan region. It examines the evolution of LML and identifies its remarkable period in China's Tang and Song dynasties (618-1279 C.E.).

The results indicate that the lake and water systems, the major parts of LML, have multiple functions: rainwater detention for flood and drought mitigation, agricultural irrigation, food production, disaster risk reduction, and public recreation. Evidence shows that the shaping and management of LML were led and funded by local authorities, and involved a wide public engagement. The traditional wisdom embodied in LML is significant for the mitigation of projected worsening drought and flood events in the background of climate change, the integration of food-producing with recreational space in the emergence of the "productive landscape" idea, and the representation of local culture and aesthetics in green infrastructures in improving human well-being.

1. Introduction

Human-nature harmony has been deeply rooted in China's culture. As reflected in the "*shan-shui* (mountains and waters) city" concept, the natural environment context is significant for urban sustainability. China has a history of thousands of years in shaping and managing the landscapes around metropolitan areas. In recent years, an increasing number of studies have shifted from designing small-scale exquisite gardens to managing large-scale urban landscapes, through which Chinese traditional knowledge has been continuously revealed.

Municipal (or *Zhou-fu*) Landscape (ML), a relatively less researched concept compared to Imperial Gardens and Private Gardens in China, refers to mountains and waters surrounding historic municipal areas (*Zhou-fu*). The globally renowned West Lake in Hangzhou is a quintessential example of ML. The city and its surrounding environment exhibit characteristic features of a social-ecological system. On one hand, the peri-urban environment sustains human survival and cultural continuity through its diverse resource attributes, including land, ecological functions, and cultural heritage. On the other hand, urban development introduces varying degrees of human disturbances, impacting ecosystem structure and function. Consequently, the natural and social systems are interwoven and highly coupled (Wang etc. 2020).

Critical geographers and scholars have consistently demonstrated that seemingly natural systems are profoundly shaped by human interventions. Political ecology, the interdisciplinary field examining these dynamics, transcends an exclusive focus on the environment per se to analyze the political-economic relations and power structures driving environmental change, integrating ecology with political economy (Wang and He 2021).

Landscapes and their components are neither permanent nor static entities. Resource, environmental, territorial, and other land-based relations are best understood as moments within temporal trajectories. By exploring intertwined ecological and political-economic histories, historical political ecology (HPE) illuminates the long-term consequences of socio-environmental transformations (Davis 2009).

Research applying political ecology to aquatic environments is particularly prolific (Mathevet etc. 2015; Vitz 2018; Wang etc. 2020), demonstrating the framework's analytical utility. However, a large portion of such studies are grounded in Western contexts and focus predominantly on post-industrial environmental changes, leaving a significant research gap for applying the HPE perspective to premodern Chinese landscape histories.

2. Historic Lingnan Municipal Landscape

The concept of "Municipal Landscape" was initiated by Prof. Guanping Liu, the recipient of the Lifetime Achievement Award from the Chinese Society of Landscape Architecture. This concept is further elaborated in Dr. Guangzhen Lin's thesis, which defines it as the space developed through historically evolved methods and utilized as multiple urban-supporting functions, leveraging the natural landscapes in the suburban areas of Lingnan's prefectural cities and supported by urban water management systems (Lin 2018).

The southern region of China, covering the modern Chinese subdivisions of Guangdong, Guangxi, Hainan, Hong Kong, and Macau, was called "Lingnan" in history. In this region, over 2000 years of Chinese cities' development have represented the synergy of the urban areas and their surrounding landscapes. Lingnan is in the subtropical zone, characterized by a hot and humid summer with copious rainfall and frequent typhoons, causing tough drought and flood events for human settlements. *Zhou-fu*, known as the administrative divisions in Chinese history, were economically and socially well-developed. These municipal (*Zhou-fu*) areas are normally adjacent to river intersections, making them vulnerable to flooding. Therefore, it was crucial for the municipal authorities to manage the water systems and to create floodwater detention and retention spaces, which was the key motivation for shaping and managing Lingnan Municipal Landscape (LML). It suggests that studying LML is valuable to reveal Chinese traditional wisdom for sustainable and resilient urban development.

This paper focuses on the period of China's Tang and Song dynasties (618-1279 C.E.). During this period, Chinese society and economy experienced rapid development, and underwent a crucial turning point, and this included the Lingnan region as well. Meanwhile, the garden-making boom, which coincided with the flourishing of literature, poetry, painting, and a deeper appreciation of natural beauty, also marked an important period for the formation and development of LML (Lin 2018).

3. Methods and Objectives

This paper conducted a diachronic analysis of typical cases through a historical literature review. These typical cases of LML include Chaozhou West Lake, Huizhou West Lake, Zhaoqing Star Lake and Leizhou West Lake in Guangdong Province, and Guilin Yin Mountain and West Lake in Guangxi Province, covering most subdivisions in the Lingnan region.

The objective of this paper is to answer two research questions: (1) As an important green infrastructure, what functions did Lingnan Municipal Landscape offer in the perspectives of environment, economic, and social (the three pillars of sustainability), and disaster resilience? (2) Through the lens of HPE, how did local authorities' management support LML's multi-functionality?

4. Sustainable and Resilient Functions

During the Tang and Song dynasties, people gradually recognized that the natural mountains and waters surrounding prefectural cities served as vital protective barriers. Protecting and managing these landscapes is aligned with the fundamental interests of the cities. The mountains, waters, and the city itself in the immediate suburbs constituted an indivisible entity in terms of their physical spatial form, exerting mutual spatial influence and forming an ecologically interdependent relationship where their functions interpenetrated.

Situated in a subtropical zone, Lingnan's prefectural cities faced dual hydrological challenges—floods and droughts—exacerbated by their geographic placement at river bends, which increased vulnerability to erosion. To address these risks while supporting urban functions, integrated water management systems were developed. Natural water bodies originally located in the urban outskirts were regulated and transformed into ecologically buffering water storage areas for the prefectural cities. Among them, the larger lakes served multiple functions, including military defense, flood control and drought mitigation, agricultural irrigation, and the supply of drinking water for urban residents.

Through this process, gradual landscaping renovations were carried out, turning these areas into scenic spots on the outskirts of Lingnan's prefectural cities. As practical achievements of ancient landscape urban construction, numerous elements such as green mountains, lakes, rice paddies, city walls, and architectural structures were organically integrated, presenting a harmonious and coexisting vista (Lin and Li 2023).

Typical examples are listed in Table 1. This pre-modern urban ecological framework illustrates how artificially engineered hydrological networks synergized with natural topography to sustain both city operations and surrounding landscapes, forming a balanced settlement pattern unique to Lingnan's subtropical environment.

5. Governance and Actors

5.1. Laws and Regulations

According to the underlying principles of the Tang Code with Subcommentary (*Tanglü Shuyi*), the Collected Statutes of the Song Dynasty (*Song Xingtong*), and the Classified Essential Statutes of the Qingyuan Era (*Qingyuan Tiaofa Shilei*), legal governance over ML during the Tang and Song dynasties primarily focused on four key aspects: (1) Construction projects were required to be officially reported, with clearly defined budgets, and the quality of construction had to meet prescribed standards; (2) Water conservancy facilities and water resources, had to be properly managed and maintained; (3) Officials were held responsible for the governance and regulation of urban periphery and surrounding areas, and the construction of water conservancy projects to support agricultural production constituted a critical component of officials' performance evaluation; (4) Environmental protection was emphasized, with strict prohibitions against unauthorized deforestation and resource exploitation. Table 2 shows the actors, related regulations, and the governing scales of selected examples.

5.2. Administration by Government Officials

Given the large scale of the landscapes in the outskirts of Lingnan prefectural cities, the shaping of ML demands extremely prudent judgment. At the macro-level, the planners must possess a fundamental understanding of the spatial layout, integrating mountains, waters, and the city. At the meso-level, they need the capability to mobilize or coordinate the resources of the prefectural region. At the micro level, they should have sufficient cultural and aesthetic awareness. Therefore, this determines that the shaping of ML is not an endeavor that ordinary residents can undertake. These place-making activities were often led and managed by ancient official figures who held "academic titles or official ranks". They might be administrative officials governing Lingnan

prefectural cities or literati and officials exiled or demoted there.

These scholar-officials were commemorated by later generations for their contributions to the construction of scenic landscapes in the urban suburbs. Posterity erected memorial halls as a means of honoring them. This practice affirmed the officials' administrative achievements in benefiting the local populace, functioning as an iterative and self-reinforcing positive incentive mechanism.

This mode of place-making persisted throughout the historical development of LML. The creation and evolution of LML were consistently led by government officials. The process of integrating water conservancy projects to reshape the landscape and subsequently develop scenic environments was carried out under the direction of successive prefectural administrators. These efforts ultimately transformed LML into public spaces that served the broader needs of the prefectural populace.

5.3. Grounded in Public Funding

The construction of ancient cities often involved excavating earth outside the city walls for brick-making. Following the completion of the city walls and moats, these excavated depressions, due to their low-lying topography, were frequently transformed into lakes. This phenomenon is evident in the cases of Huizhou West Lake, Leizhou West Lake, Guilin West Lake, Rong Lake, and Shan Lake. For instance, historical records indicate that Huizhou West Lake was originally known as Langguan Lake, described as "a pond excavated during the city wall construction". This confirms that Langguan Lake emerged as a byproduct of Huizhou City's development. These resultant lakes were typically integrated into the city's water management systems. Building upon this hydraulic infrastructure, a series of purpose-built landscape structures were subsequently developed.

During the Southern Song Dynasty, the spatial configuration between Jingjiang Prefecture City and its surrounding mountain-water environment was delineated, with expenditure details listed in the appended records of city wall repairs, which included outlays for dredging the city moats. It is evident that in the construction of moats and ponds, there were not only transfer payments from the central (national) fiscal authority but also financial allocations from functional departments (such as the transportation and granary administration). Additionally, there were investments of manpower and material resources from the local level. The shaping of ML required enormous investment and exhibited distinct publicity, making it impossible for ordinary people to undertake the construction of such large-scale scenic places. In ancient China, public gardens or landscapes were generally funded by the government or constructed through fundraising initiated by officials and local gentry. The daily maintenance of these completed places necessitated even greater fiscal input from the prefectural authorities, and instances of neglect due to insufficient funding were not uncommon. Therefore, well-planned management measures were essential to ensure good effect and low cost. For example, in the development of Yin (Hidden) Mountain, Li Bo made meticulous preparations in terms of funding and materials. A detailed evaluation of the required workload was prepared for the construction of a pavilion at the mountain's summit, indicating that cost estimation was an essential part of the planning process.

5.4. Wide Public Engagement

In ancient times, public finance was relatively limited, and urban construction and LML shaping relied heavily on broad public contributions. The public engagement primarily stemmed from two sources. One was individual donations, mainly from influential local gentry. The other was the involvement of public institutions outside the prefectural administration, such as academies and temples. A significant number of official schools and academies were established within LML. Buddhism was introduced to Lingnan relatively early, leading to the widespread construction of temples and monasteries on the outskirts of Lingnan cities. The construction activities of Confucianism, Taoism, and Buddhism exerted a positive influence on the landscapes of Lingnan and the prefectural gardens that were integrated into the natural environment. These collective efforts jointly shaped the spatial characteristics of LML.

6. Conclusion

Through an HPE lens, typical examples of LML are analyzed by a historical literature review. Public engagement and fiscal investment in shaping the suburban landscape around the ancient prefectural cities demonstrated that LML were subject to the governance of the prefectural authorities, and signified that such activities were not private initiatives but likely represented the pursuit of the public good, and in turn, further reinforced the legitimacy for prefecture to assert its governance authority over the space (Lin etc. 2018). From the perspective of place-making and management, local

officials in premodern Lingnan prefectures played a pivotal role. Regarding actual usage, although these suburban landscapes fell under the governance of the prefectural authorities, their spatial utilization exhibited a distinctly secular character, serving as a shared public open space for the residents of the ancient prefecture.

The results indicate that the lake and water systems, the major parts of LML, have multiple functions: rainwater detention for flood and drought mitigation, agricultural irrigation, food production, disaster risk reduction, and public recreation. Evidence shows that the shaping and management of Lingnan Municipal Landscape were led and funded by local authorities, and involved a wide range of stakeholders. The traditional wisdom embodied in LML is significant for the mitigation of projected worsening drought and flood events in the background of climate change, the integration of food-producing with recreational space in the emergence of the "productive landscape" idea, and the representation of local culture and aesthetics in green infrastructures in improving human well-being.

Table 1. Sustainable and Resilient Functions of Lingnan Municipal Landscape

Functions	Cases	Descriptions
Water Supply	Huizhou West Lake	The well water within Huizhou city was unsuitable for drinking. Consequently, water from the East River was channeled into the city through the Hanbi Conduit, utilizing Huizhou West Lake as its source.
Rainwater detention for flood and drought mitigation	Huizhou West Lake	Through long-term development, a series of hydraulic structures, including dikes, sluice gates, and canals, were gradually established to regulate and store the water body of Huizhou West Lake. Functioning akin to a reservoir, the lake played a crucial role in mitigating flood impacts by absorbing excess rainwater, thereby reducing its adverse effects on the urban area.
Agriculture irrigation	Leizhou West Lake	The Leizhou Peninsula is characterized by short streams with shallow flows, resulting in limited water storage capacity. Combined with high rates of soil evaporation, it ranks as one of China's five major arid zones. Proximity to the sea also subjects the area to frequent saltwater intrusion. Beginning in the Song dynasty, an urban water system centered on Leizhou West Lake was developed to irrigate adjacent farmland, a system that remained operational throughout the Qing dynasty.
Disaster risk reduction	General	Water stored within the city's moat and urban lakes served the auxiliary function of defending against urban fires.
Food Production	Chaozhou West Lake and Huizhou West Lake	Lake Fishing became a famous sightseeing program.
Transportation	Huizhou West Lake	In ancient times, many buildings were constructed around Huizhou West Lake, with convenient water transportation facilitating commercial development.
Public Recreation	Guilin Water Systems	During the Song Dynasty, a comprehensive waterway system was excavated, allowing visitors to embark on boat tours. Boat tours to explore the scenic spots of Guilin became a highly acclaimed theme among tourists.

Table 2. Regulations and Actors of Typical Examples of Lingnan Municipal Landscape

Actors	Regulations/ Actions	Period	Cases	Events/Policies/Regulations	Scale
Central Govern-ment	Laws	Tang	General	The *Tang Code with Subcommentary* explicitly designated mountains, fields, ponds, and lakes as under state legal jurisdiction. Unauthorized appropriation of these resources and the private profiting from them were prohibited; any construction required official reporting and approval.	national
		North Song	General	The *Collected Statutes of the Song Dynasty* recognized private land ownership, and mandated clear accountability for local officials in managing public resources.	national
Local authorit-ies	Land Acquisition	South Song	Chaozhou West Lake	Lin Guangshi led the dredging of Chaozhou's West Lake. To secure the necessary land, he negotiated with the "powerful households" (*haohu*) who owned property within the lake's bounds. Through compensated transactions, specifically, purchasing the land "at its original price", he obtained the required space. The *haohu*, recognizing that the land's repurposing would enhance the lake's public function, complied willingly.	local
	Public Proclamations Functioning as Regulatory Instruments	North Song	Chaozhou West Lake	On Chaozhou West Lake Mountain, there are stone inscriptions declaring rules such as, "Firstly, do not damage houses, altars, or walls. Secondly, do not quarry stones from the mountainsides or create graves or burn corpses here. Thirdly, do not let cattle and horses run wild and trample on the paths."	local
	Review and Authorization of Technical Plans	Tang	Guilin Yin Mountain	Li Bo (the then administrative chief official)'s subordinates proposed excavating a plank road on the cliff face, constructing the Qingyun Pavilion on the summit of Yin Mountain, and building a place for wine-drinking gatherings at the entrance of Yin Mountain Cave. They submitted blueprints for these projects, and Li Bo gave his approval.	local
Central Govern-ment and Water (Infrastr-ucture) Manage-	Official Assessment	North Song	general	The "Regulations on the Advantages and Disadvantages of Farmland" (1069) and the "Four Virtues and Three Bests" (1089) criteria, which took the promotion of irrigation works, the cultivation of mulberry trees and silkworms, and the elimination of	national

ment Bureau				uncultivated land as assessment standards for prefectural and county magistrates, spurred irrigation construction nationwide. They also propelled large-scale irrigation projects in the Lingnan region during the Song Dynasty.	
	Public funding	South Song	Guilin Jingjiang Prefecture	When Li Zengbo undertook the reconstruction of the city wall and the dredging of the city moat, the project received fiscal transfers from the central government as well as financial allocations from the designated administrative bureau.	
Local authorit-ies	Public funding	South Song	Chaozhou West Lake	Lin Guangshi financed the dredging of Chaozhou West Lake to improve its hydraulic functions through the expropriation of civilian-owned land, with partial funding sourced from the prefectural fiscal funds.	local
Academ-ies	Donations and contributions		Leizhou West Lake	LML often housed official schools and academies.	local
Religious Instituti-ons			Duanzhou Star Lake	A number of Buddhist temples and Daoist shrines were constructed within LML.	local
Local Gentry and residents		North Song	Huizhou West Lake	Su Shi, his family, as well as the local residents, donated resources to construct a new bridge. This act highlights the participatory governance model of prefectural administration, where elites and commoners collaboratively enhanced public infrastructure.	local

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ANALYZING THE KEY INFLUENCING FACTORS OF URBAN BLUE SPACE ON MENTAL HEALTH: USING AI IMAGE SEMANTIC SEGMENTATION AND XGBOOST-SHAP APPROACHES

TOPIC: Guiding cities through what is alive: rainwater and water landscapes

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Keywords: blue space, mental health, machine learning, Yongding River

Abstract:

Many studies have shown that urban blue space significantly affects human mental health. Most of them used the linear modeling method to analyze data and explore the effects of blue space factors on human mental health. However, the traditional data analysis method makes it difficult to reveal the nonlinear effect of multidimensional environmental factors on mental health, and cannot quantify the relative importance of each factor as well.

In this study, we innovatively introduced a methodology that used AI semantic segmentation of street view images and XGBoost machine learning algorithm combined with SHAP interpretation framework to generate a landscape feature dataset covering the 16.5km urban section of Yongding River, Beijing. Based on the analysis of this dataset, we ranked and analyzed the relative importance of different blue space environmental factors on mental health.

AI constructed a landscape database of the Yongding River urban section integrating physical environment and functional evaluation through millimeter-level identification and extraction of blue space elements. The SHAP value showed that after controlling for self-selection bias, the influence factors of cultural identity (SHAP=0.1249) and facility entertainment (0.1117) had a greater impact on mental health than our traditional understanding of natural elements.

These results demonstrate that AI can realize the whole-area-real-time-quantitative collection of riverine waterfront landscape elements through multi-source perception technology, cracking the data barriers of large-scale riverine landscape research. Different from the traditional environmental determinism, the SHAP explanatory model demonstrates that the mental health benefits of blue spaces are significantly "human-led" by revealing the non-linear interaction between people and the environment, which suggests that the way people perceive and use the space (How) has more influence on their mental health than the physical attributes of the space (What), which suggests that the "human factor" is more influential than the "human factor" in the mental health of blue spaces. This shows that cultural factors have an important influence on people in the triadic coupling effect of "people-environment-culture".

1. Introduction

Recently, the ongoing progression of urbanization has rendered citizens' mental health difficulties increasingly salient, appearing as a pivotal concern

in public health. The World Health Organization (WHO) asserts that optimal mental health is fundamental to individual well-being and a crucial element in sustained social advancement. Simultaneously, the significance of urban settings in fostering mental health has garnered attention, with natural features like green spaces and blue spaces acknowledged for their beneficial impacts on stress reduction and the enhancement of subjective well-being[1].

Blue space, typically characterized as visible and accessible aquatic habitats and their adjacent areas in urban settings—such as rivers, lakes, and artificial water features—differentiates itself from green spaces through its fluidity, openness, and visual uniqueness. Research indicates that blue spaces provide significant health benefits for public well-being: (1) enhancing urban ecological conditions to alleviate pathological states, such as diminishing the urban heat island effect and lowering ambient temperatures[2,3]; and (2) improving subjective well-being by reducing psychological stress and promoting social interactions[4,5] An increasing number of medical studies suggest that coastal inhabitants often display fewer signs of mental discomfort and report greater life satisfaction than inland communities. Nonetheless, despite mounting research indicating the beneficial impacts of blue spaces on mental health, the fundamental mechanisms remain ambiguous, especially regarding public perception. There is still a deficiency in systematic study regarding the impact of blue spaces on mental health.

In recent years, Urban space and health research have integrated machine learning techniques as a powerful tool for investigating intricate nonlinear mechanisms. Model interpretability is a crucial aspect of machine and deep learning. Although intricate deep neural networks and ensemble models have superior prediction capabilities, their obscure decision-making procedures frequently classify them as "black boxes." SHAP (Shapley Additive exPlanations), which is based on game theory, provides clear explanations for the results of any machine learning model, helping to overcome the understanding challenges of black-box algorithms.

In this study, we examined the urban segment of the Yongding River in Beijing as the research object, utilizing AI-driven semantic segmentation of street-view pictures to create a comprehensive database of blue space components. We carefully looked at how different blue space features affect mental health in complex ways and assessed the nonlinear impact of each blue space components on mental health and its relative importance by using XGBoost and SHAP models. We aim to answer the following core question: Within the ternary relationship of "human - environment - culture", which blue space perception factors serve as key influencing factors of mental health?

2. Materials and Methods

2.1 Study area

This study takes the urban segment of the Yongding River in Beijing as the research object, which is one of the important surface water bodies in Beijing. The river segment traverses four urban districts of Beijing: Mentougou, Shijingshan, Fengtai, and Fangshan.The route commences from the Sanjiadian River Closure Gate in Mentougou District and concludes at the Xiaoyue Lake Pipeline in Fengtai District, spanning an approximate length of 16.5 kilometers. This river segment has several aquatic regions, including Menghu Lake, Lianshi Lake, Yuanbo Lake, Xiaoyue Lake, and Wanping Lake. Numerous urban parks are situated along the Yongding River, including Yongding River Park, Shougang Industrial Heritage Park, Yongding River Recreational Forest Park, Garden Expo Park, Lvdi Park, and Xiaoyue Country Park, in addition to various infrastructure amenities, including the Daning Reservoir. Moreover, numerous historical artifacts are located along the Yongding River, including the Lugou Bridge and Wanping City.Along the river, there are several blue space nodes including Lianshi Lake, Yuanbo Lake, and Xiaoyue Lake. These regions display both natural ecological features and human-functional qualities, rendering them emblematic of urban blue spaces. It combines natural ecology and humanistic functionality, and possesses typical urban blue space characteristics.

2.2 Data Collection

Street view image data: We used a methodology called "walking sampling + multi-angle photography" to collect environmental data from the perspective of spatial perception in this study. Sampling points were set up at the intervals of 200 meters. Images in the front, back, left and right directions were taken at each point. Eventually, the number of images obtained reached 820. The shooting height was uniformly set at 1.65 meters to replicate the perspective of the human eye.

Questionnaire survey data: The study utilized online surveys (via Wenjuanxing platform) and on-site research to gather subjective mental health assessments and individual attribute information. The questionnaire consisted of three sections: demographic information, perceived functional utilization of blue spaces, and self-assessed mental health. A total of 4,579 valid questionnaires were obtained, encompassing various demographic categories, including ages, genders, incomes, and educational backgrounds.

2.3 Construction of a Multidimensional Indicator System

Population Attributes:The psychological health consequences experienced may differ due to variations in physiological and social traits and behavioral choices among distinct groups. In current research on factors affecting mental health, demographic characteristics are frequently considered as contributing variables: ① Regarding individual characteristics, the elderly and adolescent demographics derive more significant mental health advantages from blue spaces[6], whereas women are more inclined to experience health benefits from strolling in these environments [7]. 2. Regarding social features, blue spaces exert a more significant influence on individuals with lower educational attainment. Gascon et al. [8] suggested in their research that how easy it is to access blue spaces greatly affects the depression levels of people with lower education; in terms of income, some researchers found that there is a negative relationship between residents' mental health and their family income levels.In conclusion, population features are considered a significant influencing factor in this study.

Physical environment:The physical environment refers to the explicit, objective and tangible attributes of the elemental physical environment of blue space, which is the material dimension in the ternary relationship of "human - environment - culture". The indicators represent the objective environmental conditions of aquatic environments. This study identified five physical environment features as indicators to clarify the association between public mental health and blue spaces, namely blue view index, green view index, naturalness, openness, and diversity.

Functional use:This dimension, situating between the physical environment and mental health, signifies intentional and selective human activities in blue spaces. We assessed the functional use indicators using the "landscape value" paradigm. Adjustments were made to accommodate the Yongding River's urban blue spaces based on a typological framework comprising 14 common functions (e.g., aesthetics, biodiversity, culture, economy, future, history, existence, environmental quality, learning, recreation, livelihood, spirituality, therapy, and wilderness).This study sought to preserve a maximum number of landscape value types to thoroughly encompass all functions of the area.

Initially, eleven categories were preserved: aesthetic, biodiversity, cultural, economic, future, historical, environmental quality, learning, recreational, livelihood, and wilderness. Three categories—existential, spiritual, and therapeutic—were omitted for the following reasons:

"Existence" denotes "the intrinsic value of a location solely due to its presence, irrespective of human perception or utility," while "spiritual" pertains to "a location deemed sacred by a community." During fieldwork, respondents frequently perceived these notions as challenging to comprehend or considered them uninteresting, so they rationalized their exclusion.

This research examines the mechanisms linking blue space and mental health, intentionally excluding therapeutic value to prevent overlap with the study's specific objectives. Furthermore, two new categories of landscape value were introduced: Safety: Considering the persistent flood hazards along the Yongding River, the capacity of its infrastructure to guarantee safety for local residents is a paramount concern. Social interaction is acknowledged as a crucial role of urban blue-green spaces, especially in promoting community participation. This study ultimately identified 13 forms of landscape value for the functional utilization dimension of the urban sector of the Yongding River.

Mental health:We used the WHO-5 Well-Being Index and empirical research to identify four components of internal emotional health, namely pleasure, tranquility, energy, and interest. Thereby we created a multidimensional variable table to assess the effects of blue spaces on mental health

Table 1. Multidimensional Factors Influencing Mental Health

Latent Variable	*Observed Variable*

Population Attributes	Gender
	Age
	Monthly Income
	Education Level
	Familiarity
	Residence Duration
Physical Environment	Green View Ratio
	Blue View Ratio
	Naturalness
	Spaciousness
	Diversity
Functional Use	Aesthetic
	Biological/biodiversity
	Cultural
	Economic
	Future
	History/heritage
	Life-sustaining/life-support/
	Environmental quality
	Learning/knowledge
	Recreational
	Subsistence
	Wilderness
	Social
	Safety
Mental Health	Pleasure
	Peacefulness
	Shelter
	Energy Restoration
	Interest/Fun
	Habitation Preference
	Exercise Intention
	Social Intention

2.4 Image Segmentation and Variable Extraction

The deep learning model DeepLabV3+ was employed to analyze street view photos for the extraction of quantifiable environmental factors. The AI system accurately identified 12 categories of blue space elements associated with human activities, including static water bodies, dynamic water flows, artificial wetlands, waterfront trails, waterfront vegetation, bridge structures, hydrophilic platforms, and reflective surfaces of riparian buildings. This tool can recognize 150 distinct landscape classes. The landscape components of the case study area within the urban segment of the Yongding River encompass 19 categories: vegetation, bare land, water bodies, sky, stones, mountains, roads, buildings, street lamps, walls, bridges, signboards, benches, trash cans, utility poles/towers, guardrails, vehicles, people, and undefined elements. Due to the absence of automobiles and individuals as permanent features of blue spaces, along with certain ambiguous labels primarily indicating recognition failures, the aforementioned three categories were omitted from the subsequent index computation, yielding a total of 16 landscapes. This study categorizes blue space elements into five variable categories based on the multi-dimensional variable table: blue view rate, green view rate, openness, naturalness, and diversity.

According to the multidimensional variable scale, the blue space elements are divided into the following five categories: blue view rate, green view rate, openness, naturalness and diversity.

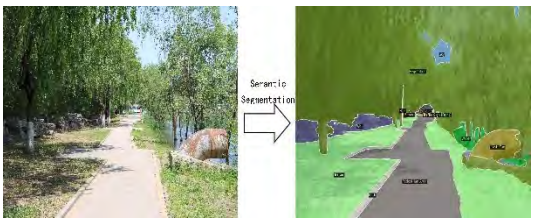


Figure 1. Write your figure caption here.

2.5 Methodology: XGBoost Regression

This study employed the eXtreme Gradient Boosting (XGBoost) regression model to discover nonlinear pathways. XGBoost is an ensemble learning method based on boosting, which provides benefits like robust anti-overfitting properties, elevated fault tolerance and expedited training. It appropriates for high-dimensional, multivariate data challenges. XGBoost has become a preferred instrument among data scientists and experts in several fields, celebrated for its outstanding predictive performance. We attribute its superiority to the integration of boosting approaches with significant flexibility, which makes it robust against various obstacles in predictive modeling XGBoost, which specializes in gradient boosting—a method that creates new decision trees to correct errors from prior trees—demonstrates exceptional capability in managing intricate data linkages and detecting nuanced trends, making it an ideal instrument for predictive modeling.

The research employed SHAP (Shapley Additive Explanations) to clarify the incremental contributions of variables to mental health scores in the XGBoost model. SHAP values, which come

from game theory, measure how much each variable helps predict results for individual cases, allowing us to understand the model's outputs both overall and for specific instances.SHAP values quantify the overall influence of features by assessing their marginal effects over all potential feature combinations, including main effects (alone contributions) and interaction effects (combined contributions with other features). The average SHAP value shows how important each feature is, and the relationship between SHAP values and feature values indicates whether the features help or hinder predictions: strong positive correlations mean the features help, while negative correlations mean they hold back. SHAP values provide a thorough understanding of the impact of features in models, making them an effective tool for deciphering intricate machine learning predictions.

3. Analysis and Results

We employed the frame-by-frame semantic segmentation of street-view images along the 16.5-kilometer river section to meticulously document intricate details of blue spaces at the physical structural level, encompassing water body types (e.g., static versus flowing water), waterfront facilities (e.g., docks, platforms), visual accessibility (e.g., unobstructed views, open waterfront pedestrians), and spatial connectivity (e.g., walkway network density, ease of access).

In the modeling process, the XGBoost algorithm used mental health assessment markers like anxiety levels, life satisfaction, and self-efficacy as the main factors to predict outcomes, while different aspects of blue space were used as the influencing factors. The model exhibited robust predictive efficacy.

The main findings indicate that cultural identity is the most significant geographical variable affecting mental health, with a SHAP value of 0.1249, which greatly exceeding those of conventional natural features such as the water body area or greenery. This finding indicates that citizens' acknowledgment of a blue space's historical importance, symbolic worth, and cultural affiliation significantly improves psychological resilience and social cohesion, which can alleviate worry and enhance happiness.

The recreational amenities ranked second among the spatial functional variables (SHAP = 0.1117), which highlights the behavioral incentives associated with blue spaces. Diverse amenities (e.g., jogging pathways, fishing locations, playgrounds, communal places) markedly enhanced resident participation and frequency of use, with these active behaviors intrinsically linked to improved mental health.

Although physical attributes, such as the blue view index, green view index, naturalness, and openness, significantly impacted mental health, their incremental contributions were very minor. This finding indicates that the spatial aesthetics and ecological quality are not the only factors influencing mental health. Their advantages typically necessitate human cognitive assessment and active engagement to be realized.

This finding challenged the conventional notion of "space-as-therapy" environmental determinism, emphasizing the initiative and proactiveness of space users in constructing the meaning of space.

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REIMAGINING THE STIEMERBEEK: A NEW COMMON

TOPIC: Guiding cities through what is alive: Rainwater and water landscapes

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Keywords: Water, Garden, Human and non-human, Ecological restoration, Climate resilience

Abstract

The course of a river is never merely a matter of hydrological flow; it reflects time, history, and culture, shaped by both nature and human agency. The case of the Stiemerbeek in Genk is no exception.

The Stiemerbeek flows through a valley long shaped by urban expansion and industrialization, notably the mining history that defined Genk's identity for much of the 20th century, where nature has often been relegated beneath the concrete, coal, and metal of human development. The river has been canalized, channeled, and altered, its natural course obscured by infrastructure. As these interventions have unfolded, the true memory of water—the risks, the relationships, and the vital presence of its force—has been lost. This project aims to restore that memory by reintroducing the creek as a living entity, while articulating places that foster a dialogue between the landscape and its inhabitants—both human and non-human.

At the heart of this transformation is the **parallel creek**, a new water system designed alongside the existing canalized Stiemer. This is not merely a technical addition but a reclamation of ecological processes long suppressed. The new creek and wet forest draw water from the surrounding valley through surface, seepage, and groundwater. This natural flow revitalizes the landscape, promoting biodiversity, water infiltration, and flood resilience. The creek is not just a passive infrastructure; it becomes a living organism, an ecological space where life flourishes, and water reasserts its presence. Here, we engage with water not as something to control but as something to live with.

Parallel to this new feature are the **linear gardens**, spaces where human activity and nature converge. A 'soft spine' connects them all: a new pedestrian and bicycle path that follows the Stiemerbeek and redefines the valley as one new "front" for the city, reversing its historical condition as a backside. Along this spine, the gardens are strategically placed and invite diverse forms of engagement. Each garden is conceived as a place for encounter— a pergola, a bench, a fireplace — simple elements that encourage appropriation, where people redefine their relationship with the landscape. In this way, the gardens are not fixed entities but evolving places that allow nature and water to be part of everyday life, in much the same way that a river's meandering path reshapes its course over time.
The gardens also echo the dynamic history of the valley, a site shaped by both industrial intervention and natural forces. The landscape itself becomes an archive, where the layers of the past—floods, drainage systems, protective infrastructures, and human settlements—are in constant dialogue with the future. These gardens act as living testimonies.

The Stiemerbeek project responds to the dual needs of hydro-ecological restoration and a cultural reawakening of a forgotten landscape. By giving the creek **space to restore** and **time to remember** the valley once again acts as a canvas upon which the rhythms of water, textures of soil, movements of people, and wildlife converge. Through this approach, the project offers a possible model for cities dealing with climate change — one that acknowledges the resilience of natural systems, fosters social connection, and reawakens the memory of water in the urban landscape.

Introduction: the valley that forgot it was a creek

> *"Accepting the situation" is about being at home in the world—that is, in the physical, material world. It is about making, more than healing; it is about celebrating everyday life, not the sublime; it is about living with contradictions in a fragmentary world, and abandoning any notion of an idealized nature, apart from man." [1]*

The course of a river is never merely a matter of hydrological flow; it reflects time, history, and culture, shaped by both the agency of nature and the interventions of human activity. The case of the Stiemerbeek in Genk is no exception.

The Stiemerbeek in Genk, Belgium, flows for about 8km through a valley once defined by wetland ecologies, then disrupted by coal mining, canalization, and urban expansion.

The story of this small creek is one of loss — of natural shape, of ecological rhythm, of civic presence — but also of slow remembering. It is a story embedded in layers of land use: once a coherent agricultural valley, where hayfields, pastures, and heathlands created a multifunctional landscape that supported rural economies and village life. Settlements developed along the valley slopes, with the valley floor forming a vital shared space—a living system of seasonal water, grazing, and cultivation.



Figure 1. The Stiemer today

Later on, for much of the 20th century, Genk expanded around extractive infrastructures: industrial zones and working-class neighborhoods aligned with mines, railways, and access roads. The Stiemer, once a soft-spoken lifeline, was buried during the 1960s, straightened, and reduced to a technical conduit. Programmed to evacuate water quickly, not to nourish places, it was enclosed in concrete and flanked by overflow collectors. During storms, sewage would spill into the brook, further severing its ecological function. Its invisibility became normalized, and its valley fragmented—interrupted by large-scale infrastructure and residual zoning.



Figure 2. Genk's landscape, as depicted by Emile Van Doren in De Bloei van de Gagel (ca. 1890).

As the mining era faded and Genk entered a post-industrial transition, the Stiemer Valley persisted—not as a common green space, but as a buffer zone: undervalued, degraded, yet quietly regenerating. Over time, nature crept back. Wet soils gave rise to alder carr forests; drier slopes to oak stands. Spontaneous rewilding unfolded across plots of unused land. Though unmanaged, these emergent ecologies gained intrinsic value—revealing the valley's quiet resilience.

Today, the Stiemervalley is undergoing a radical reimagination. No longer treated as residual land, it is being repurposed as a living laboratory—a water landscape where hydrological restoration is inseparable from cultural reawakening. Through design interventions such as the parallel creek and linear gardens (among others), Genk is composing a new civic language around water: one that values slowness over speed, dialogue over control, and presence over erasure. Reimagining the role of the Stiemer valley within the urban fabric reveals a latent potential: the valley could become a vital ecological corridor between De Maten and the

Hoge Kempen National Park, while also acting as thread connecting Genk's historic center, its neighborhoods, and new centralities such as Thor Park and C-mine, coherently with Genk's identity as a "raster city" [2].

At the heart of this transformation lie two intertwined threads. Water reclaimed as a living system, and gardens as spaces of encounter. Together they reveal how a forgotten valley can become a new commons—one shaped by experiments, time and care.

The parallel creek

"Quelque chose commença qui était déjà là" [3]

The Stiemerbeek, historically a meandering brook embedded in a wet valley system, had over time become a technical channel, primarily functioning as a collector of stormwater, wastewater and water pumped from the former mining zone of Waterschei. Heavy canalization, infrastructural interruptions, and ongoing combined sewer overflows left it ecologically inert and socially disconnected. As climate pressures intensified and the city's permeability declined, the limitations of the existing system became increasingly evident.

The parallel stream was born as both a critique and a counter-proposal: a soft, meandering, ecologically attuned creek that runs alongside the old Stiemer. This is not mere redundancy— it is restoration by re-invention. The curves of the new river interact with the straight line of the preserved historic canal.

Unlike the existing canal, the parallel creek draws clean water sources: surface runoff, seepage and groundwater flows. This choice was informed by detailed hydrological and soil analyses from fieldwork and site-specific ground mapping. The design introduces a sponge logic that slows, filters, and infiltrates water rather than simply evacuating it. This manifests physically through the development of new wetlands along the brook, most notably the formation of an emergent alder carr forest. These wetlands are rooted in areas of high groundwater and seepage and are designed to evolve gradually with minimal intervention, ensuring habitat complexity and long-term resilience.



Figure 3. The parallel stream

Such ecosystems are recognized for their role in improving water quality, supporting rare plant and animal species, and stabilizing microclimates. The introduction of native hydrophilic vegetation and the modulation of micro-topography (small ridges, hollows) support varied hydrological regimes—allowing for seasonal inundation, temporary pooling, and slow filtration.

In the design of the parallel stream conventional ideas of ecological 'stability' are being re-evaluated: disturbance — erosion, deposition, seasonal flooding — is not seen as a failure, but essential for ecological regeneration and the creation of native biodiversity . Recognizing this meant creating an *espace de liberté* [4] : a 30-meter-wide corridor within which riverine processes can establish themselves, allowing water, sediment, and animals to move freely—beyond rigid control or conflict with human uses.

In the case of the Stiemer, however, the relatively low flow and energy of the stream required a shift in the paradigm of design process. Rather than promoting active morphological shifts, the ecological strategy here privileges the safeguarding of existing vegetation structures already compatible with a wet alder carr forest. The parallel stream was embedded carefully within these zones of high conservation value —preserving moist woodland patches, seepage areas, and old meander relics.

The creation of the parallel stream it is not an isolated project, but a strategic component of long-term decentralization of Genk's stormwater system driven by a recently developed Water Action Plan. Sustainable urban drainage systems in surrounding neighborhoods, starting from Waterschei as the first pilot project, are now feeding into this new landscape. This reduces overflow loads, allows for seasonal inundation, and restores the natural delay time of water. Overflow hotspots are subject to phased mitigation, including backflow preventers and attenuation basins. This integration represents a city-wide hydrological rethink, where landscape is no longer the endpoint of infrastructure but the matrix through which it operates.

The design of the new stream not only addresses hydrological questions, but also allows the emergence of biodiverse-rich ecosystems.

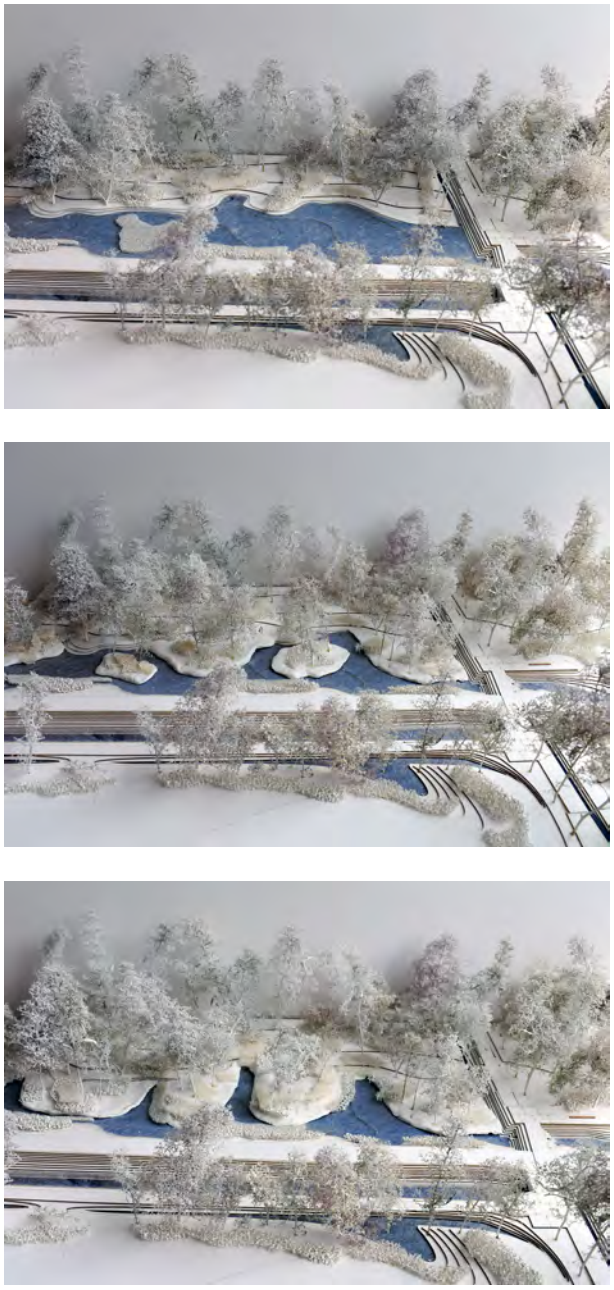


Figure 4. Study model of the parallel stream

A marsh creek, open and visibly meandering; an open flow-through marsh with dynamic water exchange; and a closed flow-through marsh, submerged and biodiverse. These types arise in response to variations in gradient, soil type, moisture levels, and groundwater dynamics.
Marsh creeks form along sandy or loamy soils where gently sloping banks support wet grasslands. Open flow-through marshes retain high water levels and feature riparian vegetation and patches of open water, attracting typical wetland wildlife. Closed flow-through marshes, such as alder carr woodlands, develop where seepage dominates, and are marked by dense canopies and a rich, layered undergrowth. Together they will form a living

corridor, rich in edge ecologies and habitats for the movement, shelter, and reproduction of insects, amphibians, birds, and small mammals. In effect, the creek becomes a corridor not only for water but for life. Typical species may include frogs, newts, damselflies, and dragonflies, while birds such as marsh warbler, bluethroat, and willow tit use these zones for feeding and nesting. Beavers, already present in the valley, will contribute by building dams and lodges, creating microhabitats and small wetlands that further enhance biodiversity and slow water flow.

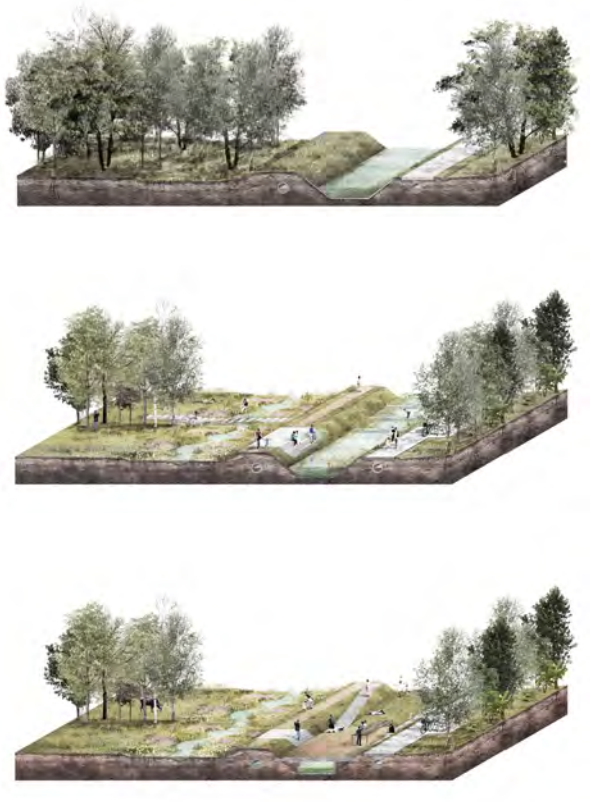


Figure 5. Axonometric views of the Stiemerbeek: existing condition (top), introduction of the parallel stream and bike path (middle), and transformation into a linear garden (bottom).

The creek is also a landscape of experience. Bridges, foot- and bikepaths, and informal gathering zones enable residents to see, hear, and smell clean water again. The reintroduction of hydrological and ecological rhythms transforms the perception of the valley. Where once the water moved only straight or out of sight, the visible rise and fall of levels in the parallel creek reintroduces time into the landscape. This time is no longer marked only by human use but by seasonal overflow, sediment deposits, the blooming and fading of riparian vegetation, and the presence and passage of wildlife. The old and new creeks now flow side by side — one as memory, the other as possibility.

Gardens of encounter

> *"... I like the idea of discrete, tactical operations over the clumsy "totality" of the master plan. I believe that the largest of territories can be irreducibly restructured through small, laconic interventions as opposed to the unbearable excess of everything - object, forms and materials." [5]*

If the existing canal and the new parallel stream structure the valley, the linear gardens activate it. They act as invitations: places where water, soil, and human presence meet. Their purpose is clear — to turn passage into presence.

Rooted in civic collaborations and temporary interventions already visible across the valley — from community walks to open-air classrooms and social gardens — the linear gardens extend a new grammar of use: modest, open, meaningful.
In that sense, the gardens embody not only a program but an attitude — one that opens the landscape to care, cohabitation, and encounter.

The gardens are negotiated territories: always becoming, always in relation. They are shaped as much by what grows as by what gathers. These gardens respond to the valley's fragmented perception: long treated as a backspace of Genk, invisible to many, crossed unknowingly by roads and paths. Woven into this transformation is a continuous pedestrian and bicycle path that follows the left bank of the creek — a soft spine that gently threads valley and city, offering a quiet but persistent line of connection.
Together, the linear gardens and the soft spine invite both informal inhabitation and everyday passage, restoring the valley's visibility — both physical and cultural — and redefining it as a new civic front for the city.

The placement of the linear gardens follows an intentional logic of restraint and reuse. Rather than expanding into untouched parts of the valley, the gardens are embedded within the existing footprint of the canal and the hard infrastructures already present along the stream — former maintenance paths, bridges/squares, and adjacent platforms.



Figure 6. The Stiemer valley masterplan

This careful siting limits ecological disturbance and guarantees the coexistence between public use and natural processes, recreational activities and the valley natural environment. The result is a clear spatial configuration in which the gardens and the soft spine together amplify the readability of the valley's structure — public life is guided, not scattered, ensuring that presence does not become pressure.

The reuse of the canal is not a gesture of preservation, but of reinvention. It acknowledges our shared "right to inherit" [6]. What we inherit are places already shaped by use, memory, and imagination. Working within these traces is a way of grounding contemporary life in a deeper continuity — one that (and it is fundamental) carries the responsibility of creating new qualities and values.

Read not as isolated interventions, the gardens do not impose a sequence; they respond to it. They are placed where the terrain offers a moment of openness, a shift. Their placement follows the latent logics of the site: the line of the canal, the platforms of service routes, the bridges that cross the creek. Each garden acts as a gate, yes, but also as thresholds — conditions of arrival, of pause, of passage. Their character is drawn from what surrounds them: a slope, a shadow, the presence of water or the rustle of trees. They work with what is already there. They do not ask to be visited, but invite one to stay.

There is a garden that looks. Perched on the northern edge of the valley, the terrace garden does not extend into the valley so much as lean toward it. Its benches and steps draw the body into a moment of recognition. From this point, the valley is not abstract—it is real, present.

Another garden listens. The yoga garden, near the old meanders. It is held lightly above the ground, a suspended wooden platform, a place more for being than doing. It is where silence gathers.

Some gardens engage the elements more directly. The water garden, located at the origin of the new stream, touches hydrology with playfulness. Shallow channels, a larger pool and shifting ground invite children to explore water. It is a garden of touch, of play.

Others nourish. The kitchen garden, with its community ovens and long tables, cultivates conviviality. Here, food becomes more than

function—it is language, memory, exchange. The scent of bread or roasted vegetables anchors the garden in the daily lives of nearby residents. A pizza oven and a tandoori oven stand side by side—quiet gestures toward the communities that have helped shape Genk's landscape: men and women who came to work in the mines and made the city their home.

And then, the shelter garden. A pavilion of raw concrete encircles a fireplace — a gesture both architectural and ancestral. The fire, at once tool and symbol, becomes the center of a shared moment. It warms, it illuminates, it draws people together even in winter's stillness.

At the far end, the pergola garden offers a different rhythm: linear, shaded, quiet. Where once cars passed on asphalt, now gravel crunches underfoot. The pergola marks time, filters light, carries scent. The pond reflects the sky, birds move through the reedbeds, and the city feels far.

Threaded through the valley, between one garden and the next, a series of small, deliberate interventions lend rhythm to the landscape. A bench beneath an old oak tree. A cluster of edible herbs at the path's edge. A thin cascade of water over concrete steps. A low aqueduct carrying flank water gently across. These are not landmarks, but cues — subtle traces that shape how one moves, where one lingers, when one notices. These elements do not speak loudly. They wait. They accompany.

Together, gardens and small elements scattered in the valley offer tactile, sensorial experiences. As one moves through these gardens, the rhythm shifts. Some are narrow and linear, like threads pulling toward the creek. Others open up into wider clearings where children can play and neighbors rest. The proximity to water always matters. From the garden, one can hear the creek, watch the reeds move in the wind, trace the reflection of the sky in seasonal pools. In certain moments, the sound of water becomes a backdrop; in others, it demands attention. Reflections glimmer briefly across shallow pools. Water becomes a moving edge, a shifting mirror, a presence that anchors the senses. This nearness allows for a quit form of emotional attachment to grow — "a catalyst of affection" [7] — an attachment not only to a park or bench, but to a valley as a shared landscape.



Figure 7. The shelter-garden

Emerging from complementary strategies of social programming, the linear gardens are evolving commons. The design is not static but open-ended. This openness is what grants these spaces their strength. They offer the slower intimacy of everyday use. Shaped as much by what people bring to them as by what they offer, the gardens become extensions of daily life. A bench becomes a meeting place. A pergola a shaded classroom. A slope a stage for informal gathering.

The architectural interventions are elementary. The materials used are modest — gravel, timber, concrete, water, vegetation. This restraint is deliberate, not reductive — an economy that seeks to clarify rather than distract. Structures are slight, yet precise: a deck hovers just above ground, a slab

reaches toward the creek, a steel profile carries water with minimal intervention, a square pavilion offers shelter from the rain. They try to carry a sense of quit precision, aiming to frame, support, and enable life. What results is not a singular design, but a possible new condition of inhabiting the valley. A space that is at once modest and layered. Grounded in presence, and open to change.

Space to restore, time to remember

The transformation of the Stiemer valley is not a return to an untouched past but an act of reading and interpretation — an attempt to work with what endures, while opening space for what might emerge.

Drawing on the layered logics of what exists on the site, the Stiemer is given space to restore and time to remember itself. Here, hydrological systems engage with civic life, gardens invite informal use, and infrastructure supports new forms of encounter.

The reactivation of the parallel creek reclaims natural rhythms; the linear gardens recompose social proximity. Together, they contribute to a broader understanding of designing — one in which reading the landscape becomes a way of imagining the city.

This is all part of learning to live with water. Not to control or mimic nature, but to engage with it — thoughtfully, attentively. The Stiemer shows how even a small creek in a post-industrial city can pulse with new meaning.

This is not a definitive model, but one possible way of working. A step, among many others, to guide a city through what is alive. Meaning restoring its capacity for conflicts and relations: to others, to place, to time, to the slow insistence of water.



Figure 8. Design study model, on site



Figure 9. Image series showing the gardens along the valley: the lived space (left) and the constructed space (right). From top to bottom: the bridge leading to the yoga platform, the water garden, the kitchen garden, and the floating path.

Acknowledgments
This article draws on the collective work undertaken within the framework of the Stiemerbeek project, from masterplan to pilot project. I wish to acknowledge my colleagues at Tractebel, Bart Van Gassen and Mark Wilschut, for their commitment and contributions throughout the project's development and various phases. I am also deeply grateful to Georges Descombes, whose involvement has been both an honour and a continual intellectual provocation and source of insight — his critical engagement consistently pushed the project toward greater conceptual and design clarity. Finally, I extend sincere thanks to Genk City and its public servants. Despite some difficulties along the process, our collaboration proved to be productive and grounded in a shared commitment to the project.

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THE GUADALMEDINA IN MALAGA

TOPIC: Through what is alive (ecosystems, rainwater, soil, rivers) Rainwater and water landscapes

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Keywords: Sustainable drainage, Water systems, Ecological structure, City image, River

Abstract

The city of Málaga is divided by the Guadalmedina River, which for most of the year exists as a dry concrete channel. For approximately 350 days annually, the river remains dry, with water flow occurring only on rare occasions. The phenomenon known as *riadas*—sudden, intense floods—typically happens once or twice a year, completely filling the channel. One such event occurred in November 2024.

Originally designed in the 1970s, the channel no longer meets the needs of a city that has undergone substantial transformation over the past two decades. Although the 2011 PGOU (General Urban Planning Plan of Málaga) [1] introduced a special plan for the Guadalmedina River, it has yet to be fully implemented. In December 2024, the current administration launched a design competition (with submissions open from January to March 2025), aimed at providing shade for the river's central section. The competition's stated objectives include maximizing urban land use, encouraging gentrification, and concealing the river's natural features beneath hardscaped plazas.

In contrast, ArquitectonicaGEO de Europa SLU, in collaboration with Estudio Seguí Architects and other professionals, has proposed an alternative intervention focused on expanding green spaces and enhancing water connectivity across multiple scales. This vision aims to reimagine the river channel as a vibrant natural feature through landscape integration and revegetation. The project envisions a continuous green corridor linking Málaga's park system, the coastal promenade, the Jardín Botánico-Histórico La Concepción, and the Limonero Reservoir—potentially making it one of the city's most significant urban elements. This initiative aligns with the PGOU's special plan and prioritizes sustainability, climate change mitigation, and nature-inspired design strategies.

Rooted in principles of biomimicry and Nature-Based Solutions (NBS), the proposal embraces a nature-led approach that informs every aspect of the spatial experience. It integrates urban connectivity and systemic thinking while remaining respectful of the site's cultural and environmental contexts. The design is structured around three main goals: expanding Málaga's green infrastructure, enabling water storage within the city, and fostering community engagement around the Guadalmedina River.

This green corridor has the potential to transform the city's landscape, support diverse modes of mobility, and promote ecological biodiversity. Additionally, blue infrastructure elements and Sustainable Urban Drainage Systems (SUDS) would enable water capture and storage during dry periods, providing essential irrigation throughout the summer and autumn months. Rather than allowing this vital resource to be lost, Málaga could begin to conserve and reuse it efficiently.

Ultimately, the project aims to address both urban systems and natural processes. By fostering synergy between these realms, the proposal envisions the Guadalmedina River as a unifying element for the city—one that honors its heritage, restores its ecological value, and strengthens the social fabric of Málaga.

1. Introduction

ArquitectonicaGEO brings extensive experience in managing green and blue infrastructure, as well as implementing Nature-Based Solutions (NBS), particularly in urban contexts such as Miami. As Spear notes [2], the firm has successfully applied these approaches in real-world projects, including the development of Canopy Park—an exemplary case where sustainable urban design and ecological principles were fully integrated. These practical applications have contributed to meaningful advances in local building codes and urban development policies, demonstrating how landscape architecture can drive systemic change at the municipal level.

The methodology of the proposal is rooted in a comprehensive understanding of ecological systems and urban dynamics. It emphasizes not only technical feasibility but also the capacity of landscape design to influence regulatory frameworks, improve quality of life, and foster environmental resilience. The proposal employs an interdisciplinary approach that integrates ecological planning, water-sensitive design, and community engagement.

The discussion centers on the outcome of the design competition, contrasting the prevailing political agenda with interventions that deliver genuine, long-term impacts. While the official competition brief emphasizes economic capitalization and aesthetic transformation through hardscaping, the proposed green corridor prioritizes environmental restoration, social inclusiveness, and climate adaptation. This divergence highlights the tension between politically driven urban development and ecologically informed, sustainable design practices.

Ultimately, the project advocates for a shift in how cities like Málaga approach their natural resources—not as obstacles to be concealed, but as assets to be celebrated, restored, and integrated into the urban fabric.

2. Material and method: Greener Malaga

Case Study: Málaga, Spain

Málaga, located on the Costa del Sol, is a Mediterranean city in southern Spain with a semi-arid climate and highly irregular rainfall. Water typically arrives during just two periods each year, often through intense storms known as *riadas*. These events are currently treated as problematic, with excess water rapidly diverted rather than utilized as a valuable resource.

Over the past five years, drought has become increasingly severe. In November 2024, for example, extreme rainfall caused major flooding in Valencia and, to a lesser degree, in Málaga. Despite such challenges, the city holds significant potential to become greener and more resilient by adopting the Water Sensitive City framework [3].

This approach promotes integrated water management that views stormwater as a resource to be stored, reused, and reintegrated into the urban landscape. By implementing Nature-Based Solutions and sustainable drainage systems, Málaga can transition toward a regenerative urban model—enhancing ecological health, improving quality of life, and increasing climate resilience.

2.1. Green and Blue Ecological Structure

Integrating the Guadalmedina riverbed into the urban fabric presents a unique opportunity to create a continuous green corridor, similar in scale and function to Málaga Park. The proposal envisions a "green linear landscape" along the riverbanks, fostering sustainability, climate adaptation, and environmental innovation.

The Guadalmedina has the potential to become the city's main green and blue axis—a structural spine that connects and organizes the surrounding urban context. As shown in Figure 1, this green network can link key areas, unify the built and natural environments while enhancing spatial continuity and ecological function.

The initiative seeks to connect the riverbed with nearby neighborhoods, public spaces, and the city's transportation systems. In doing so, it transforms an underutilized channel into a multifunctional public space that supports both ecological health and social well-being.

To fully realize this opportunity, the project emphasizes expanding and linking green areas across the city, while increasing the share of permeable surfaces to support water absorption, reduce heat, and enhance urban resilience. This integrated green and blue infrastructure strategy supports Málaga's shift toward a more sustainable, climate-adapted urban future.



Figure 1. Green and blue axis structure.

2.2. Patterns and Biomimicry: Historic form of the Guadalmedina

Historically, the Guadalmedina River exhibited a natural meandering form, as evidenced in historical cartography, for example, the 1717 map shown in Figure 2. This earlier morphology reflects a more organic relationship between the river and its surrounding landscape, prior to its current engineered and channelized state.

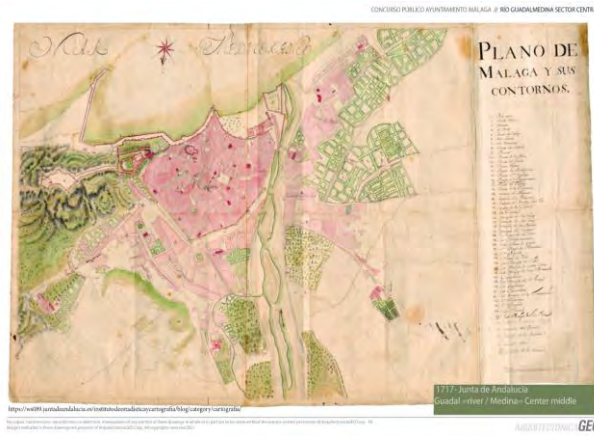


Figure 2. Malaga Map 1717.

Drawing on the work of Alexander [4] (1977), Benyus [5] (2009), and Bell [6], this project embraces the idea that natural forms offer inherent benefits using patterns, biomimicry, and systems thinking. These benefits extend across various dimensions, including scale, shape, movement, texture, processes, and cycles. The methodological approach for the conceptual design was rooted in analyzing and applying the natural patterns of the Guadalmedina River.

In this context, the meandering form of the river serves as the guiding principle for the design process. This approach informs not only the spatial layout and geometry of the proposal but also integrates key characteristics of the river's natural behavior. The project recognizes and responds to the varied typologies and dynamics of the river system, including the types of vegetation, textures, the water cycle, drainage systems, and the enhancement of pervious surfaces. The design seeks to replicate these natural processes, reinforcing the ecological balance and promoting greater resilience.

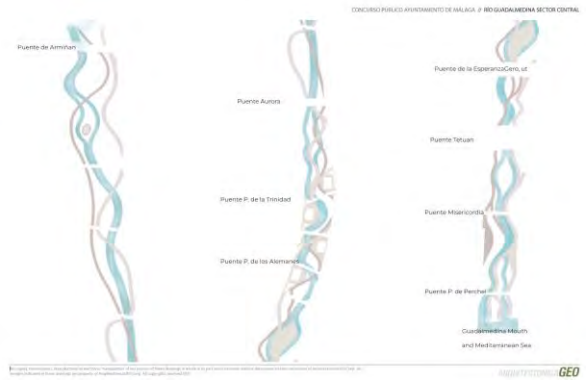


Figure 3. Meandering design

In Figure 3, we observe the incorporation of the meandering form, which is adapted to suit the various programs required for this public space.

2.3. Native seeds

The proposal envisions a "chromatic vegetal tapestry" composed of native plants, creating a green space that is both visually appealing and resilient to flooding. The design features scenic riverside trails with photoluminescent pavements and integrated rainwater management systems. These elements ensure the riverbed's functionality while enhancing its aesthetics.

This innovative intervention focuses on underutilized native vegetation, selected for its landscape potential. The result is a striking palette of seasonal colors and textures. A chromatic study of both vegetation and walkway materials is proposed to reflect seasonal changes. It is essential that selected materials and plants not only enhance aesthetics but also withstand the region's climate and fluctuating water levels. Durable, water-resistant vegetation and materials are prioritized to improve the landscape without compromising hydraulic safety. The aim is to promote diversity in the Mediterranean landscape, where both concentration and variation can coexist [7]. The project proposes "Garden Walks" along the riverbanks to strengthen connections between urban areas on both sides. These walks will help naturalize the river's image, offering access points and welcoming public spaces. Shade trees of various types will be planted along the garden paths to offer relief from the sun and Sustainable Urban

Drainage Systems (SUDS) will be used to manage rainwater and reduce flooding. Additionally, technological solutions—such as energy-generating pathways—will support improved urban mobility. The riverbed's design is based on a linear, spatially continuous approach. The "Garden Walks" will contribute to the river's ecological and urban renewal, while a riparian forest along these promenades will further enhance the site's ecological value.

3. Proposed Result: Storing water

In this green and blue infrastructure, the water that flows twice a year should be embraced, stored, and utilized throughout the year, particularly during the prolonged periods of drought. Stormwater management must be approached with a long-term strategy, ensuring that water is captured and efficiently used even in the driest seasons.

3.1. Hydraulic constraints

The study area presents significant limitations in terms of hydraulic drainage capacity along the urban stretch of the Guadalmedina River, with the narrowest point located at Puente de los Alemanes, measuring only 33 meters in width.

The proposed interventions in the competition include slope regularization downstream of Puente de Armiñán to provide sufficient clearance for removing urban barriers, such as the walls near Puente de la Aurora. The removal of these obstacles, combined with the creation of a low-flow channel, results in a rectangular cross-section that must be maintained all the way to the river's mouth.

The projected roughness downstream of Puente de Armiñán is designed to correspond to smooth riverbeds (n = 0.025), whether fixed or mobile, ensuring the river's hydraulic efficiency.

3.2. Blue Infrastructure

The Guadalmedina River plays a well-established role as both a drainage channel and a flood mitigation measure. Flood risk has been effectively managed through the construction of the Limonero Dam, which regulates water flow without allowing excessive accumulation. This approach facilitates the integration of the riverbed into the urban landscape, managed through tools such as civil protection plans, thereby improving the relationship between the city and the river.

This aspect is essential for strengthening the connection between the urban environment and the river, enabling the seamless integration of natural and built elements. It also enhances the potential for creating vibrant urban spaces along the Guadalmedina River, thereby contributing to the overall resilience of the city.



Figure 4. Meandering design Guadalmedina river

- The proposed design complies with the required conditions to ensure the hydraulic capacity of the study area. By replacing partially covered sections with intermediate piers—positioned at one-third and two-thirds of the riverbed width—and adopting an open-channel approach with obstacle removal, the proposal maintains hydraulic performance and increases the safety margin against potential flooding.
- The use of cantilevered structures and pedestrian walkways eliminates the need for most structural elements within the riverbed, ensuring full compliance with drainage regulation 5.2 – IC, as specified in the competition guidelines.
- The inclusion of viewpoint piers at designated locations adheres to the competition parameters, maintaining a minimum clearance of one-third of the riverbed width from the retaining walls to preserve hydraulic flow.
- Perforated prefabricated concrete panels, or similar materials, are proposed to support vegetation growth. During flood events, high water velocities would naturally remove the vegetation, exposing a smooth underlying surface. This ensures that the riverbed roughness remains consistent with the characteristics of smooth channels during extreme flow conditions.

As such, the submitted proposal guarantees the hydraulic capacity outlined in the competition guidelines, while allowing flexibility for refinement of specific elements and materials during the preliminary design phase.

3.3. NBS and SUDS

This green and blue infrastructure strategy is reinforced through the implementation of Nature-Based Solutions (NBS), as demonstrated by the incorporation of pervious pavements, rain gardens, green roofs or elevated green spaces, and bioretention systems [8]. These elements align with what Cahill refers to as Low Impact Development strategies [9].

The design features "River Pathways" that integrate drainage and water retention systems—specifically Sustainable Urban Drainage Systems (SUDS)—to create a more resilient and sustainable urban environment. This holistic approach to water management promotes plant biodiversity, ecological restoration, and positions the project as a reference for green infrastructure within the city. It aims not only to improve environmental quality but also to enhance the overall well-being of residents.

One of the key interventions is the use of underground "storage cisterns," which support localized water absorption. These systems reduce flood risks and alleviate pressure on the municipal sewage network. For example, the CAC Plaza includes rainwater harvesting infrastructure, illustrated in Figure 5, which presents a schematic diagram of the functional system proposed for this portion of the project.

These water retention and drainage systems are designed to temporarily store rainwater for later use in irrigation or to allow infiltration into the soil, enhancing water efficiency across the site. In addition, the project incorporates recycled materials in the construction of permeable pavements. These eco-friendly surfaces are engineered to withstand major water surges and have a projected lifespan exceeding 50 years.

By integrating SUDS features such as rain gardens, cisterns, and permeable materials, the proposal not only conserves water but also supports the long-term maintenance and vitality of green areas across the Guadalmedina River corridor.

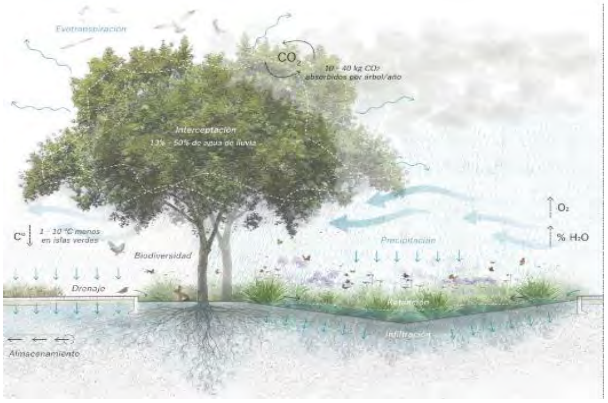


Figure 5. Harvesting water in the CAC plaza and SUDS

Climate Change Adaptation

The proposed drainage system contributes to climate change adaptation by mitigating the urban heat island effect in the areas surrounding the Guadalmedina River. Additionally, it enhances the city's capacity to respond to extreme weather events—such as heavy rainfall and flooding—thereby improving overall urban resilience.

The application of Nature-Based Solutions (NBS) demonstrates benefits in two critical climate scenarios: during heatwaves and in flood events. As highlighted by Majidi (2019) [8], various case studies have shown that NBS can significantly lower temperatures and manage excess water more effectively through natural processes. By integrating vegetation, permeable surfaces, and sustainable drainage systems, the proposal adopts a holistic and adaptive approach that aligns with contemporary climate resilience strategies.

4. Unifying social and physical space

The proposal aims to reestablish the relationship between the river and the city by reimagining its banks as transitional spaces that connect both sides and enhance accessibility—without compromising the river's hydraulic function. The goal is to create a valuable public space for collective use, enriching urban life and fostering community engagement.

4.1. Biodiversity

The Montes de Málaga and the Guadalhorce River surround the urban area, and the biodiversity present in these natural systems can be integrated into the proposed green and blue infrastructure. Currently, activities such as birdwatching and trekking are already promoted at the mouth of the Guadalhorce River. Embracing and connecting these natural areas with the city enhances public awareness and engagement with local biodiversity. Figure 6 illustrates the potential of these ecological corridors

to enrich both recreational and environmental value within the urban landscape.

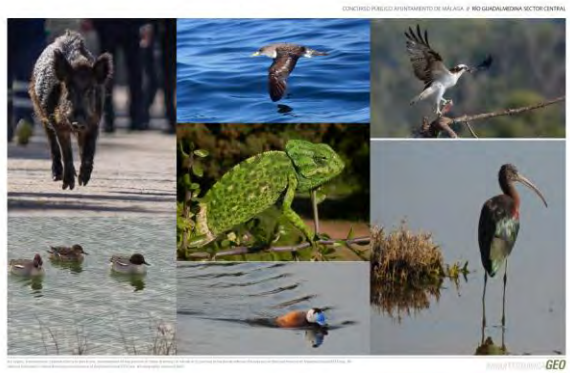


Figure 6. Biodiversity in the area

4.2. Physical connection with water and the activities

The proposal seeks to strengthen the connection between the riverbanks and the surrounding urban fabric. Central to this vision is the creation of "Bridge-Walkways," which integrate the river's green corridor with adjacent neighborhoods, improving accessibility and continuity across the city. The plan also suggests a reorganization of key sections along the river:

- **Section 1: From Puente del Perchel to Puente de la Esperanza** – This stretch will feature a landscaped area with tiered seating, providing direct access to the river and creating a flexible public space for gatherings, cultural events, and outdoor performances.
- **Section 2: From Puente de la Esperanza to Puente de la Aurora** – Enhancements to pedestrian infrastructure include the construction of new bridges to improve cross-river connectivity, facilitating movement and strengthening integration with the urban environment.
- **Section 3: From Puente de la Aurora to Puente de Armiñán** – Covered sections will be replaced with "Park-Bridges," which preserve the river's visibility and continuity while respecting hydraulic requirements. These structures allow for public use without compromising flood resilience.

At the upper urban levels of the riverbed, interventions aim to "stitch" the city's edges together by reinforcing existing landmarks and aligning street grids. Strategically placed pedestrian bridges will promote urban cohesion, improve mobility, and enhance the river's role as a unifying public space.

5. Discussion

The political approach plays a vital role in advancing the city's development, particularly in areas such as public health, quality of life, ecological awareness, and urban water management. To facilitate this progress, it is essential to update relevant codes and regulations. The competition organized by the City of Málaga should consider the current framework, while embracing best practices, social engagement, and local context.

It is crucial to align contemporary challenges, such as climate change, sustainability, and ecological preservation. Rather than focusing solely on economic-driven hardscaping, the approach should be inclusive, sustainable, and aimed at delivering environmental benefits for the people who live in and experience this space.

6. Conclusion

In summary, the project adopts a sustainable approach while emphasizing resilience to climate change and the enhancement of the urban environment. Its execution and ongoing maintenance rely on innovative and efficient solutions that ensure both long-term viability and success.

Change is a collective process, involving collaboration among public authorities, private entities, social communities, and education on the subject.

About ArquitectonicaGEO

ArquitectonicaGEO is a landscape architecture firm founded 20 years ago to create resilient, sustainable environments that connect people with nature while addressing climate change and biodiversity loss. From the start, GEO has promoted green infrastructure, native planting, and the fusion of landscape, art, and architecture.
Known for transformative projects in Miami and beyond, GEO designs adaptive, innovative landscapes that support well-being and urban resilience. Their work underscores landscape architecture's vital role in uniting people, places, and nature within the built environment.
Guided by sustainability and resilience, GEO creates timeless, functional spaces that respond to rising seas, climate challenges, and biodiversity restoration—while enriching human experience. The pandemic has only deepened the urgency of accessible green spaces as a foundation for a healthier, more sustainable world.

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BRIDGING THE GAP: INDUSTRIAL LANDSCAPES AS A TOOL FOR RIVER ENGAGEMENT

TOPIC: Guiding cities through what is alive: Rainwater and water landscapes

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Abstract

In 2002, Gilles Clément introduced the concept of the "Third Landscape," highlighting the potential of post-industrial sites to enhance biodiversity while preserving their cultural and historical significance, in line with UNESCO's definition of cultural landscapes. Beyond their ecological and cultural values, these spaces can reconnect communities with their neglected or polluted rivers, increase public access, and contribute to flood mitigation.
Historically, water played a crucial role in industrial development, powering machines, transporting goods, and serving as a vital resource. However, industrial expansion often reshaped waterfronts, limiting public access and polluting water sources. Despite this, water remains a central force in shaping cultural landscapes, playing a significant role in both climate resilience and heritage preservation.
This presentation explores post-industrial sites, which are often fragmented and underutilized, along urban waterways as strategic opportunities for landscape connectivity, ecological restoration, and urban resilience. Adaptive reuse integrates historical structures into contemporary urban contexts, fostering a sense of place and cultural continuity. Converting these spaces into flood retention zones, wetlands, or permeable landscapes helps reduce runoff, mitigate flood risks, and support climate adaptation. These interventions not only improve river health but also create inviting public spaces that strengthen human connections to water.
The James River in Richmond, Virginia (USA) serves as a case study. Once central to industry, commerce, and recreation, its banks now contain underutilized post-industrial sites. Redevelopment efforts have frequently prioritized real estate interests and rigid flood-control measure over more resilient, integrated approaches. By connecting key post-industrial sites along the river into a cohesive system and emphasizing landscape adaptation over time, the authors propose an alternative vision for the James River in Richmond. This vision integrates these sites into a broader urban strategy that enhances the river as a unique ecological corridor while fostering transformative riverine processes that intertwine the physical landscape with its inhabitants. This adaptive strategy seeks to mitigate urban flooding, while balancing ecological restoration with cultural memory, positioning water as both a medium of resilience and as catalyst for public engagement.

In this way, post-industrial landscapes can be transformed into powerful tools for reconnecting people to rivers, fostering resilience, ecological health, and a renewed public connection to the waterways that shaped their history.

1.Introduction

Post-industrial landscapes, often situated along rivers and former infrastructural corridors, represent a critical interface between cultural memory, ecological regeneration, and community resilience. Historically shaped by extraction, manufacturing, and logistical flows, these sites are imbued with material and symbolic layers that continue to influence the identity of local communities long after their economic functions have ceased [1]. The latent potential of these derelict spaces lies not only in their industrial remnants but also in their capacity to serve as ecological refuges and catalysts for urban renewal.

In 2002, Gilles Clément introduced the concept of the "Third Landscape" to describe unmanaged or residual spaces, such as abandoned railways, brownfields, and fallow lands that escape conventional forms of control and planning [2]. These areas, he argued, provide essential habitats for biodiversity while acting as cultural archives. The Third Landscape thus invites a re-evaluation of marginal spaces, recognizing their hybrid role as both ecological reservoirs and memory-laden terrains.

More recently, the adaptive reuse of post-industrial sites has been explored for its capacity to foster reconnection with urban rivers, which have long been marginalized, polluted, or rendered inaccessible by industrialization. Reconfiguring these sites as public spaces can help cities restore ecological functions, such as riparian habitats and flood mitigation, while also enhancing social equity through improved access and recreational opportunities [3]. This integrative approach repositions post-industrial landscapes not merely as relics of the past, but as active agents in bridging fragmented urban ecologies and disconnected communities.

II. Goals, Objectives and Methods

To address the issues outlined above, this study adopts a case study approach focusing on the urban section of the James River in Richmond, Virginia, characterized by decommissioned industrial areas. It explores how these landscapes can be transformed into strategic spaces for river engagement and climate adaptation.

The Background and Case Study section contextualizes the challenges of post-industrial riverfronts through the lens of Richmond's James River, analyzing its industrial legacy, ecological vulnerabilities, and the limitations of current planning frameworks. It identifies both spatial gaps and opportunities for adaptive reuse. The Results section presents a strategic proposal for the southern riverfront that repurposes industrial parcels as multi-functional green infrastructure, combining flood mitigation, wetland restoration, and public access. The Discussion and Conclusion section reflects on how such adaptive reuse can integrate historical remnants into living systems, supporting climate resilience, cultural continuity, and create engaging public spaces that reconnect communities with water.

III. Background and Case Study

The term post-industrial encompasses a wide range of productive structures and polluted landscapes, from abandoned factories to quarries and other derelict sites along rivers [4]. These decommissioned industrial areas are increasingly recognized for their cultural significance and heritage value [5].

The redevelopment of these sites has become a prevalent urban strategy, responding to population growth and market-driven imperatives by promoting real estate and commercial initiatives. Frequently, these projects incorporate aestheticized green spaces intended to beautify, secure, and activate urban areas. However, such interventions often fall into the logic of "greenwashing," wherein ecological narratives obscure the erasure of historical traces and contribute to green gentrification and socio-spatial displacement.

In contrast, post-industrial sites hold strategic potential for addressing the fragmentation of contemporary landscapes driven by urbanization and infrastructure. Although often perceived as "gaps" within the territorial fabric, these areas can instead be reimagined as latent resources for ecological restoration, spatial integration, and socio-environmental regeneration [6]. Their peripheral conditions offer critical opportunities for implementing integrative landscape approaches and may serve as connective tissue within broader ecological and social networks.

Historically, water has been a foundational element of industrial development. It functioned as a source of power, a component in manufacturing processes,

and a medium for the transport of goods. Rivers and canals underpinned the spatial logic of industrial expansion, fostering a deeply interdependent relationship between water and industry. Industry not only depended on water; it also appropriated adjacent land to harness its power. Consequently, extensive segments of riverfronts were claimed, reorganized, and transformed into industrial estates. The river's edge became industrial ground. Despite this, water remains a central force in shaping cultural landscapes, playing a significant role in both climate resilience and heritage preservation [7].

A salient example is the urban stretch of the James River in Richmond. Once vital to industry, commerce, and recreation, its banks are now dotted with underutilized post-industrial sites. Recent redevelopment efforts have often prioritized real estate value over resilience, relying heavily on rigid flood-control infrastructure rather than adaptive or integrative approaches.

III.1 Flowing Histories: The James River's Industrial Past and Ecological Futures

The James River, Virginia's largest waterway, spans the state and provides drinking water to one-third of its residents. While historically impacted by pollution, the river's ecological health has steadily improved due to extensive restoration and resilience initiatives such as riparian buffer installations and shoreline management.

Beyond its ecological role, the James River has long served as a driver of cultural and economic development. It was a transportation corridor and power source for early industries, including grist mills, hydroelectric systems, and colonial-era tobacco trade. During the 19th and early 20th centuries, Richmond became a global center for tobacco production, with a dense complex of factories and warehouses along the river. This industrial heritage remains visible in sites like the Manchester neighborhood, Fulton Gas Works, and the Southern States silos, as well as along the historic 2-kilometer Canal Walk.

However, the river's benefits have long been coupled with risks. Flooding has played a defining role in shaping Richmond's relationship with the James River. Catastrophic flood events, such as those caused by Hurricane Camille in 1969, exposed the city's vulnerability and prompted significant infrastructural responses. Most emblematic is the floodwall completed in 1995, which now acts as both a physical barrier and a symbol of Richmond's evolving climate adaptation. While the wall protects urban development, it also reveals tensions between ecological systems and engineered solutions.



Figure 1: Floodwalls and industrial areas within the James River's 50 and 70 year floodplain by NOAA. (drawings by C. Bonura)

III.2 Richmond Riverfront Plan and the James River Park System: One Green Corridor, Interrupted by Industrial Gaps

To preserve riverfront heritage, enhance public recreation, and mitigate flood risks, the City of Richmond launched two major initiatives: the Richmond Riverfront Plan (RRP) in 2012 [7] and the James River Park System (JRPS) Master Plan in 2019 [8]. While distinct in scope, both plans envision the James River as a unifying landscape element.



Figure 2: The Richmond Riverfront Plan (RRP) indicating industrial areas for future development.

The RRP, developed as part of the City's Master and Downtown Plans (2009), proposes a cohesive riverfront system, a "great, wet Central Park", that integrates natural, cultural, and recreational assets while protecting key viewsheds [7]. It outlines

actions and priorities for various riverfront sections to link existing green spaces into a unified network.

Building on this vision, the JRPS Master Plan, developed by VHB and Hargreaves Associates, addresses the 600-acre linear park system. It proposes strategies for trail connectivity, river recreation, natural resource protection, improved access, and repurposing underused sites [8]. It also anticipates sea level rise, projecting 45 cm by 2050, 91 cm by 2080, and 130 cm by 2100, and references the 100- and 500-year floodplains.



Figure 3: The James River Park System (JRPS) map

Despite their ambitions, both plans leave unresolved gaps, particularly where disused industrial parcels disrupt the green corridor. Sites like the Southern States Silos (1957) and Fulton Gas Works (1856–1972) face demolition rather than adaptive reuse, despite their cultural value. JRPS aims to preserve a "wilderness" character, treating remnants and ruins as *objets trouvés* in a rewilded setting.

Although both plans advocate future park expansion via land acquisition, neither offers a coherent framework for adapting industrial parcels into ecologically functional and culturally resonant public spaces. Especially on the southern riverfront, where industrial activity is set to decline, these areas offer critical opportunities for integration into the city's green vision through strategies that favor 'green buffers' over intensified urbanization. Community concerns about overdevelopment, the loss of cultural landmarks, and the privatization of riverfront access further underline the urgency of inclusive and adaptive planning.

Without a reintegration framework, these dismissed industrial areas remain unresolved interruptions in an otherwise continuous green corridor, threatening the city's ability to connect its industrial past with its ecological future.

III.3 Bridging the Gaps?

The 2025 City of Richmond Cultural Heritage Stewardship Plan (CHSP) [9] represents a significant step toward identifying, recognizing, and conserving the city's cultural and historical assets. Rooted in the Richmond 300 Master Plan (2020), the CHSP promotes preservation through reduced demolition, adaptive reuse, and recognition of underrepresented communities. It also outlines alternative zones for urban growth to safeguard heritage resources.

Although the CHSP does not directly address industrial remnants along the James River, it offers a policy framework that could support their future inclusion in broader cultural narratives. Meanwhile, the Richmond Department of Parks and Recreation promotes public education programs focused on the park's cultural history through ranger services, tours, and events.

The RRP, JRPS, and CHSP were all developed with extensive public engagement. The CHSP process included interviews, surveys, hybrid meetings, youth involvement, and interactive events. The JRPS team hosted public sessions across all nine City Council districts and collected over 2,300 survey responses. The RRP's approval also went through forums, stakeholder meetings, and public commentary.

Together, these efforts demonstrate the city's commitment to inclusive cultural and ecological stewardship.

IV. Results

IV.1 Weaving River, City and Industry: A Proposal for the Southern Riverfront

The collaborative planning frameworks described above offer a strong foundation for bridging industrial heritage gaps. The southern riverfront presents a unique opportunity to do so by integrating environmental resilience, cultural continuity, and public access.

This area is shaped by a mosaic of active and post-industrial land uses, including two quarries nearing the end of their lifecycle and a water treatment facility. Located within a floodplain affected by the floodwall, it channels river overflow and runoff into industrial parcels. Rather than viewing this as a liability, this proposal reimagines the southern riverfront as a hybrid landscape.

Constructed wetlands are introduced to absorb stormwater and moderate floods, functioning as ecological filters and public green infrastructure. Adjacent quarries are repurposed as flood retention basins. Together, these interventions mitigate both routine and episodic hydrological events.These spaces are also designed for public engagement. Boardwalks, trails, and platforms encourage encounters with water, memory, and change—helping the public reconnect with both ecological and industrial heritage.

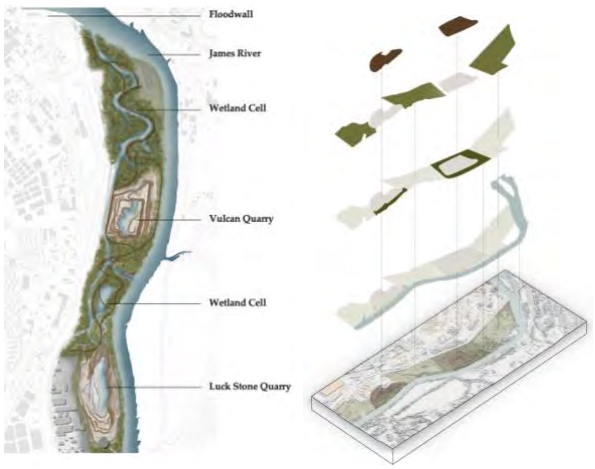


Figure 4: Master plan and diagram of the spatial components of the proposed landscape. (drawings by C. Bonura)

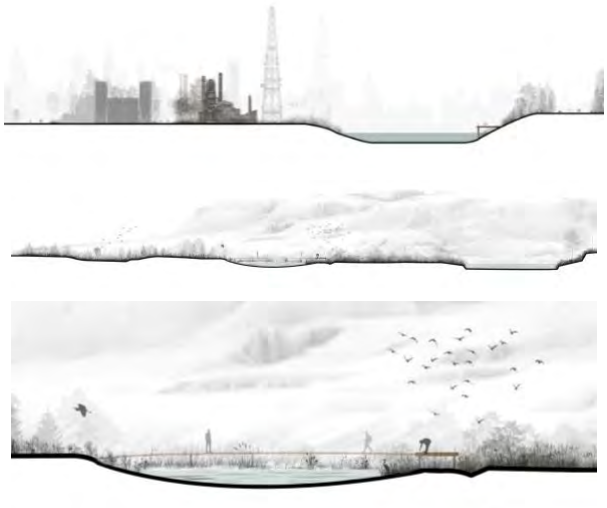


Figure 5: The new integrated profile of river, city and industry and the wetland walk. (drawings by C. Bonura)

Unlike the predominantly recreational JRPS greenways, this proposal aligns with Robert Searns' concept of multi-purpose greenways, which combine climate adaptation with habitat protection, water quality improvement, historical preservation, and education [10].

V. Discussion and Conclusion

The Richmond Riverfront Plan (RRP), the James River Park System (JRPS)master plan , and the Cultural Heritage Stewardship Plan (CHSP) each articulate ambitious visions for ecological restoration, cultural preservation, and public access along the James River. However, these plans often overlook the potential of disused industrial sites, particularly those located within flood-prone zones, as critical elements in shaping a more resilient, inclusive, and culturally layered riverfront. Their reintegration into urban planning remains fragmented, despite their strategic value in advancing climate adaptation, heritage conservation, and community connectivity.

This study argues for a more integrative framework, one that positions dismissed industrial landscapes not as obstacles but as active agents in shaping urban-river relationships. Process-based remediation strategies, including constructed wetlands, flood retention basins, and phytoremediation systems, can transform these sites into multifunctional green infrastructure. Beyond their technical performance, such interventions support biodiversity, regulate hydrological cycles, and improve environmental quality, while simultaneously creating new terrains for public interaction, ecological learning, and cultural engagement.

Importantly, these landscapes offer opportunities to confront and reframe the legacy of industrialization, embedding memory and identity into future-oriented ecological design.

The proposal for Richmond's southern riverfront demonstrates how adaptive reuse can anticipate and repurpose industrial decline through layered interventions that accommodate both human and non-human needs. By combining stormwater management, habitat creation, and interpretive public spaces, the project outlines a model for reimagining industrial fragments as connective tissue within the broader urban and ecological fabric.

To support such transformations, a range of policy tools is needed: from tax incentives for brownfield

redevelopment to grants and planning mechanisms that prioritize cultural and ecological integration. While elements of these tools already exist within Richmond's planning landscape, their targeted application to dismissed industrial sites remains limited. Integrating these sites into existing frameworks would not only expand the city's climate resilience strategies but also address long-standing concerns about overdevelopment, restricted river access, and the erasure of cultural landmarks.

Ultimately, this approach challenges the logic of greenwashing by positioning post-industrial terrains as sites of authentic transformation, places where infrastructure, memory, ecology, and public life intersect. Their adaptive reuse offers Richmond an opportunity to close the gaps between past and future, between communities and their river, and between engineered resilience and living systems.

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BLUE-GREEN LANDSCAPE THROUGH NATURE-BASED SOLUTIONS; CASE STUDY OF GRØNNALLMENNINGEN IN MINDEMYREN, BERGEN

TOPIC: Guiding cities through what is alive: Rainwater and water landscapes

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Keywords: blue-green infrastructure, nature-based solutions, climate adaptation, urban biodiversity, rain garden

Abstract

Nature-based solutions in urban development are increasingly recognized for their role in mitigating the impacts of climate change and enhancing urban ecology and social sustainability through the creation of green public spaces. Bergen, a city characterized by high precipitation, has developed several strategies to adapt to climate change through innovative city planning. These strategies include the Nature Strategy, Green Strategy, and Waterbody Restoration Strategy, all of which prioritize the integration of blue-green infrastructure. This infrastructure plays a crucial role in climate adaptation through stormwater management, flood risk reduction, and biodiversity enhancement while providing recreational spaces for the community.

This paper presents a case study of a project called Grønnallmenningen in Bergen focusing on the prioritization of blue-green infrastructure in the design process. The framework for the case study is derived from a literature study on nature-based solutions in urban contexts. The study identifies the challenges of the area under transformation and how nature-based solutions can address these challenges from social, environmental, and economic perspectives. The proposed solutions in the project, such as creating urban biodiversity, rain gardens, maximizing pervious surfaces, and open natural water channels amidst the newly developed and proposed residential blocks, create a green axis in the neighborhood. Furthermore, it examines how planning strategies, local participation, and societal sustainability goals influence the design process and lead to the selection of nature-based solutions at a local scale.

In an urban context, nature-based solutions are carried out through interdisciplinary involvement and the participation of various stakeholders. By exploring the design process of Grønnallmenningen, this paper aims to provide insights into the application of nature-based solutions in design practice, contributing to a broader understanding of sustainable urban planning practices through the agency of landscape architecture.

1. Introduction

Bergen is known as a rain-city, due to its high precipitation. It is located along the west coast of Norway, between the mountains and the fjords. The landscape of the region has been carved out by the glaciers thousands of years ago, forming the deep inlets of sea into the land and steep slopes creating numerous streams flowing into the sea. This geographic location and the terrain formations make it prone to higher precipitation and ecological impacts due to climate change. The precipitation is driven by the forced ascent of moist air over the mountainous terrain and plays a major role in shaping regional and micro-climates.

Human activities have significantly increased greenhouse gas emissions, leading to global warming. We are already witnessing the impact with rising temperatures, increased rainfall, extreme weather events and loss of habitats for plants and animals. In the future, the consequences of climate change will become more severe in various ways. In Bergen city, this will manifest as rising sea levels, heavier rainfall, and a heightened risk of floods and landslides [1]. Such challenges necessitate intensifying our efforts to adapt to these changes. However, the severity of these consequences can still be influenced by collective action. If we reduce greenhouse gas emissions going forward, the impacts of global warming will be less damaging for the planet.

Today the response to climate change involves mitigation and adaptation. While mitigation activities encompass those attempts to reduce emissions by reducing energy usage or use of renewable energy, adaptation includes activities that attempt to adjust or respond to the environmental changes caused by climate change as a comprehensive response strategy [2].

The majority of the world's population live in urban areas, and cities consume a large portion of world's natural resources while accounting for more than 70% of global carbon emissions. The cities however have the potential to become an integral part of the mitigation through comprehensive urban development strategies.

Effective mitigation can reduce the need for adaptation; however, changes to the climate already put into motion cannot be reversed in the near future only by cutting emissions. The cities therefore must rely on adaptation measures to increase their resilience.

In Bergen, climate change is causing the weather to shift with bottlenecks and flooding, as the stormwater infrastructure was not designed for managing the recently occurring amount of precipitation. To address the need for increased capacity, Bergen municipality has conducted strategies to open up creeks and rivers to allow the stormwater flow through the surfaces as well as infiltrate into the ground as opposed to building larger pipes.

Nature-based solutions in urban development are increasingly recognized for their role in mitigating the impacts of climate change, while enhancing urban ecology and adapting towards social sustainability through the creation of green public spaces [3]. Utilizing the natural processes, providing sustainable and resilient adaptation methods that also offer recreational opportunities, nature-based solutions address climate change effects through multiple functions.

Urban nature is increasingly envisioned as a crucial element for sustainable urban planning and development, as highlighted by various studies and reports. This concept builds upon a longstanding tradition of incorporating nature into urban planning, exemplified by practices such as garden cities and green belts. Modern urban greening strategies include Green Infrastructure (GI) and Ecosystem-Based Adaptation (EBA). Nature-Based Solutions (NBS) represents the latest advancement in this evolving lexicon [3].

Green infrastructure stands outs as a nature-based, sustainable solution as opposed to the traditional 'grey' infrastructure due to being environmentally friendly and cost effective. Although it lacks a unified definition in the urban context, it is acknowledged for its connectivity and multi-functionality [4]. These characteristics enable it to integrate seamlessly into urban landscapes, enhancing resilience and environmental stewardship.

To navigate the challenges in planning, designing, implementing, and maintaining Green Infrastructure projects, it is crucial to develop customized design guidelines. These guidelines need to consider each city's unique characteristics, risks, and resource constraints, ensuring effective management across all project phases to meet the specific needs of urban environments [5].

For Bergen, adapting to a changing climate involves managing large amounts of water. For instance,

today snow-melted water and rainwater running on the surface are directed through the drainage system. There is a risk that future rainfall will overwhelm this system. Nature-based solutions, such as opening streams, using green roofs, and increasing natural vegetation, can help manage more of the water effectively [1].

Bringing the stormwater systems to the surface is part of a citywide adaptation plan called Grønnstrategi. This adaptive plan, which is informed by national guidelines, prioritizes using nature as a buffer to protect infrastructure against climate change. These nature-based solutions include restoring wetlands, planting trees to shore up erosion and covering roofs with plants to reduce localized heat.

The implementation of nature-based solutions is realized through city-scale planning strategies. However, identifying their potential during the design phase for local-scale projects can be challenging. This raises important questions: How can we develop specific design guidelines for blue-green landscape projects that address the distinct characteristics, challenges, and resource constraints of urban environments, ensuring cohesive integration across all phases of planning, design and implementation? And what role can landscape architects play in integrating nature-based solutions into planning?

2. Methodological framework

Through the study of scientific and professional literature, the existing and the newly developed policies in Bergen that are focused on climate adaptation and urban green spaces, the role of nature-based solutions in urban development is identified.

This review indicates the prioritization of nature-based solutions in urban planning, as highlighted in key municipal documents such as the nature strategy and green strategy. A case study project that is initiated by Bergen municipality with a design team led by landscape architects, serves as the focal point to understand how planning principles, local participation, and societal sustainability goals influence the design process leading to the selection of nature-based solutions at a local scale. The evaluation employs a rating system to assess the degree of consideration of various principles at both the policy level and within the design process. The evaluation is based on direct participation in the design process. The methodology integrates literature review, policy analysis, stakeholder engagement, and detailed examination of project documentation designed by landscape architects to provide a structured and quantitative assessment and emphasizing the importance of the design approach that leads to the selection of nature-based solutions at a local scale.

3. Policies for urban development and climate adaptation in Bergen

In 2021 a study was conducted for Bergen municipality to compare four central urban spaces in terms of their quality of space and landscape elements. People in the urban areas were surveyed to rate these spaces. These spaces have diverse profiles and various qualities.

The survey results indicated that the four urban spaces were rated evenly, however, Ole Bulls plass scored highest points. It is the urban space in the survey with the most natural elements, and the respondents highly value the blue-green aesthetic of the space. The other spaces received lower score and were praised for other urban qualities based on openness, historical value, proximity to sea and view. The result from this study demonstrates the preference of natural elements in the urban spaces and has been one of the foundation documents for further developing the Nature strategy of Bergen [7].

In the nature strategy for Bergen, ecological diversity and sustainability while integrating opportunities for human recreation and mobility is prioritized. The emphasis on native vegetation and diversity supports robust ecosystems, which can enhance environmental resilience. Wildlife corridors and flood management structures are crucial for maintaining ecosystem health and protecting human developments from natural events. Ensuring interconnected and accessible recreational pathways promotes community engagement and well-being. Using native plants can reduce maintenance costs and create habitats for local wildlife. Designing corridors for both wildlife and water flow can prevent habitat fragmentation and enhance flood resilience. The recreational aspects should be integrated thoughtfully to ensure human activities do not undermine ecological goals. Balancing conservation efforts with human usage will be key to achieving a harmonious and sustainable landscape according to the nature strategy document.

The Green strategy is an initiative for Climate and Environmental Plan for Municipal Operations in Bergen. The two goals are: by 2030, Bergen will be

a low-emission society and by 2050, Bergen will be a 1.5-degree society. To achieve these goals, the strategy has described several initiatives for the city. One of the strategies is that Bergen shall be adapted to a changing climate, especially to manage increased rainfall, extreme weather, and rising sea levels. Nature-based solutions will be the first choice, and the measures shall protect biodiversity.

A diverse natural environment is less vulnerable to climate change and can help adapt to a changing climate. By using nature-based solutions, the properties of nature and the processes of ecosystems are harnessed to adapt to climate changes. These solutions also offer new opportunities for recreational activities and help preserve biodiversity in urban areas. Conservation, restoration, and establishment of nature-based solutions is recommended as primary choice. The biodiversity shall not be compromised and naturally occurring species should be chosen when restoring nature.

4. Blue-green landscape

The phrase blue-green or green-blue emerged in the past two decades from the growing need for a more integrated systems-approach of nature-based solutions to the management of the green and blue infrastructure. The blue-green infrastructure is defined as ‘an interconnected network of natural and designed landscape components, including water bodies and green and open spaces’ [6]; a short list of examples could include green roofs, retention and detention ponds, re-naturalized and de-culverted rivers, swales and ‘bioswales’, or rain gardens.

Nature-based solutions should be seen as a transdisciplinary umbrella, integrating concepts from 'blue-green infrastructure' in engineering, 'natural capital' and 'ecosystem services' in economics, and 'landscape functions' [9] in environmental planning.

In Bergen, the post-war urban development has predominantly centered around a car-dependent transport system, influencing city planning and the design of the built environments. This approach has led to the creation of new urban structures characterized by extended distances and low population density. Today, the city is undergoing development in central urban areas to address the demand of affordable and energy-efficient housing. In 2019, the Bergen City Council, through Bymiljøetaten, initiated the project "Blue-Green Structure - Central Areas of Åsane" to develop a method for planning the overarching blue-green structure in densely built-up areas of the city.



Figure 1. Blue-green structures in Bergen.

The "Blue-Green Structure – Åsane" project was conducted to evaluate the existing blue-green infrastructure in Åsane in Bergen and inform the ongoing planning process on where new structures should be created to enhance the blue-green environment. The method used has been developed through this project and is not exclusively designed for Åsane; it is intended for use in both transformation areas and areas with limited development.



Figure 2. Mindemyren development plan.

Mindemyren is an industrial area in Bergen that is undergoing an urban transformation. It is situated in a valley surrounded by two prominent mountains. In the past, rainwater flowed down these steep slopes into a river and wetland area below. However, as Bergen grew in the 1950s, developers decided to bury the river to accommodate urban expansion. The area is set to emerge as a new and appealing neighborhood. The light rail will pass through here, the canal will be excavated and exposed to daylight, and 35,000 square meters have been allocated for new squares and parks.

Blue-green infrastructure is intended to make Mindemyren resilient to climate change and

contribute to an attractive neighborhood. The reopening of the canal, which was hidden beneath the road Kanalveien, is a key strategy in the area's development and climate adaptation for Mindemyren. Several areas are being developed in various phases. Part of the development besides Mindebyen is a public space connecting a park and a square between two residential areas: Grønnallmenningen.



Figure 3. Mindebyen and Grønnallmenningen

5. The case study of Grønnallmenningen

The project area is located south of Bergen city center in Bergensdalen (valley), at the transition between Wergeland and Mindemyren. The area is currently in a transitional phase, shifting from an industrial and residential area to becoming an urban center.

The project is initiated by the municipality of Bergen as part of a masterplan of Wergeland and Mindemyren. The ambitions of the project owner in terms of biodiversity and NBS were high.

The project area includes public spaces amidst housing blocks, kindergarten, playgrounds, park area, commercial spaces and key public transport junctions. The design included a passage between the commercial spaces and the park that has a terrain height difference of around 9m, thereby addressing a need for slowing down the surface water along the passage with green and blue landscape design.

Grønnallmenningen is designed by greening the area with a biodiverse plant scheme which is combined with an open channel that will offload the stormwater infrastructure during heavy rainfall and creating opportunities for natural play areas for the local kids.

5.1. Active participation from stakeholders including local communities

The project started with a survey in the neighborhood where the residents and users were asked what kind of spaces do they wish for in this area.

The outcome indicated that the majority wanted a green space, sitting areas and less car-traffic.



Figure 4. Word cloud showing the most used words in the participatory survey.
Grøntareal= green space
Sitteplasser= sitting areas
Færre biler= fewer cars

5.2. Blue-Green Factor

As part of the Nature Strategy, the implementation of the blue-green factor (BGF) as a tool for planning new development projects in Bergen Municipality has been evaluated [10].

The purpose of this tool is to ensure local stormwater management, enhance biodiversity, and preserve ecosystem services. Additionally, the tool will help promote blue-green environments in future urban development. This can create better quality outdoor spaces, increased well-being, and improved public health in a greener urban setting.

The blue-green factor is measured by a standard method quantifying the area's water infiltration capacity through use of surface materials and area and volume of vegetation. Through planning densely planted trees of local species and surface water infiltration through pervious surfaces and rainbeds, the project achieved a BGF of 0,93 which is considered a high score.

5.3. Design principles and nature-based solutions

Grønnallmenningen translating to 'the green commons' is designed as a lush and green space. As

people move through the space, the vegetation will make a greater impression than the tall new buildings adjacent to the public areas.



Figure 5. Blue-green landscape, Grønnallmenningen

Grønnallmenningen will serve as a thoroughfare with a primary focus on the neighborhood. Hard surfaces from previous design phases are reduced to accommodate more vegetation, play areas, activity zones, and neighborhood spaces. Providing a universally accessible passage through Grønnallmenningen, instead of stairs along the residential building facade, ensures that everyone can move along the same path and under the same conditions. Different sub-areas will have their own identities and characters to introduce greater variety in an area and suited to the micro-climate where buildings and outdoor spaces are predominantly new.



Figure 6. Principle section of a rain garden

Grønnallmenningen and Eikeveien on the northside, indicated as green corridors in early planning phases, will be connected over the square with a step-free passage and open sightlines. This is a crucial strategy for creating a good meeting point between the streets and enhancing connections.

Grønnallmenningen, together with Pulsparken on the southwest side will form part of a green corridor in Mindemyren. These green corridors are designed to enhance biodiversity and the cityscape.

The case study identifies and evaluates the implementation of five guiding principles [8] of planning nature-based solutions in the design process, aligning with the framework outlined by recent studies. The consideration of NBS within the case study project is summarized in Table 1, which marks each principle on its influence from the policy level and its adoption in the design process.

Table 1. Evaluation of NBS Principles in the case study project.

Principles of Planning NBS	Recommen-dation in Policy/ Strategy	Adopted in Design Process
Place-specificity:		
Space organization.		●
Micro-climate.		●
Addressing needs for local context.	●	●
Evidence Base:		
Biodiversity mapping.	●	
Mapping and registering existing vegetation.		●
Calculation of stormwater for future climate.	●	●
Integration:		
Connecting with surrounding blue-green structures.	●	●
Equity		
Universal design.	●	●
Active participation of local community.		●
Accessibility.	●	
Public spaces for users of various age-groups.		●
Transdisciplinarity:		
Participation of various professional fields.	●	●

The study indicates that place-specificity, evidence base and integration had high degree of consideration within the case study project, reflecting their significant impact on successful NBS implementation. The other principles, while also present, exhibit varied levels of influence, highlighting their contributions to the overall effectiveness of the planning process. The table also

indicates that the design process has successfully adopted certain principles without a requirement from the planning policy.

6. Conclusions

The literature review highlights the growing recognition of nature-based solutions in urban development for their critical role in mitigating climate change impacts and enhancing urban ecology and social sustainability through the creation of green public spaces. These solutions are increasingly being adopted as integral components of urban planning and design. In the context of the case study project, it is indicated that the planning criteria and principles for nature-based solutions are reflected in the ongoing municipal strategies for the area. Consequently, the case study project can effectively integrate its nature-based solutions on a broader scale within the surrounding environment, leveraging the existing municipal vision.

However, a gap is identified in the absence of specific design guidelines that explicitly incorporate nature-based solutions for public urban spaces in Bergen. The tool for BGF can be an effective method of quantifying the effectiveness of a blue-green landscape. However, a specific requirement for BGF is not set in the municipal policies. This ambiguity necessitates further exploration into the formulation of standardized design methods for a blue-green landscape that are adaptable to the unique needs and characteristics of specific urban environments.

The discussion on the application of nature-based solutions must extend to areas where projects lack existing development plans. The necessity for place-specific design approaches implies that nature-based solutions should not be restricted by the absence of pre-existing plans but rather should inspire innovative and adaptable strategies tailored to local characteristics. The adoption of nature-based solutions in the case study project indicates that landscape architects can play an important role in initiating a process for adopting nature-based solutions that can lead to new opportunities for incorporating them on an urban scale.

Within the transdisciplinary framework of the planning process, the agency of landscape holds significant potential to inform the design from multiple perspectives. This includes considering biodiversity, physical planning of infrastructure, and the design of open spaces. By viewing the city as an integrated landscape of land and water, planning policies and strategies can profoundly influence the design process for local-scale projects within neighborhoods, ensuring that urban development is both ecologically sustainable and socially beneficial.

Acknowledgments

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Short papers

TOPIC 1
Guiding cities with society: Use, memory and artistic creation

RESEARCH ON COMMUNITY PUBLIC SPACE RENEWAL STRATEGIES FROM THE PERSPECTIVE OF SPATIAL JUSTICE: A CASE STUDY OF CAOYUAN COMMUNITY, BEIJING

TOPIC: Guiding cities with society: Use, memory, artistic creation

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Keywords: Spatial justice, Beijing, Community Public space, Renewal Strategy, Caoyuan Community

Abstract

In the context of global urban renewal returning to human-oriented values, the balance between justice in spatial resource distribution and cultural heritage has become a key issue. As a special area carrying the core functions of the capital and the memory of city life, Beijing Old City is located in the Cao Yuan community of Beixinqiao Street in Beijing Old City, which is in the core transition area of the sacred and secular cultural axes constituted by Yonghegong (a Buddhist holy place) and Guijie (a modern commercial street). Currently, it is facing three major public spatial justice dilemmas: the conflict between the protection of historical street texture and the modernization of functional adaptation, the imbalance in the distribution of public resources across groups, and the tension between planning control and community autonomy. Based on the theoretical framework of spatial justice, this study firstly analyzes the material form and behavioral characteristics of the community's public space through the PSPL research method, and analyzes the phenomenon of spatial justice deficiency and its causes; secondly, combining with the ERG theory, we constructed a four-dimensional evaluation system of "material-environmental-communication-social equity", and found that, through quantitative analysis, the public space justice of Cao Yuan community is as follows. Through quantitative analysis, it is found that the overall level of public space justice in Cao Yuan community is low, and the main problems are concentrated in the aspects of material justice, interaction justice and social fairness. Finally, the four strategies of balanced spatial supply and distribution, reconfiguration of spatial environment and order, activation of spatial vitality and interaction, and protection of spatial respect and rights and interests are put forward for the evaluation dimensions, and through the paths of historical spatial function superposition, compensation of facilities for disadvantaged groups, and the construction of digital participation platforms, we can promote the shift

from “efficiency priority” to “fairness priority” for resource allocation. Through the overlaying of historical space functions and compensation of facilities for disadvantaged groups, and the establishment of a digital participation platform, we have shifted the allocation of resources from “prioritizing efficiency” to “prioritizing fairness”, and shifted the governance mode from unidirectional control to multi-party collaboration. This practical framework not only enhances the spatial justice of the community and the well-being of the residents, but also provides an operable model for the progressive renewal of high-density historic urban areas around the world, balancing cultural heritage and social equity.

Text

1. INTRODUCTION

In the process of rapid urbanisation, the capital-driven logic of spatial production and the imbalance in power structures have exacerbated the stratification of social classes in terms of spatial resource ownership. Vulnerable groups face marginalisation in terms of their rights to access public spaces, participate in decision-making, and achieve cultural recognition, with developing countries being particularly affected. The United Nations' New Urban Agenda notes that approximately one billion people worldwide live in slums and informal settlements, where public space is squeezed into a ‘residual domain’ of survival resources. Under the gentrification wave, historic districts in European and American cities have also become embroiled in controversies over the privatisation of public space and cultural homogenization \cite{Tavares2024}. The unjust distribution of spatial resources stems from structural contradictions between social power and capital operations. and addressing it requires attention to dimensions such as procedural justice, cultural identity, and social inclusion. Spatial justice theory has emerged as a crucial perspective for evaluating urban renewal processes and reflecting on social values, with its core focus on how to reconfigure public spaces under an efficiency-first model to serve as vehicles for social inclusion and democratic deliberation, thereby addressing cross-regional challenges.

Since the 1960s, accelerated urbanisation in the West has highlighted urban issues, prompting scholars in Europe and America to focus on urban spatial quality. Henri Lefebvre combined Marx and Engels' ideas on spatial justice with urban spatial production, pointing out the existence of spatial injustice in cities. Castells argued that urban space is an expression of social structure, while David Harvey revealed the unfair distribution of space. Subsequently, scholars such as Soja and Feinstein applied this theory to urban planning and governance \cite{Lin2023}. By the end of the 20th century, China's urbanisation process accelerated, and domestic scholars began to integrate spatial justice theory with China's national conditions \cite{ Iveson 2011}. In 2006, Professor Ren Ping first introduced the concept into Chinese urban development \cite{Ren2006}. In 2011, Professor Cao Xianqiang emphasised its practical significance \cite{Cao2011}. Subsequently, professors such as Li Hao \cite{Li2018}, Tian Baojiang \cite{Liu2019}, and Yang Peifeng applied it to the planning and design of urban public spaces, old residential areas, and urban parks \cite{Yang2020}. Today, spatial justice has become an important theoretical perspective for urban renewal, social development, and the optimisation of public spaces.

In China's rapid urbanisation process, the renewal of community public spaces faces numerous challenges, such as capital-driven commodification of space, governance models that weaken resident participation, and the disruption of historical and cultural contexts leading to emotional alienation. This study aims to establish a spatial justice-oriented evaluation system for community public spaces, proposing renewal strategies across four dimensions: material, environmental, social interaction, and social equity. It seeks to provide a replicable model for the gradual renewal of public spaces in high-density historical urban areas, balancing cultural heritage preservation with social equity.

2. RESEARCH SUBJECTS AND METHODS

2.1 Selection of research subjects

Caoyuan Community is located in the northwestern part of Beixinqiao Subdistrict, Dongcheng District, Beijing. Its jurisdiction extends from the west side of Dongzhimen North Small Street in the east to No. 19 Beixinqiao First Alley and the eastern section of Yonghegong Street in the west, from the north side of Dongzhimen Inner Street in the south to Beixinqiao Third Alley in the north. The

community covers an area of 19 hectares, with a registered population of 6,481. The permanent resident population is significantly aged, including a group requiring care for the disabled, and under high-density living conditions, the per capita living space is severely insufficient. The community is located within the Yonghegong-Guozijian Cultural Heritage Zone in the historic core of Beijing. The Caoyuan Community is deeply affected by tourists occupying recreational spaces in the Yonghegong area, forcing the elderly to retreat, while commercial activities on Guijie Street encroach on the alleyway layout. Additionally, tenants and the elderly population are excluded from decision-making processes regarding urban renewal, collectively exacerbating the deprivation of spatial rights in the historic district. Therefore, this study selects it as a sample community to reveal the mechanisms of spatial rights deprivation in high-density historical urban areas(see Figure 1-3).



Figure 1. Map of Beijing's Old Town.

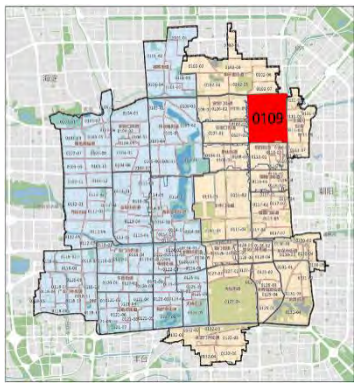


Figure 2. Location map of Beixinqiao Street.



Figure 3. Location map of Caoyuan Community.

Jan Gehl proposed the PSPL research method, which involves studying public spaces and the behavioural characteristics of people within them to identify issues and propose solutions. PSPL stands for Public Space - Public Life. Public spaces are physical entities that provide venues for activities such as leisure and entertainment, sports and fitness, and social interaction. High-quality public spaces can enhance the quality of life, shape the city's appearance, and showcase its unique characteristics. Public life refers to the interactions and relationships between people in public spaces. Diverse activities infuse public spaces with vitality, publicness, and sharedness, highlighting their value and significance.

The Analytic Hierarchy Process (AHP) is simple and practical, widely applied in fields such as architecture, urban planning, and sociology. This method is suitable for multi-objective decision-making. The evaluation of the fairness of community public spaces is a multi-objective problem, making the AHP particularly applicable. The weighting of evaluation indicators is calculated using the Delphi method. Expert scoring questionnaires are distributed to professionals in urban planning and landscape design, and the corresponding scoring results are collected and summarised. The average scores are calculated, and the judgment matrix is constructed using Yahhp software to calculate the indicator weights(see Figure 4).

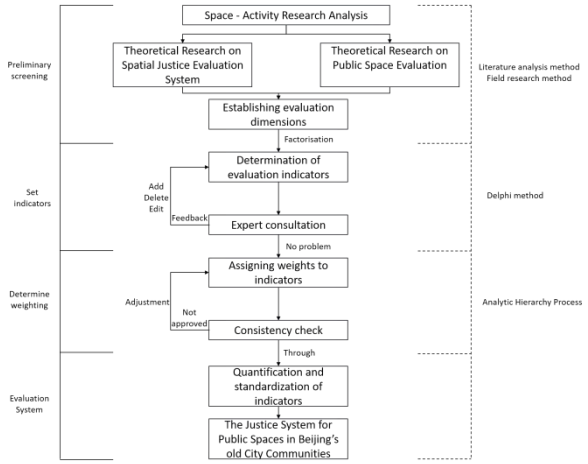


Figure 4. Evaluation System Construction Flowchart.

3. Construction of a Community Public Space Justice Evaluation System

3.1 Theoretical Framework

Aldefer from Yale University developed the ERG theory based on Maslow's hierarchy of needs, proposing that people have three core needs: existence, relatedness, and growth. First, physiological survival needs are met; second, the need for interaction and activity among people is fulfilled; and finally, attention is given to personal growth and spiritual fulfilment \cite{Chang2022}. Based on the ERG theory and the research content of this paper on the evaluation of justice in community public spaces, the four dimensions are summarized as fulfilling the core needs of people at different stages and levels. When the material needs at lower levels are secured and met, people can pursue the functional improvement and quality enhancement of material spaces. On this basis, people can pursue the vitality of spaces, an atmosphere of equality, harmonious relationships, and finally ascend to the spatial expression of their own rights and socially oriented care and concern(see Figure 5).

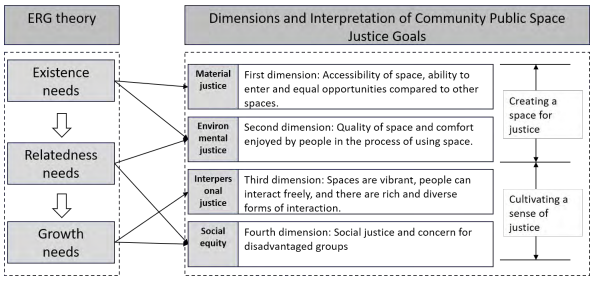


Figure 5. Interpretation diagram of the dimensions of community public space justice objectives.

3.2 Construction Principles

First, the principle of scientificity: the selection of indicator elements should scientifically and reasonably reflect the degree of deficiency and achievement of community public space justice, thereby enabling a scientific evaluation of community public space justice. The quantification methods and weighting determination of indicators should also be scientifically sound. Second, the principle of universality: the construction of a community public space system based on spatial justice should be applicable to the evaluation of public spaces in most old urban courtyard communities, demonstrating a certain degree of universality. Therefore, the selection of indicators should not be based solely on theoretical research but should also be grounded in practical considerations and issues identified through field research to establish universally applicable indicators that address real-world problems. Third, the Principle of Operability: Due to the limited research on spatial justice evaluation within the academic community, there are few reference indicators available. Therefore, the selection of indicators should prioritise their accessibility. Specific evaluation indicators should be applicable to this study, and qualitative indicators should also be amenable to data quantification.

3.3 Indicator Extraction and Selection

This study draws on a literature review to extract evaluation elements from the fields of spatial justice systems and public space evaluation. By analysing the dimensions of evaluation literature related to spatial justice, the study summarises the systematic elements required for constructing an evaluation system. Additionally, it screens indicators and factors related to justice evaluation from literature on public space evaluation to establish a public space evaluation system from a spatial justice perspective. Combining spatial surveys and interviews with residents in the Caoyuan Community, and integrating the results of questionnaire surveys, evaluation elements for the justice of community public spaces were extracted. Through systematic organisation, it was found that the material justice dimension focuses on spatial safety, spatial distribution, spatial enjoyment, and spatial access, with spatial safety being the basic measurement standard; the environmental justice dimension includes spatial

function, spatial facilities, and spatial quality; the social justice dimension covers spatial activities, spatial belonging, and spatial identity; and the social equity dimension encompasses spatial autonomy and spatial care \cite{Jian 2020}.

3.4 Construction and Weighting of the Evaluation Indicator System

The evaluation indicator system refines the evaluation objectives of community public space justice and serves as an operational tool closely aligned with the practical needs of spatial justice. To ensure that evaluation factors fully fulfil their intended roles in operational and management processes, this study conducted systematic reviews and indicator analyses through literature research and field surveys, summarising system elements and related indicators under four dimensions: material justice, environmental justice, relational justice, and social equity. Four experts from fields such as urban planning and landscape architecture were invited to participate in expert consultations and multiple rounds of revisions through a combination of online and offline methods. Ultimately, a community public space justice evaluation system was established, comprising 4 objective dimensions, 12 element systems, and 31 evaluation indicators. To ensure the scientific rigor and convenience of the statistical process, the weight assignment process was conducted using YAAHP 10.2 software. Through the solution of the judgment matrix for weights and relative weights at each level, as well as matrix consistency testing, the specific weights for each indicator were determined(see Table 1).

Table 1. Community Public Space Justice System.

Overall Objective	Objective Dimensions	Element System	Evaluation Indicators	Weights
A Community Public Space Justice Evaluation System	B1 Material Justice	C1 Space Security	D1 Lighting Safety	0.0544
			D2 Traffic Safety	0.1525
			D3 Safety Monitoring Protection	0.0357
		C2 Spatial distribution	D4 Types of public spaces	0.0070
			D5 Number of public spaces	0.0191
		C3 Space enjoys	D6 Spatial Recognisability	0.0150
			D7 Building Density	0.0591
			D8 Space Enjoyment	0.0298
		C4 Space Access	D9 Accessibility	0.0260
			D10 Spatial selectivity	0.0553
	B2 Environmental Justice	C5 Space Functionality	D11 Business Diversity	0.0080
			D12 Functional rationality	0.0389
		C6 Space Facilities	D13 Leisure Facilities	0.0027
			D14 Sanitation Facilities	0.0053
			D15 identification facility	0.0018
			D16 Sunshade and Rain Shelter	0.0090
			D17 Accessibility Facilities	0.0130
		C7 Space Quality	D18 Environmental Cleanliness	0.0099
			D19 Scenic Beauty	0.0026
			D20 Street and Alley Space Suitability	0.0045
	B3 Interpersonal Justice	C8 Space Activities	D21 Activity Participation Rate	0.0292
			D22 Activity Richness	0.0053
			D23 Event Features	0.0115
		C9 Space Belonging	D24 Neighbourhood Integration	0.1005
			D25 Community Care Index	0.0223
		C10 Spatial Identity	D26 Space usage equality	0.0199
			D27 Facility Satisfaction	0.0094
	B4 Social Equity	C11 Space Autonomy	D28 Policy Protection Level	0.0099
			D29 Public Participation	0.0249
		C12 Space Care	D30 Attention to disadvantaged groups	0.0177
			D31 Sense of self-worth	0.0089

4 Empirical Study on Public Space Renewal Strategies in Beijing's Caoyuan Community from a Spatial Justice Perspective

4.1 Analysis of Community Public Space Justice Evaluation Results

The comprehensive score for public space justice in the Caoyuan community was 2.84 points (out of 5), which is relatively low, reflecting the localised contradictions faced by Beijing's old city courtyard

communities under the pressures of high-density living, historical preservation, and commercial tourism(see Table 2). The score for material justice was 2.15, revealing insufficient nighttime lighting coverage in alleys, high rates of missing accessible facilities, lagging elderly-friendly renovations, and encroachment on resident spaces by Yonghegong Temple tourists and commercial outdoor displays on Guijie Street. The score for social equity was the lowest, despite the presence of the 'Small Courtyard Deliberation Hall' co-governance platform, as the adoption rate of renovation proposals from tenants and the elderly population was low. and the configuration rate of elderly-friendly seating and fitness equipment contrasts sharply with the community's 67.2% elderly population rate. In terms of relational justice and environmental justice, commercial expansion on Guijie Street has encroached on recreational areas, and although tenants account for over 30% of the population, their lack of participation has led to insufficient social integration, the continued loss of local cultural spaces, and hardware upgrades such as public toilet renovations have not addressed issues of universality(see Figure 6).

Table 2. Evaluation Results Analysis

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Target dimension	Weight	Score	Non-justice space representation
Material justice	0.304	2.15	Lack of lighting and accessibility in narrow alleys; rest areas crowded with tourists.
Social equity	0.236	2.01	Lack of tenant participation; insufficient facilities for the elderly.
Interpersonal justice	0.262	2.63	Tenants and local residents are not integrating; local cultural activities are disappearing.
Environmental justice	0.198	3.42	Public toilet renovations prioritise technology over accessibility; commercial interests erode public functions
Overall score	1.000	2.84	-



Figure 6. Community space issues.

4.2 Community Public Space Renewal Strategies from a Spatial Justice Perspective

4.2.1 Material Justice Strategy: Balancing Spatial Supply and Distribution

In the renewal of public spaces in Caoyuan Community, to achieve spatial justice, efforts should focus on optimising alleyway spaces to balance spatial supply and distribution. First, existing alleyways should undergo minor renovations, such as improving lighting, optimising paving, and installing small-scale landscapes, to activate alleyway spaces, enhance their safety and comfort, and make them places where residents are willing to linger. Next, integrate spatial functions by reasonably allocating cultural display areas, community commercial points, and leisure and interaction zones along both sides of the streets and alleys to meet residents' diverse needs. Additionally, connect dispersed public space nodes through walkways and pathways to form a continuous public space network. Finally, the overall alleyways will be repaired, the layout of the streets and alleys will be optimised, public spaces will be expanded, closed spaces will be opened up, and the overall vitality and accessibility of the space will be enhanced. At the same time, the historical functions of the space will be integrated, combining the historical culture of the streets and alleys with modern functions, such as renovating traditional buildings into cultural activity venues or special commercial spaces to preserve the historical and cultural heritage(see Figure 7).

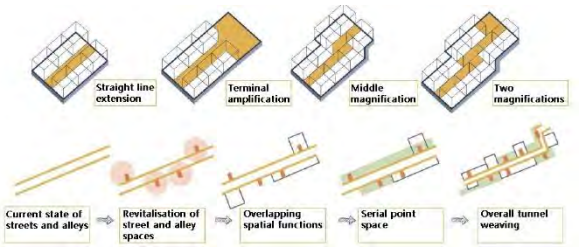


Figure 7. Schematic diagram of rebuilding street space.

4.2.2 Environmental Justice Strategy: Reconstructing the Spatial Environment and Order

In the public space renewal of Caoyuan Community, to address the issue of an ageing population, the reconstruction of the spatial environment and order requires the comprehensive improvement of various facilities. First, the overall public space should be optimised through spatial functional reallocation; greenery should be reasonably laid out to enhance the aesthetic appeal and comfort of the space, while

also providing residents with shaded areas for relaxation. The road network should be optimised to ensure it is spacious, flat, and well-connected, facilitating residents' mobility. Second, recreational and entertainment facilities should be improved, including the addition of ergonomically designed comfortable seating and the proper placement of fitness equipment to meet the daily exercise needs of the elderly. Furthermore, focus on improving accessibility facilities, including adding tactile paving, installing gentle, slip-resistant ramps, installing guardrails (handrails), and setting up accessible ramps to facilitate the movement and activities of the elderly, those with mobility impairments, and visually impaired individuals. Finally, strengthen the barrier-free renovation of public toilets, widen the doorways, install barrier-free toilet stalls, and install safety handrails(see Figure 8).

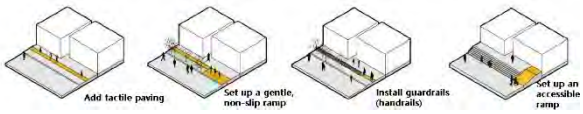


Figure 8. Schematic diagram of non-facility design.

4.2.3 Social Justice Strategy: Activating Spatial Vitality and Interaction

In the public space renewal of Caoyuan Community, activating spatial vitality and interaction from the perspective of relational justice is one of the key strategies for enhancing community cohesion and residents' quality of life. The community has established various shared spaces, such as shared balconies, shared courtyards, and shared vegetable gardens. These spaces not only provide residents with diverse functions such as leisure, clothes drying, and vegetable gardening but also promote communication and cooperation among neighbours. Shared balconies facilitate small-scale social activities, shared courtyards serve as daily leisure and interaction spaces, while shared vegetable gardens strengthen community bonds through collective labour and harvests. Additionally, the community organises various cultural activities, such as traditional festival celebrations and art exhibitions, attracting residents of all ages and further enhancing a sense of community belonging(see Figure 9).



Figure 9. Public spaces and crowd activities.

4.2.4 Social equity strategy: safeguarding spatial respect and rights and interests

In the public space renewal of the Cao Yuan community, safeguarding spatial respect and rights and interests from the perspective of social equity is one of the important strategies for building a harmonious community environment. The community focuses on the protection of the rights and interests of vulnerable groups, prioritises the space needs of special groups such as the elderly, children and the disabled, and ensures that they are able to enjoy public space resources on an equal footing by improving barrier-free facilities and setting up dedicated activity areas. At the same time, residents are encouraged to participate in public space planning and decision-making, and community governance platforms, such as the 'Small Yard Council', are established to allow residents' voices to be fully expressed and respected, and to enhance the sense of belonging and responsibility of community members. The community also actively promotes exchanges and cooperation between different groups, organises diverse community activities, promotes interaction and integration between tenants and local residents, as well as residents of different age groups, bridges the gap and creates an inclusive cultural atmosphere. In addition, through policy guidance and publicity and education, it raises residents' awareness of spatial justice and fosters respect for the spatial rights and interests of others, so as to ensure that every resident can feel fairness and dignity in the community(see Figure 10).

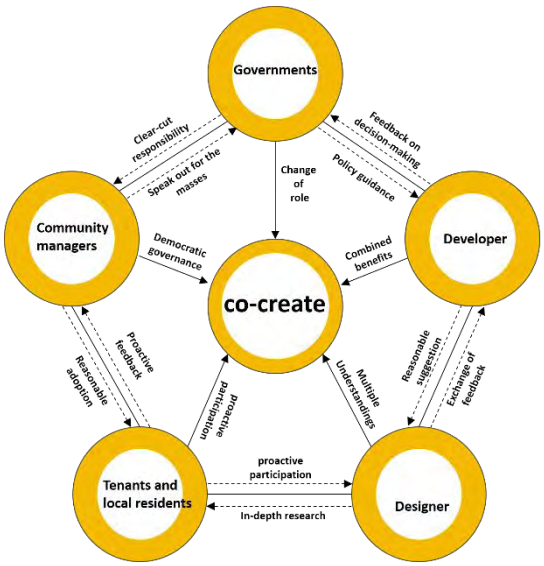


Figure 10. Schematic diagram of shared governance by multiple actors.

5 Conclusion and Discussion

Against the background of rapid urbanisation, the fair distribution of spatial resources and cultural heritage have become key challenges for urban development. Taking the Cao Yuan community in Beijing as an example, this study explores the optimisation strategy of community public space from the perspective of spatial justice. Through the PSPL research method and the hierarchical analysis method (AHP), the study constructed a four-dimensional evaluation system of 'material-environmental-interaction-social equity', and carried out quantitative and qualitative analyses of the justice of public space in Caoyuan Community. The study finds that the overall level of justice in public space in Cao Yuan community is low, and the main problems are concentrated in the aspects of material justice, interaction justice and social equity. For this reason, the study proposes renewal strategies for the four dimensions, including balancing spatial supply and distribution, reconstructing spatial environment and order, activating spatial vitality and interaction, and safeguarding spatial respect and rights. It aims to enhance the spatial justice of the community and significantly improve the quality of life of the residents, providing a practical framework that can be learnt from for the renewal of public space in similar high-density historic urban areas.

Although this study has achieved some results in theoretical construction and practical application, there are still some limitations and issues that need to be further explored. Firstly, the study mainly focuses on the specific case of the Cao Yuan neighbourhood, and the generalisability of its conclusions may be somewhat limited. Future research could be extended to more different types of communities to validate and enrich the findings of this study. Second, although the study proposes a variety of optimisation measures, how to balance the interests of various parties and ensure the sustainability of the measures during the specific implementation process still needs to be explored in depth. In addition, as urbanisation continues and community needs change dynamically, the optimisation and management of public space requires continuous attention and dynamic adjustment. Future research can further explore how to build more equitable, inclusive and sustainable community public spaces through the efforts of policy support, technological innovation and community participation.

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CONTEMPORARY PUBLIC SPACE: PRACTICES IN THE LATIN AMERICAN URBAN LANDSCAPE

TOPIC 01: Guiding cities with society: Use, memory, artistic creation

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Keywords: Public space, urban landscape, design, planning, Latin America

Abstract
Public space is a fundamental element of urban space in Western cities. It is understood that public spaces are prominent elements in the composition of the urban landscape. The socio-spatial relevance of their material expression constitutes an important component in the landscape vocabulary. It constitutes a crucial spatial concept to understand contemporary urban life and is essential to promoting fairer, more inclusive, equitable, healthy, innovative, and sustainable cities. This article will discuss the preliminary results of research guided by the Lefebvrian triad, which focuses on two analytical dimensions: the symbolic and the environmental. The results present a groundbreaking study on the design, management, and planning practices of public space in Latin America, with the collection, analysis, and evaluation of spatial proposals, legal and regulatory frameworks, and types of control that characterize public space. Two questions guided the investigation: How are the projects, built works, and planning processes of public spaces in Latin American countries in the 21st century? What can be considered singular, general, and particular in the practices of this context? This paper presents a set of data and practices that have been systematized in an unprecedented way and could help in the expanded understanding of the state of the art formed in the landscape of this part of the Americas. At the same time, it will reveal the specificities and similarities between this socio-spatial reality and its counterparts around the world, also highlighting the relevance of its theories and practices.

1.1 Introduction

Public space is a fundamental element of urban space in Western cities, where it is impossible to imagine the city without its existence [1]. It is understood that public spaces are prominent elements in the composition of the urban landscape [2]. The socio-spatial relevance of their material expression constitutes an important component in the landscape vocabulary, as "it is in the DNA of urban life" [3] and can be considered a "visible ethical compass of society" [4]. The growing interest in issues related to this category reflects an increasingly urbanized and heterogeneous world. Moreover, public spaces offer the possibility of addressing the consequences of humanity's three greatest global crises (climate emergency, social injustice, and public health). Thus, it constitutes a crucial spatial concept to understand contemporary urban life and is essential to promoting fairer, more inclusive, equitable, healthy, innovative, and sustainable cities. This article will discuss the results of research guided by the Lefebvrian triad, which focuses on two analytical dimensions: the symbolic, which helps understand one of the constitutive essences of public space, and the environmental, connected to issues of combating and adapting to the effects of the climate emergency. The results present a groundbreaking study on the design, management, and planning practices of public space in Latin America, with the collection, analysis, and evaluation of spatial proposals, legal and regulatory frameworks, and types of control that characterize public space. Two questions guided the investigation: How are the projects, built works, and planning processes of public spaces in Latin American countries in the 21st century? What can be considered singular, general, and particular in the practices of this context? Latin American public space shares common characteristics, but it is also shaped by

local political, cultural, social, and environmental particularities. Although there are several international efforts to promote public spaces [5] recognizing the necessity of public domain to achieve the "Sustainable Development Goals" (SDGs), there is still a scattered set of efforts from administrative entities in Latin America [6] [7] [8] [9] and no comprehensive publication on design practices. Thus, this paper summarizes a set of data and practices that have been systematized in an unprecedented way and could help in the expanded understanding of the state of the art formed in the landscape of this part of the Americas. At the same time, it will reveal the specificities and similarities between this socio-spatial reality and its counterparts worldwide, highlighting the relevance of its theories and practices.

1.2 Methods

The results presented here are part of an ongoing investigation that has been developing since 2010, on several fronts. Between 2010 and 2019, the focus was on investigating the physical configuration of public spaces in central areas of major Brazilian metropolises: Manaus, Belém, Fortaleza, Recife, Salvador, Belo Horizonte, Goiânia, Curitiba, and Porto Alegre. The expansion of this research to the Latin American context was partially carried out between 2019 and 2022. However, due to the COVID-19 pandemic, it was limited to monitoring news related to public space issues in major newspapers from Latin American metropolises: Bogotá, Buenos Aires, Guatemala City, Mexico City, Lima, Rio de Janeiro, Santiago, and São Paulo.

A new phase began in 2024, aimed at understanding design, planning, and management practices related to public space within this continental scope, starting with Brazil. The current data collection team is composed of undergraduate and graduate students from the Federal University of Paraná, working within the Public Space Observatory, and divided into two groups: design and planning. The first group is gathering spatial solutions through a public call and by surveying websites, journals, and public design competitions from the last 25 years (2000–2025). The second group is investigating the legal and regulatory production concerning public space in all state capitals and Brazilian municipalities with over 500,000 inhabitants, totaling 47 cities. This grey literature is being collected from the websites of municipal executive and legislative branches. Both groups are also investigating practices from organized civil society, such as NGOs, university extension groups, state public prosecutors, etc., with the goal of mapping the collective production of and about public space in Brazil. With this systematized data, an editorial team and a team of design and planning experts will be assembled to select representative materials addressing the symbolic and environmental dimensions of the Brazilian context. The inspiration comes from the solid work of the Landscape Architecture Foundation (LAF), published since 2006. Based on this experience, the foundational principles for the collection, analysis, and systematization of the Latin American experience will be established.

1.3 Results and Discussion

This paper presents two types of results: i) data gathered from major Latin American newspapers; and ii) public space design and planning practices, which are still in the initial identification stage.

The news collection regarding public space in the analyzed metropolises was carried out over different periods and published in various bulletins by the Public Space Observatory: from March to June 2020 (https://www.observatoriodoespacopublico.com/_files/ugd/79ecc6_364a661acde744f3880d83f3d581712a.pdf), from July to October 2020 (https://www.observatoriodoespacopublico.com/_files/ugd/2ca33b_7806595a06d945d4b813c2f4202855f1.pdf), from January to July 2021 (https://www.observatoriodoespacopublico.com/_files/ugd/2ca33b_c2fb132c99f94ba49e227eaa92f67f7c.pdf), and from August to December 2021 (https://www.observatoriodoespacopublico.com/boletim-008). In total, approximately 4,500 news items were analyzed.

From this set of daily news reports on public space in Latin American metropolises, two main points can be highlighted: i) News related to "violence and security" are dominant across all the newspapers analyzed, throughout the data collection period, echoing previous research focused solely on the Brazilian context (https://www.observatoriodoespacopublico.com/_files/ugd/2ca33b_919e1c657fac432cb2592f1941172a42.pdf). In addition to being a (regrettable) means of attracting readers, they also reflect the real challenges faced by the analyzed cities. ii) Some topics receive little media attention, being underreported or rarely discussed—such as "urban greenery," "street furniture," and "urban art." This suggests a gap in public interest regarding themes that are highly relevant to the professional fields dealing with landscape and urban public spaces.

As for the design and planning practices, the survey is being carried out during July and August 2025, and a more accurate overview is expected soon. However, it is worth noting that preliminary data

which inspired this research already point to a limited structural focus on so-called "Nature-Based Solutions" in both design practices and public space regulations in Brazil—and likely throughout Latin America.

1.4 Conclusion

The growing and widespread interest in public space issues over recent decades has been highlighted by several authors. Mitchell [10] identifies the 1990s as a turning point in the scientific production on this topic, due to the political and economic transformations many countries were undergoing. In terms of governance, the recent involvement of international agencies is notable, particularly the United Nations (UN), through its human settlements program, UN-HABITAT, which has paid special attention to the subject. This effort reflects the established understanding of the indispensability of public space for achieving the Sustainable Development Goals (SDGs), agreed upon during the Rio+20 conference in 2015.

In Latin America, however, a fragmented set of initiatives by administrative bodies can still be observed—this is true for Brazil as well, where this research initially began.

This research is relevant because of its systematic and unprecedented gathering of data and practices, which can contribute to a broader understanding of the state of the art in the landscape of this part of the Americas. It may serve as a guide—or even a provocation—for other urban areas across the continent. At the same time, it will allow for the identification of specificities and similarities between this socio-spatial reality and its global counterparts, also highlighting the relevance of locally developed theories and practices.

Indeed, the Latin American city of the early 21st century, like its predecessors in earlier centuries, reflects in its landscape the prevailing political and socioeconomic structures and the ongoing socio-spatial conflicts. This has shaped an urban form directly resulting from exclusionary patterns of development, planning, and territorial management, in which irregularities, informality, and illegality are not exceptions, but rather the general rule.

These aspects become even more significant when considering that many studies on public space themes are deeply rooted in the physical, social, and legal realities of more economically developed countries. As such, they often do not adequately correspond to the phenomena taking place in Latin America's urban landscape.

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GUIDING LANDSCAPES: LANDSCAPE ARCHITECTURE IN POST-APARTHEID SOUTH AFRICA

TOPIC: Guiding cities through what is alive: Use, memory, artistic creation

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Keywords: Landscape Architecture, Post Apartheid, African Identity, Urban Parks, South Africa

Abstract
This study is based on research conducted in the context of democratic, post-Apartheid South Africa, over 30 years into its democracy. Since South Africa's democratisation, the country has experienced unprecedented change across all facets of society, including science, politics, and environmental concerns. This transformation extends to landscape architecture, mirroring the nation's political emancipation and the profession's evolution.

The Legacy of Apartheid and Public Space
Before 1994, landscape architectural commissions were predominantly driven by the private sector, with government investment in public spaces being both inadequate and misdirected. As a result, the value and meaning of public spaces were severely neglected. The surviving public landscapes lacked significance for the majority of South Africans, as the Apartheid regime's segregation policies prevented the formation of shared spaces where communities could unite.

Common ground—essential for community identity—exists in shared public domains, including streets, plazas, neighbourhood parks, regional parks, and heritage sites. In a sustainable and thriving society, such spaces should be multi-functional, personalised, productive, safe, human-scaled, and resource and energy-efficient. However, under Apartheid, these spaces remained underdeveloped and inaccessible to large segments of the population, particularly in townships where parks were virtually non-existent.

The Post-1994 Transformation
The 1994 political transition ushered in a period of intense national flux, with all aspects of governance and society up for debate. One critical discourse centred on the function, meaning, and relevance of public open space in the new South Africa. This conversation highlighted the necessity of such spaces for community development, particularly in underprivileged townships and heritage projects. The role of designed public landscapes became increasingly significant, demanding socially, culturally, and environmentally responsive solutions. New commissions sought to create spaces that embodied identity and common ground, serving commemorative, memorial, cultural, recreational, and functional purposes. Gradually, landscape architecture began to take on newfound importance, aligning with the broader societal shift toward inclusivity, transformation and identity.

The Emergence of a Distinct post-Apartheid Landscape Architecture
This paper examines two public landscape projects as key milestones in the evolution of post-Apartheid landscape architecture. Each project has pushed the profession beyond its historical boundaries, reinforcing its role in shaping the emancipated landscape. These developments have guided the discipline from a Western-centric model toward an African approach that prioritises identity, authenticity, and communal ownership. By addressing social and environmental challenges, the profession has played a crucial role in guiding the landscapes of a new South Africa. The emergence of these new public spaces has paralleled the political emancipation of African communities, reinforcing the ideals of an African Renaissance and fostering a collective sense of identity and belonging. Through these visionary landscapes, South Africans continue to negotiate their place within an evolving national narrative, solidifying the role of landscape architecture in the country's transformation.

EMERGENCE … NEW BEGINNINGS!

Mpumalanga Provincial Government Complex, Nelspruit, Mpumalanga

Mpumalanga, the "land of the rising sun", was established as one of nine new provinces in a South Africa that emerged in 1994 from a history of racial and cultural intolerance as one of the world's new free democracies. In July of that same year, after much debate amongst the politicians, the Mpumalanga Provincial Legislature decided to centralise all the legislative and executive functions of the provincial government in a single complex of buildings in the provincial capital, Nelspruit, to be renamed Mbombela.

In his presentation to the Cabinet soon after winning the architectural design competition for the complex, McInerney of the firm MPTS referred to it as an 'African Building'. In response to a critic who had asked what was so African about the building, he argued that the completed project would be African by its respectful relationship with the site.

The architects responded by designing "a string of low-strung pavilion-like office buildings that follow the sweeping curve of the tree line, along the natural contours of the site. The buildings open up and engage the forest, creating a gentle transition between buildings and nature. In the southern portion of the site, the Legislature interacts with nature along the riverside edges with the opposite façade also shaped as a sweeping walkway defining a civic square, a place of gathering on axis with the newly constructed boulevard linking the parliamentary complex with the town" (Malan and McInerney, 2001: 24).



Figure 1. Mpumalanga Provincial Government Complex (Source: GA Young).

In early discussions with the architects, it soon became evident to the landscape architects (KWPNLA Landscape Architects in Association) that, in addition to the imperative of sensitively integrating the buildings into the natural environment, the complex and its landscape should reflect its African context in terms of form, materials, and aesthetics. The architectural response would "be informed by past experiences, firmly rooted in the present, whilst giving expression to aspirations and providing for the demands of the future" (Malan and McInerney, 2001: 18).

Given the sensitive approach employed by the architects and referring to the natural environment for contextual and narrative clues, the challenge was to create a new landscape that not only merged and enhanced the fabric of the buildings but also expressed itself with an African identity for its own sake. The overall aim was to create a landscape setting that did not appear as an autonomous add-on, but rather one that integrated the buildings, the designed landscape and the natural environment in a seamless manner.

To this end, landscape and architectural elements were effectively combined to create places for social interaction at a variety of scales. The curved Civic Square, *Isigcawa*, is an extension to the Legislative Assembly.



Figure 2. The domed legislative assembly building (Source: GA Young).

It is an impressive place and is the pivotal space of the entire scheme. Its design presented a challenge for the designers because this was the most public space and in the Client's mind the complex's design needed to make reference to historical patterns of African governance (Noble, 2011:38). The space forms a grand plaza that openly welcomes the public as a venue for large-scale social gatherings and public demonstrations. In responding to the Client's concerns that "some symbolic reference to the old African ways should also be recognised, if only to facilitate a dialogue with the cultural roots of an African democratic consciousness" (Noble, 2011:39), the landscape architects and architects referred to the practice of African elders who would meet outdoors under a tree to debate political concerns and to administer justice. "A village would always have this designated space beneath a tree where the elders would gather, and this provides us with a spatial type

for the traditional African 'court'" (Noble, 2011:38) This interpretation was realised by "including trees – a symbol of an African court – with nearby stepped seating that descends into the square and the comforting sounds of a trickling water feature (see Figure 4)" (Noble, 2011:38). Furthering the reference to local culture, and to be interpreted by the people of Mpumalanga from their differing cultural perspectives, a fountain, resembling a bowl, became the central sculptural element in the plaza. The patterns in the granite sculpture and stainless steel base reflect African motifs and designs also used throughout the building, which relate to various indigenous cultures and date back to Iron Age motifs on pottery shards salvaged from the site.

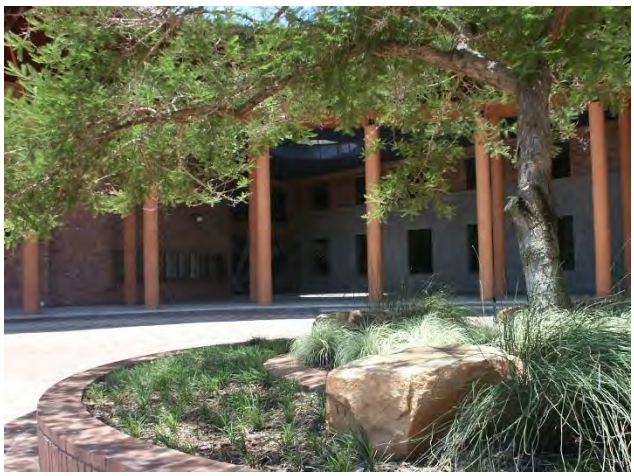


Figure 3. The *Kgotla* tree in *Isigcawa* (plaza) (Source: GA Young).

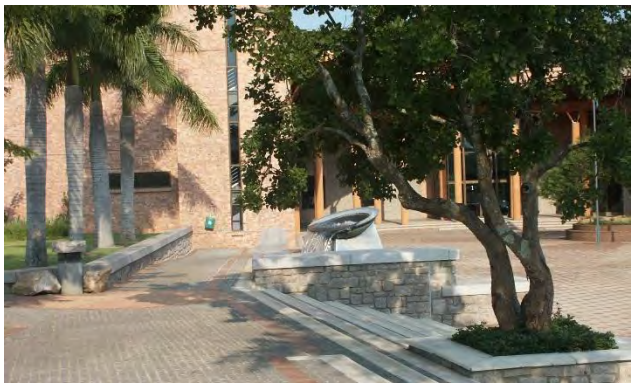


Figure 4. The stylised bowl water feature (Source: GA Young).

The stylised bowl can also be interpreted as a woven basket, a piece of pottery, or, in its most basic form, a sieving pan, making connections with the early gold mining activities and cultural artefacts of the region. At the legislature building, a sunken garden becomes an open-air extension of the parliamentary foyer. This natural granite-walled space with its featured waterfall provides a cool, enclosed retreat that echoes aspects of the Nels and Crocodile River gorges neighbouring the site. Large granite boulders have been placed unevenly in the pool, bordered by sedges, to suggest a natural river course.

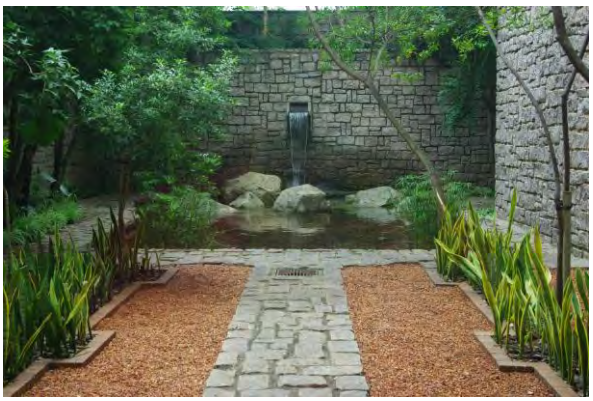


Figure 4. The *Kgotla* tree in *Isigcawa* (plaza) (Source: GA Young).

The overall concept was established during the landscape design competition stage, when environmental responsiveness was introduced as a guiding principle. The aim was to keep the majority of the site as 'natural' as possible, using mainly indigenous plant materials, and to create a transition zone from building to natural landscape in as sensitive and seamless manner as possible.



Figure 5. Transition from built to natural (Source: GA Young).



Figure 5. Transition from built to natural (Source: GA Young).

Interpretation and significance
The project emerged at a time of fluidity, when a spirit of change permeated all spheres of South African life and a new African identity was being sought for the country. "As one of the first major public buildings commissioned in a newly constituted South Africa, the Mpumalanga Provincial Government Complex challenged all those involved to enter, in some respects, uncharted waters. A sense of renewal was to be expressed not only in the desired result, but also in the actual collaborative process leading towards that goal" (Malan and McInerney, 2001:8).

The landscape architects addressed this challenge by creating a landscaped setting that supports and enhances the architecture, while at times being subordinate to it. Yet, at places, the landscape is visible as a unique and distinct art form responsive to environmental and cultural consciousness. This is somewhat analogous to and paralleled what many South Africans were trying to achieve in that honeymoon period soon after the advent of democracy. Perhaps this response symbolised the country's diverse cultures and the emerging political agenda to promote the ideal of an African Renaissance, where the overall effect of cultural interaction was harmonious and unforced and where groups would support and enhance each other, yet at times maintain their unique and distinct identity.

The success of the project lies in its achievement in bringing together many diverse disciplines in the making of a major civic building. "For five years, the Mpumalanga Provincial Government complex engaged thousands of participants from the fields of politics, law, financing and management, architecture, interior design and landscape architecture, electrical, electronic and acoustic engineers. …. Each contributor dedicated his or her unique talents and skills, time and energy to the project" (Malan, C and McInerney, 2001: 8).

The endeavours to introduce symbolic reference to old African ways are also to be commended. They facilitated a dialogue with the cultural roots of an African democratic process, albeit in a tentative manner that "gives preference to tropes of tradition and authenticity. The African signifiers, although pragmatically linked to modern needs, nevertheless rely upon realist representations of traditional themes" (Noble, 2011:53).

The project successfully changed the frame of reference for Government projects. It brought together a multifaceted design team that worked with the Client to deliver a project that responded to the democratic ideals of the new South Africa and created an African identity for the people of Mpumalanga.

ACCEPTANCE AND TAKING OWNERSHIP - COMMUNITY FACTORS
Moroka – Mofolo Park Precinct, Soweto, Gauteng

Urban parks did not enjoy a high profile in South African townships during the Apartheid era. In townships, the few parks that were developed fell prey to the wrath of youths during the 'struggle' and were broken down as a means of protest. Ironically, 'People's Parks' evolved in their place but mainly as a form of protest and to keep youths off the streets and out of the way of the Apartheid police. The parks would literally spring up overnight and would often contain some form of political statement, only to be demolished by the police as soon as they realised the actual intent of the park. The creation of the parks allowed youth to meet and discuss political protest actions, as it was illegal for large groups to gather or engage in any form of political protest. So these parks were an ingenious way to get around the authoritarian Apartheid police, at least for a few days.

Apart from this specific movement, the urban park, before the emergence of the 'new' South Africa, was a relatively unknown entity in the townships. Social engagement and recreation mostly took place in the streets and dusty, overused soccer pitches. Developed park space was not a phenomenon that most township dwellers had a chance to appreciate, and people had few points of reference as to what makes a park 'good'.

Moving into the new political dispensation in the late 1990s, the challenge for designers and public entities concerned with providing parks was to aggressively promote the vital role that parks could play in uplifting communities. The very real perception that they were places of fear, crime and vandalism would have to change and evolve into a vision of parks being catalysts for community development and enhancement; parks could become an essential component in transforming and enriching life in the townships (Oryx Environmental & Newtown Landscape Architects, 2000).

With this residual negative perception of parks, it was essential for landscape architects to reference the objectives of the People's Park movement and remember that what people don't understand, they will not value. And what they do not value, they will not embrace. When the community is passionate

about their environment, is actively engaged in the process of its betterment, and by doing away with single-minded outside designers, something of meaning and relevance can be created.

Moroka Park Precinct

At the start of the planning process for Moroka Park in 2001, the landscape architect, together with the local ward councillor, established a working group to guide the project. The group included the City Council of Johannesburg, Johannesburg City Parks, Department of Agriculture, Conservation, Environment and Land Affairs (DACEL), Working for Water, Department of Environment and Tourism (DEAT), Department of Water Affairs and Forestry, Danish Aid Agency (DANCED), politicians, the ward councillor, and members of the local community.

A series of public meetings between the community and the landscape architect (see Figure 12) resulted in a vision for the park that centred on the rehabilitation of the Moroka Dam. In discussions, the community recalled memories of a clear, open dam in the 1970s, and so the vision for the park evolved to create a beautiful and safe place for the people of Moroka.



Figure 6. A public meeting to discuss the design of the Thokoza Park (Source: GA Young).

The area around the dam was designed to function primarily as a 'neighbourhood park' with facilities that encouraged socialising and play, were easy to access and well connected to the surrounding community. The park was designed to be visible from the street and the surrounding residences, allowing people to see right across it. This was important from a safety perspective because many people used the park as a shortcut between neighbourhoods.



Figure 7. Access across the park was kept open with view lines for safety (Source: GA Young).

Employment of local labourers was an issue raised at community meetings, which resulted in approximately 300 residents being employed during the construction phase. The landscape architects, supported by the community, also felt it necessary that the park gain "added community value". An arts training programme, to run concurrently with the implementation process, was introduced. The program allowed individuals to add personal touches to their environment through the creation of mosaics. The works were installed in strategic locations throughout the park. *Arts in Action,* a group of artists working on collaborative interactive public arts, participatory community projects and developmental programmes concerned with social transformation and change, was employed to implement the project.

Women and local artists were trained, and the mosaics, reflecting neighbourhood and park activities as well as political and social issues, were installed around the park. The program was a huge success. It has added a unique aesthetic to the park, trained people in the art of mosaic and contributed to the community's sense of pride and ownership.



Figure 8. Mosaic of a child's drawing (Source: GA Young).

Interpretation and significance

The park was created using an approach that integrated social and ecological objectives with security concerns (Young, 1993). The overall premise was that traditional approaches to designing urban parks need to change if they are to survive and have ecological and social relevance, thereby contributing to the environmental health (sustainability) and liveability of our cities. Five objectives were established:

- Incorporate social values;
- Develop a planning process which encourages community participation;
- Capitalise on the nature of place and design according to ecological principles;
- Strive for safe environments
- Ensure financial feasibility.

This method was adopted for the Moroka Park Precinct project, reinforcing the notion that to secure the sustainability and quality of urban parks, it is vital to ensure community involvement from the outset and throughout the process.



Figure 9. Women from the community being trained in the art of mosaic making (Source: GA Young).

CONCLUSION

The paper has described the emergence of new landscapes that paralleled the political emancipation of Africans as they negotiated their place in the New South Africa, promoting the ideal of an African Renaissance and identity. The projects pushed the profession beyond its limits at that particular time and advanced post-Apartheid landscape architecture. They also placed the profession at the centre of the emancipated landscape. A new landscape that has grappled with the issues of social and environmental responsiveness and has arguably progressed the profession away from the Western model towards an African model that speaks to identity, authenticity and ownership.

At the Riverside Government Complex, African identity is primarily expressed through architectural form, material finishes and décor. An important step was also taken to facilitate a dialogue with the cultural roots of an African democratic consciousness by referencing the practices of African elders and incorporating distinctly African objects and materials found in the region.

The Soweto project adopted the concept of involving the public from the very beginning through to the design and implementation stages, resulting in a positive shift in the people's perception of the role of public open space in their communities. The approach, grounded in ecological design principles and supported by legislation and political will, focused not only on creating a physical end product but also purposefully strove to ensure a process that fostered community pride and ownership. The project became a catalyst for community development and enhancement. Identity and ownership emerged through the community's participation and the personalised use of the park, rather than through overt forms of African symbolism.

These developments have steered the discipline away from a Western-centric model towards an African approach that emphasises identity, authenticity, and communal ownership. By tackling social and environmental challenges, the profession has played a vital role in shaping the designed landscapes of South Africa.

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The Triple Weaving in the Renewal of Industrial Heritage-type Communities ——Memory, Art and Participatory Production

TOPIC: Guiding cities with society: Use, memory, artistic creation

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Keywords: community renewal, industrial heritage, artistic weaving, participatory production, flexible intervention

Abstract

Global industrial heritage-based communities are facing a double crisis: the physical decay of material space and the social loss of collective memory in the post-industrial era. The open spatial structure of Chongqing's Central Bay community, formerly the largest special steel factory family compound in southwest China, has fallen into the typical predicament of lack of vitality of public space and dilution of community spirit due to the aging of the population. This project explores the unique path of flexible renewal of industrial heritage communities through the triple "weaving" of memory, art and community.

1. Physical translation of industrial heritage memories: The red Heart of Special Steel sculpture stands in the entry plaza of the Center Bay community, built to commemorate the history and community spirit of the Special Steel Factory, carrying the steel memories of the industrial era of the residents of the Center Bay community. The community art installation is placed under the canopy of the community entry tree, next to the Heart of Special Steel sculpture, using red and orange interlocking colors of the rope net, and the Heart of Special Steel sculpture to form a space-time dialogue.

2. Spatial activation mechanism of art weaving: As a part of the planning scheme of the community art festival, the art installation establishes key forms such as shelter umbrellas, nests and other symbols of the home, which are towed on the old tree by high-strength nylon ropes. A combination of hanging, weaving and interlocking designs are woven with 6mm thick ropes to

form a multi-perforated mesh with a density of about 5cm and an area of about 65m². This lightweight structure ensures the stability of the installation, while the flexible materials and lighting settings visually present a light and transparent beauty, intended to maximize interactive perception with minimal intervention, achieving the goal of artistic weaving for spatial revitalization.

3. Community Participatory Production: The community realizes spatial governance innovation through the mechanism of "Special Steel Sage Workshop", realizing the transformation from a production unit to a governance community. Veteran workers guide the weaving and hanging of rope nets with the experience of workshop collaboration, and children hang ping-pong balls with community stories within their reach. This intergenerational collaboration reproduces the collective DNA of "compound production" in the planned economy era, but replaces assembly line labor with artistic co-creation to build a new model of community governance.

Landscape architects play the role of "memory translator" in this project-transforming workshop collaboration into a rope network topology through spatial art techniques, and reconstructing the old industrial plaza into a memory container for intergenerational dialog. This micro-renewal practice proves that when art creation becomes a memory reproduction tool, industrial heritage communities can break through the limitations of material restoration and realize the sustainable activation of social relations, forming a virtuous cycle of "spatial restoration-emotional connection-cultural regeneration".

1. Background and Site Overview

Global industrial heritage-based communities are facing a double crisis: the physical decay of material space and the social loss of collective memory in the post-industrial era[1]. The open spatial structure of Chongqing's Central Bay community, formerly the largest special steel factory family compound in southwest China, has fallen into the typical predicament of lack of vitality of public space and dilution of community spirit due to the aging of the population.

Located in Shapingba District, Chongqing, Zhongxinwan community once served as the family area of Chongqing Special Steel Factory, carrying a heavy industrial heritage gene. As a key site for the 2023 Chongqing Community Planning Art Festival, the project is located in the core space of Zhongxinwan Community—the "Heart of Special Steel" square, a rare flat micro-space (≈120 m²) adjacent to the community's traffic hub. Serving as both a spatial transition and functional interface between the community and urban areas, it plays a dual role of spatial transition and functional cohesion.



Figure 1. Industrial elements in Zhongxinwan Community



Figure 2. Site spatial elements

Under the superposition of several relationships, the site, as a functional node connecting the community and the city, simultaneously carries the activities of residents and the spirit of the community. However, during the visits and research, the design team found that residents believed the site had a low recognition rate, insufficient sense of place, and there was a risk of "local disappearance". Moreover, the memory carriers are not prominent: Industrial memory is only presented in the form of isolated sculptures, lacking deep connections in time, space and emotions. Meanwhile, residents are eager to reconstruct a new type of community relationship - in the post-unit system era, traditional production collaboration has weakened, but a new public communication mechanism has yet to be formed. They expect to transform the original "high-frequency passing and low-frequency staying" space into a bond that promotes community identity and interaction, bringing new opportunities to activate the vitality of heritage communities.

The core proposition of site renewal thus becomes prominent: How to enhance environmental quality and achieve continuous interaction between tangible material carriers and intangible cultural elements within limited intervention?

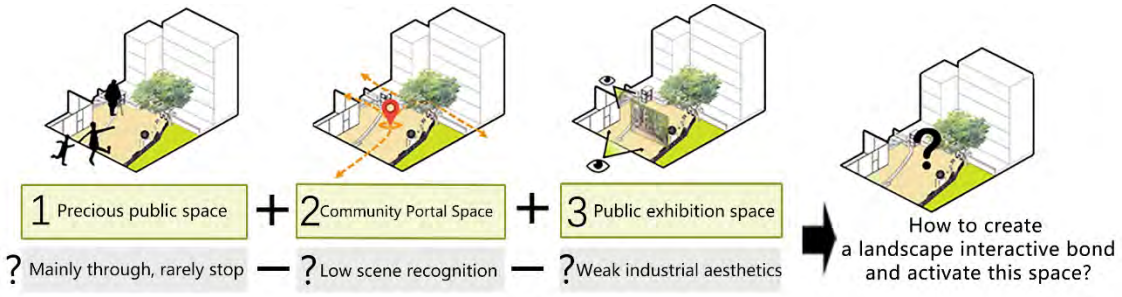


Figure 3. Spatial advantage attributes and problem analysis

2 Flexible Renewal Strategy

The conventional community renewal model often relies on rigid space transformation strategies. Although it can rapidly improve the quality of the physical environment, it also faces the challenges of maintaining the spirit of place and continuing the cultural texture[2]. How to enhance the visibility of the site and deepen the residents' emotional identification with industrial heritage through a design strategy of light intervention and strong narrative within a limited spatial carrier has become the key issue of this art festival's intervention. In view of the unique attributes of the Zhongxinwan Community as an industrial heritage community and the important characteristics of the " Heart of Special Steel" square as a dual value of spatial core and cultural memory anchor point, the design team proposed a "flexible renewal" intervention strategy: On the basis of fully respecting the existing spatial relationships and specific elements, the site will be updated into a spatial core and a new visual focus for the interaction of community residents by placing a flexible artistic landscape[3] and superimposing the original symbols to form a new cultural identity of the community, so as to stimulate the endogenous driving force of community space culture community while improving the physical environment, and explore a local renewal approach.

3 Physical translation of industrial heritage memories

3.1 Industrial Heritage Elements

The "Heart of Special Steel" sculpture stands on the site, which is heart-shaped with dark red steel plate. The mechanical form of gear bite solidifies the industrial memory and becomes the visual and spiritual landmark of the site. There is a big tree with unique shape growing at the entrance of the community building. Its umbrella shaped crown shade the entrance of the

residential building. Under the tree are fitness equipment and seats for residents. The big tree protects the important nodes of community life, forms a potential dialogue with the sculpture of "Heart of Special Steel", and reveals the juxtaposition relationship between natural growth and industrial creation.

3.2 Design Inspiration

The design inspiration comes from the natural protective nature of large trees and the industrial aesthetics of the " Heart of Special Steel " sculpture. Combined with the imagery of the old Huangjue tree and the "nest", through the design of two umbrella-shaped woven fabrics hanging, weaving and overlapping, the team has constructed a semi-wrapped stereoscopic space under the canopy of the large tree at the entrance of the community, creating a visual effect of a "suspended nest". It provides residents with a rest area full of fantasy, continues the dialogue between nature and industry, injects new vitality into the community, and reconstructs the warm image of "home".

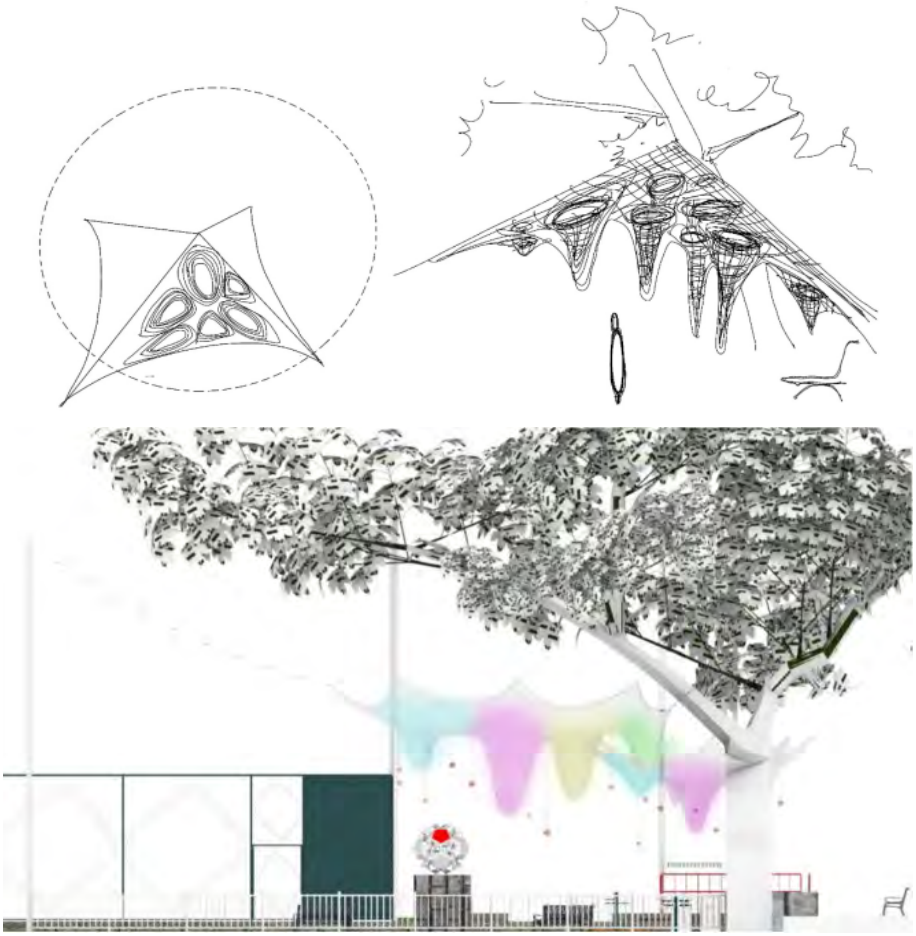


Figure 4-5. Conceptual sketches and spatial models

3.3 Shape Design

The art installation forms a third semi-transparent spatial interface between the ground and the tree canopy. The suspended and staggered conical net pockets enhance the sense of layering and interactivity in the vertical direction, creating a clever spatial interest. The upper rope net, at a height of nearly 5 meters, carries the ecological memory of the tree canopy, while the lower suspension system hangs down to 2.7 meters and easy-wo-touch, creating a spatial transition from looking up to integrating. Under the "nest net", multi-colored lightweight rattan balls are hung, which not only match the simple style of the site but also illuminate the colors, forming a dynamic installation. When the gentle breeze blows, the rope net sways gently, and the community DIY small items hanging below it dance along, making a crisp clanging sound, adding vitality and liveliness to this space.



Figure 6. Design renderings

4 Spatial activation mechanism of art weaving

4.1 Materiality and Craft

After multiple rounds of material comparison, the design team finally chose the lightweight, environmentally friendly and weather-resistant colored woven rope net. Its simple, flexible and highly malleable characteristics can achieve a good match with the community's temperament. The construction uses 6-millimeter thick ropes, with a mesh density of approximately 5 centimeters, a total area of about 65 square meters, and a weight of only about 12 kilograms.



Figure 7. Weaving methodology and material experiments

This lightweight design visually presents a light and transparent beauty. The interlaced combination of red and orange not only echoes the red tone of the "Heart of Special Steel" sculpture but also conveys a light, warm and lively atmosphere. The weaving technique of the rope net combines traditional manual skills with modern design language, ensuring the beauty and functionality of the device.



Figure 8-10. Weaving Art Installation and DIY Pendant

4.2 Lighting effect

During the day, sunlight spills through the gaps of the colorful rope net. The red, orange and orange-yellow colors interweave and collide on the ground, creating a colorful world of light and shadow. The transparency of the rope

net makes the light soft and rich in layers, creating a warm and lively atmosphere for the entire space. As night falls, solar-powered luminous woven rattan balls and LED light strings light up one by one. The light spreads through the woven texture of the rope net, creating a dreamlike and illusory light and shadow effect in the swaying tree shadows. The light, the rope net and the big trees echo each other, lighting up the way home for the community residents and responding to the theme of "Weaving Dream Home".

5 Community Participatory Production

5.1 Participatory Co-Creation

In the "Weaving Dream Home" public art practice, the design team collaborated with community wise men and residents of all ages to jointly create: the community construction team poured steel pipes to build the foundation of the installation, symbolizing the collective strength taking root in the fertile land. The residents worked together to weave a colorful rope net, using silk threads to form a crown umbrella-shaped structure, carrying their hopes for the future of the community. Under the guidance of community wise men, children draw table tennis art installations, outlining their ideal homes with innocent strokes. The elderly inject collective memory into the installation through oral history. These "memory fragments" crafted by the residents themselves not only form the artistic texture of the installation but also weave a close emotional bond. The final completed art installation not only becomes the visual focus of the community's public space, but also serves as an "emotional landmark" co-created by all.



Figure 11. Children participate in the construction process

5.2 Art as Social Catalyst

"Weaving Dream Home" is not only a static art installation but also a reflection of participatory design throughout the entire process[4-5]and a sustainable community bond. It provides rich carriers for community activities. In the festival light show, the installations will be decorated with lights to be even more colorful and splendid. Residents can enjoy the light performance here and feel the joyous atmosphere of the festival. At the story-sharing session, residents can sit around the installation, share their life stories and community memories, and enhance the feelings among neighbors. During the parent-child interactive activities, children can play and learn under the installation, while parents can take this opportunity to exchange parenting experiences and strengthen the bond within the family. Through these activities, the installation will further enhance the cohesion and centripetal force of the community, becoming a symbol of the community spirit and a source of power for sustainable development.



Figure 12-13. Residents and volunteers participate in collaboration

6 Weaving Dream Home

When night falls, the light points on the rope net and the red of " Heart of Special Steel " reflect each other, as if history and the present are having a dialogue of light. This project, centered on flexible renewal, memory weaving, and community co-creation, offers a model different from traditional space renovation: it does not pursue grand visual impact, but awakens the spirit of the place through delicate intervention; it does not emphasize the absolute authority of the designer, but builds a carrier for residents to express their emotions; it does not only focus on the beautification of the physical space, but also is committed to reconstructing the ecosystem of community relations. Here, art is no longer a decoration of the space, but the pen tip of the community's self-writing, and in each interweaving of the rope knots, it continues to write the eternal narrative about "home".



Figure 14-17. Nighttime scenes

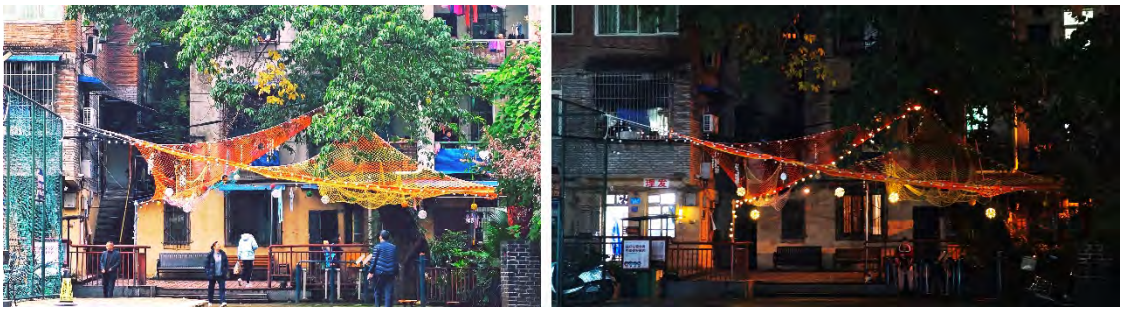


Figure 18-19. Day-night comparative views

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SANTIAGO'S CIVIC HEART: RECLAIMING PUBLIC SPACE FOR CLIMATE RESILIENCE AND SOCIAL UNITY

TOPIC: Guiding cities with society: Use, memory, artistic creation

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Keywords: Urban regeneration, Climate resilience, Public Space, Social Cohesion, Sustainable mobility

Abstract

This article offers a detailed account of a complex, long-term project, that successfully overcame significant political and social challenges to deliver a transformative public space: the redesign project for Plaza Baquedano, Santiago's most emblematic public space. Originally designed in 1928 as a sequence of gardens and monuments, Plaza Baquedano once fostered recreation and neighborhood identity. However, subsequent traffic expansion and fragmented interventions eroded its pedestrian-friendly character. As Santiago's central gathering space, it further suffered degradation, particularly after the 2019 social unrest. In response, the project tackled the challenge of reimagining the vehicular roundabout as an inclusive, vibrant, and contextually rich civic landmark promoting social cohesion and climate resilience.

To illustrate the project's careful balance between radical urban transformation and the preservation of historical identity, the site's historical evolution and the redesign´s core aims are examined. Key design principles and interventions are then detailed, focusing on pedestrian and ecological restoration, the creation of vast open spaces linking cultural landmarks for large-scale events and daily community use, and the establishment of shaded plazas with enhanced walkways to promote active mobility and a sense of belonging.

The anticipated outcomes and impacts are described, reflecting on the project's broader implications and its potential as a model for other global cities. This includes how the elimination of the vehicular roundabout transcended a mere road strategy, serving instead as a profound opportunity to accommodate diverse activities, dynamize the space's character, and integrate it into the urban fabric, thereby reinforcing its evolving significance as a continuing platform for civic discussions.

Recognizing its history as a symbol of social division, the project prioritizes participatory design. Since the 2015 competition win, extensive public engagement has been central to its evolution. Navigating shifts across three national, four municipal, and four regional administrations, the design has fostered cross-political collaboration, ensuring diverse perspectives shape its transformation. This process has achieved a delicate balance between radical urban transformation and the preservation of the site's historical identity. Public surveys confirm broad support for the civic plaza, reinforcing the project's goal of promoting social unity.

Introduction

In an era marked by climate change, accelerated urbanization, and persistent social fragmentation, the redesign of urban public spaces emerges as a fundamental strategy for fostering resilient and equitable cities. Public spaces are the collective lungs of metropolitan areas, reflecting societal challenges and offering significant opportunities for urban improvement. They are dynamic environments where urban life unfolds, communities interact, and collective identities are forged. As Anita Berrizbeitia notes, landscapes are "an act of collective will and social products that record conflicts, diverse interests, tensions, and pressures. As such, landscapes do not arise spontaneously but must be simultaneously created, maintained, controlled, and protected through institutions and government."[1].

The spatial configurations derived from landscape architecture have consequences that transcend its physical dimension. Landscape designs can both enable and inhibit various forms of relationships between entities, with citizens being central to these interactions in urban contexts. Public space represents the fundamental domain for the provision and protection of democracy, given that it is where the deepest expressions of social conflict, individual expression, and cultural exchange manifest. This article focuses on how specific spatial forms can operate as powerful tools in transforming such processes, through the redesign project of Santiago de Chile's most emblematic public space: Plaza Baquedano (or Plaza Italia).

Historically rich and deeply embedded in the city's narrative, Plaza Baquedano progressively degenerated into a functionally obsolete and environmentally compromised area. Originally conceived in 1928 as a harmonious sequence of gardens and monuments to enhance recreation and neighborhood identity, its character became significantly fragmented over a century. Urban expansion and exponential increases in vehicular traffic led to the degradation of its original design through multiple uncoordinated interventions. This erosion gradually stripped its pedestrian-friendly character, culminating in its current state.

Although this central space paradoxically became the city's main civic gathering point, often serving as a focal point for public expression and protest, its physical and social deterioration was exacerbated by significant social unrest in 2019, further weakening its status as a space for citizen gathering and consolidating its perception as a symbol of social division rather than unity. The critical confluence of functional decay, severe climatic vulnerabilities (such as amplified urban heat and ineffective stormwater management), social alienation, and neglected pedestrian environments underscored an urgent imperative for a comprehensive redesign.

The transformative redesign project was initiated with the strategy of converting a vehicular roundabout, once a barrier and a symbol of congestion, into an inviting and inclusive civic plaza. This strategy aims to reconfigure the urban landscape of the sector, primarily by reclaiming vast expanses of vehicle-dominated land for public use.

The project's central objectives are threefold: first, to physically and socially reconnect three previously fragmented urban parks, thereby creating a contiguous green network; second, to foster a significantly cooler and ecologically richer urban environment through innovative green infrastructure; and third, to consciously promote social cohesion by creating a truly accessible and welcoming public space. This redesign seeks to position itself as a strategic intervention for urban resilience and community revitalization in the face of contemporary challenges.

Plaza Baquedano as an urban palimpsest

To fully understand the redesign of Plaza Baquedano, it is proposed to conceptualize it as an urban palimpsest. As landscape theorist Thaisa Way has pointed out in several lectures, every place is a complex web of layers and histories, and Plaza Baquedano is no exception. This space condenses

histories of identity, celebration, encounter, order, violence, and resistance, which the renovation project seeks to integrate into a new design capable of accommodating or articulating these different readings while simultaneously transcending them, to consolidate its future.

In this context, the elimination of the emblematic ovoid-shaped roundabout-plaza Plaza Italia (or Plaza Baquedano), after years of debate, marks a turning point in Santiago. Far from being a mere road intervention to streamline the Alameda-Providencia axis, this change re-signifies a node steeped in historical and cultural memory, a space of collective expression, and a political agora that had lost its original meaning. Its centrality, accessibility, and continuity with three parks enshrined it as a key space for citizen gathering.



Figure 1. Santiago's Social Unrest 2019

Historical evolution of the site

Specifically, this ovoid-shaped roundabout-plaza possesses a rich and stratified history dating back to the late 19th century. Situated at the confluence of major avenues—Avenida Providencia, Avenida Vicuña Mackenna, and Avenida Libertador Bernardo O'Higgins (Alameda)—it has always been a strategic point of vehicular convergence, public transport, and intense pedestrian movement, evolving into the most significant place for mass gatherings nationwide in Santiago.

Its origins date back to 1875 as Plaza La Serena, a visionary initiative by Mayor Vicuña Mackenna to address Santiago's marked deficiency in green public spaces. As Ramón Méndez explains in La ciudad y sus arquitectos: concursos de anteproyectos Plaza Baquedano, Santiago de Chile, Vicuña Mackenna recognized that "the great deficiency of Santiago's topographical plan is its absolute lack of squares."[2] This first iteration sought to transform abandoned land into vital urban green spaces, laying the foundation for what would become one of Chile's most recognized urban landmarks.

The late 19th and early 20th centuries witnessed fundamental transformations that reshaped the plaza's spatiality. The canalization of the Mapocho River in 1888, which freed up a significant amount of land on its banks, profoundly altered Plaza de La Serena. The construction of new bridges, such as the Pío Nono bridge, became essential as the river became impassable [3]. This new configuration transformed the area from an articulator of main avenues into a more generous urban space. By 1892, to commemorate the 400th anniversary of the discovery of America, the plaza was renamed Plaza Colón.

Other architectural and landscape interventions consolidated its prominence. In 1901, Mayor Enrique Cousiño Ortúzar commissioned French landscape architect Jorge Dubois to design and build Forestal Park, which bordered the Mapocho to the south, fundamentally transforming the sector's structure and appearance. The centenary of Chile's independence in 1910 brought an influx of commemorative monuments from foreign communities. The German community installed a fountain in Forestal Park, while the Italian community selected Plaza Colón, which by then was a vibrant hub frequented by "strollers traversing the last stretches of the Tajamar... or those frequenting the newly formed Forestal Park."[4] The Italian community erected an imposing monument to the revolutionary work of 1810, leading to the adoption of the name Plaza Italia, a designation that remains strongly linked to the place even today[5].

The early 1920s saw discussions about a monument to General Manuel Baquedano, hero of the War of the Pacific. Sculptor Virginio Arias was commissioned for the equestrian statue, crowning a pedestal designed by architect Gustavo García

Postigo. A significant change occurred around 1927 with the continuation of the Mapocho canalization, further impacting Plaza Colón/Italia. This site was deemed most suitable for placing the Baquedano monument. A design competition for the new plaza was held, won by architects Carlos Swinburn and Alberto Véliz, leading to the inauguration of Plaza Baquedano on September 18, 1928 [6]. Consequently, the Italian community's "Monument to the Genius of Liberty" was relocated several times, finally finding its current position at the confluence of Andrés Bello, Providencia, and Vicuña Mackenna avenues, officially Plaza Italia today. While the monument to the Italian community christened the square, the figure of Manuel Baquedano in the center of the roundabout gave it the name that prevails to this day.



Figure 2. Plaza Italia 1928

The land freed by the second stage of the Mapocho canalization facilitated the creation of Balmaceda Park (originally Japanese Park, then Great Britain Park), designed by Viennese landscape architect Oscar Praguer in collaboration with Chilean architects. Complementary urban development followed, including the Turri Buildings (housing the University of Chile Theater) and significant urban growth along Avenida Providencia. The introduction of Metro Line 1 in 1975, with a station at Plaza Baquedano, and later Metro Line 5 in 1997, consolidating it as an interchange station, profoundly transformed the plaza into one of Santiago's busiest and most heavily trafficked pedestrian locations. The plaza evolved into a defining cross-point for the city's east-west and north-south axes, serving a dual function of gathering and passage.

Current Situation

Today, Plaza Baquedano transcends its function as a transportation hub and gateway to downtown Santiago. It has become, above all, the most characteristic meeting point and place of popular and spontaneous celebration for Santiaguinos during important sporting, social, or political events. Its central location at the head of Avenida Libertador Bernardo O'Higgins, the city's main avenue, also consolidates its status as a frequent starting point for social demonstrations. However, this profound civic and cultural significance is severely undermined by its spatial configuration. As Germán Bannen observed, the place "itself appears as an opening; the surrounding architecture is not capable of defining its shape."[7]

Despite its urban prominence—tangent to the Mapocho River, at the confluence of three major parks, and at the end of Av. Vicuña Mackenna—Plaza Baquedano has progressively lost its original character as a public space with pedestrian primacy, largely a product of intensified vehicular traffic. This degradation has made the plaza virtually inaccessible to pedestrians, as it sits in the center of an intensive vehicular roundabout. Consequently, it is primarily observed from moving vehicles, transforming it into a transit point rather than a destination for permanence and interaction.

The current deficiencies are numerous and marked, highlighting a profound inconsistency between its metropolitan relevance and its actual urban quality:

1. Dysfunctional as a Plaza:
While it facilitates passage, a plaza should also allow for stopping and permanence, a capacity it currently lacks despite its significant landscape conditions. The inability of pedestrians to access the central roundabout where the General Baquedano monument is located makes its characterization as a functional plaza questionable.

2. Inadequate Park Articulation:
The three converging parks (Bustamante, Forestal, and Balmaceda) are inadequately connected. Bustamante Park is cut off by a street, and the continuity between Forestal and Balmaceda Parks is

severely restricted, especially in front of the Baquedano monument, where pedestrian and cyclist flows converge to a minimal dimension. Similar problems affect the western end of Balmaceda Park, where a monument plinth obstructs pedestrian space.

3. Poor Suitability for Large Crowds:
Despite becoming the de facto location for mass demonstrations, its design is inadequate for such events. The roundabout does not offer adequate safety for large numbers of pedestrians attempting to cross multiple lanes of intense traffic. Furthermore, Andrés Bello's circulation lanes are very close to Baquedano's, limiting the physical space for pedestrian access and circulation north of the plaza.

The current scenario illustrates a place of profound civic importance whose design has been continuously compromised by successive road interventions that prioritize motorized transport. Its urban quality has steadily deteriorated, regaining relevance only when crowds manage to disrupt vehicular traffic to reclaim the space for demonstration. This critical imbalance underscores the urgent need for a new urban project that restores its pedestrian hierarchy while confering a symbolic re-signification.

Urban Vision and Project Objectives

The project's urban vision recognizes Plaza Baquedano not only as a point of vehicular convergence, public transport, and social protest, but as a site possessing immense potential to become one of Santiago's most urban and pedestrian-friendly places. Its current configuration, marked by an inaccessible roundabout and constrained pedestrian routes, explicitly prevents a meaningful connection between the adjacent urban parks.

The intervention in Plaza Baquedano invites a critical reflection on the role of public space in democracy, understanding it as a catalyst for diverse social and environmental demands. The proposed design seeks a future that integrates environmental and cultural health, starting from a precise reading of the site and its context to then generate a proposal that responds to that interpretation. In the words of Teodoro Fernández, "It is not infrastructure that destroys landscapes, ecosystems, and communities, but rather the lack of care in its design."[8]

Traditionally, Plaza Baquedano has played a predominant identity and urban-vehicular role for the city of Santiago. However, its ecosystem potential and its strategic position for the continuity of adjacent parks have not received the same attention. This project seeks to rebalance this, emphasizing its ecological dimension.

The redesign emerged from the 2015 New Alameda Providencia International Urban Design Competition. The winning proposal, "Paseo Cívico Metropolitano" (Metropolitan Civic Walkway), envisioned a new monumental esplanade, emphasizing its civic and pedestrian character, with the explicit goal of reconnecting Forestal, Bustamante, and Balmaceda parks. This design proposed concentrating the roadway in the southern sector of the current roundabout to create a metropolitan plaza of monumental scale, capable of accommodating large concentrations of people. Its edges would feature tree-lined promenades and green areas, materializing pedestrian continuity between the parks.

Building on this foundational proposal, the current project incorporates vital adjustments and updates that respond to significant changes in urban, regulatory, and operational contexts. The foundational operation for the surface design is the reduction and relocation of vehicular roadways, grouping them and moving them to the southern sector of the current roundabout. This strategic reconfiguration aims to establish a new and expansive pedestrian civic space that seamlessly connects Forestal, Balmaceda, and Bustamante parks.



Figure 3. General Plan

To achieve its vision, the project outlines a comprehensive set of objectives, starting with an urban design reconfiguration to create a large civic plaza that re-articulates the pedestrian connections between Forestal, Balmaceda, and Bustamante parks. This involves a reorganization of the road network, aiming for minimal impact on the central ovoidal space containing the monument. The plan also prioritizes the rescue and restoration of Plaza Baquedano's identifying elements, especially its distinctive shape, and seeks to preserve its identity as a large urban void with openness to the surrounding geography, serving as a vital space for civic representation. Furthermore, the project aims to define new tree-lined pedestrian promenades that provide continuous shade along the sector's edges to accommodate high pedestrian flows, alongside implementing a durable pedestrian pavement system suitable for intense use, with specific considerations for heritage, natural, and infrastructural elements. To enhance the plaza's environmental quality, the project will define appropriate plant material, selecting species with permeable soils that suit Santiago's climate and the plaza's diverse uses. Finally, ensuring inclusivity is paramount, with a strong focus on defining universal accessibility routes throughout the entire project area. These collective objectives clearly articulate a path toward transforming a fragmented, vehicle-dominated space into a cohesive, pedestrian-centric civic landmark that respects its historical legacy while embracing its future as a resilient and unifying public space.

Design Principles and Interventions

The transformation of Plaza Baquedano into a civic and ecologically resilient space is based on the application of six interconnected design principles and strategic interventions that transcend mere aesthetic renovation.

1. Reconfiguring the Urban Fabric
The project addresses a fundamental reconfiguration of the urban fabric, prioritizing pedestrian life, ecological integration, and climate adaptation.

2. Roadway Reconfiguration and Pedestrian Prioritization
A central axis of the redesign is the re-engineering of the vehicular landscape with the aim of reclaiming public space. Inspired by the winning proposal of the New Alameda Providencia International Competition, the project proposes a drastic reduction of vehicular lanes, relocating the Alameda Providencia axis to the south of the existing roundabout. This modification eliminates the roundabout configuration, freeing up a new and extensive civic space approximately 200 meters long, 75 meters wide, and an area of 14,000 m², dedicated exclusively to pedestrian use. This fundamental change transforms the plaza from an urban barrier to a permeable urban heart, prioritizing the pedestrian experience over vehicular traffic.

To optimize pedestrian connectivity, three new pedestrian crossings are strategically incorporated, linking the plaza with Bustamante Park, and a large crossing towards Forestal Park. Likewise, the reduction of roadways on Avenida Providencia generates a significant widening on the southern edge of Balmaceda Park, enabling the implementation of universally accessible sidewalks that facilitate uninterrupted east-west pedestrian circulation, a previously non-existent transit axis. This set of coordinated operations establishes a continuous pedestrian surface, effectively connecting adjacent parks and making historical monuments within the plaza accessible. The remaining roadways are conceived as shared or at-grade surfaces, a deliberate strategy to "demarcate this urban landmark and reduce vehicular speed,

reinforcing pedestrian priority." The reduction of vehicular roadways and the configuration of shared surfaces seek to "mitigate urban segregation and encourage pedestrian appropriation of the space."

3. The Central Void, the Edges, and the New Civic Plaza

The urban configuration is articulated around two main concepts: the enhancement of the characteristic central void and the creation of green, tree-lined edges that ensure continuity between the surrounding parks while providing shade. The central void is established around the General Baquedano monument, which maintains its current location. This space is preserved as a focal point for mass gatherings, integrated into the new civic plaza. Its iconic oval green surface is redrawn as a precise ellipse, restoring the original geometric figure of its design. This central ellipse features a subtle elevation of approximately 40 cm above the surrounding terrain, serving to "cover the underlying potable water infrastructure and visually enhance the monument, positioning it as the focal point of the plaza." The elliptical configuration and subtle elevation of the terrain around the Baquedano monument seek to "reaffirm its role as a central landmark and improve visibility for civic events." This new configuration is designed to adapt to the diverse flows and views that converge on the plaza, ensuring that during mass events, the entire space, including vehicular roadways, can be safely used by pedestrians.



Figure 3. The Central Void and the new civic plaza

Throughout the plaza, a continuous ground plane is proposed, upon which a network of straight, tree-lined promenades is defined, aligned with the proposed routes and the axes of the main existing elements on the site. This design creates a "cohesive and universally accessible ground that organizes flows and paths." Between these promenades, permeable surfaces are integrated, designed to effectively drain rainwater and provide optimal conditions for new vegetation. In the northern sector, a raised area of approximately 40 cm is designated, delimited by a longitudinal bench, for the planting of dense associations of herbaceous plants and Chilean carob trees, forming a significant vegetated edge that provides natural shade, a crucial climate adaptation strategy for Santiago's climate.

4. The Esplanade of the Arts

The Esplanade of the Arts, located in front of the historic Turri Buildings and the University of Chile Theater, is conceived to host two distinct yet converging scales of use: large-scale public events and more intimate, permanent uses, such as café terraces. The design achieves this coexistence through two differentiated ground levels. A lower level with a gentle slope, adjacent to the Turri Buildings, expands existing gastronomic terraces, resolving access to commercial premises.

The upper level forms a new continuous plane connected to the Providencia sidewalk and a new staircase for Metro Line 1. This level incorporates a strategic grid of medium-sized trees on its east and west sides, creating shaded circulation spaces while clearing the central sector in front of the theater and the Baquedano monument. This open central area ensures unobstructed use for cultural and high-attendance events. Particularly, this upper level provides greater depth above the metro station slab, which significantly aids the successful planting and long-term growth of the tree grids. To optimize tree development in this challenging urban context, the project proposes installing Silva Cell-type elements. These advanced structural modules create a subterranean framework that supports the paving above while keeping the underlying soil uncompacted. This innovative design ensures the infill soil remains loose and permeable, supplying trees with the ample oxygen, water, and nutrients vital for robust root growth and overall health—conditions often compromised in densely

paved urban areas. This approach represents a crucial advancement in green infrastructure within complex urban environments.



Figure 4. The Esplanade of the Arts

5. Landscape Design for Ecological Resilience and Experience.
The landscape proposal articulates the various types of landscapes present in the converging parks, reinforcing a sense of continuity while recognizing the unique roles of the different project elements. This approach is fundamental for integrating climate resilience.

The Tree-lined Promenades, inspired by Forestal Park, feature lines of large canopy trees strategically projected along the main pedestrian flows of the plaza. These provide continuous shade, define paths, and create long, attractive vistas. The superposition of these promenades in different directions creates diverse spatial experiences and degrees of openness. Complementing this, the Mass Tree Planting, inspired by the dense tree masses of Balmaceda Park, groups trees to form shaded areas for rest and permanence.



Figure 5. Tree-lined Promenades

The concept of an Open Esplanade to Sun and Geography maintains a clear, treeless center, marked by a pure geometric lawn around the General Baquedano monument. This area, with its gentle topography, retains its "visual dominance and its openness to Santiago's impressive geographical backdrop," seeking to "preserve the iconography of the place and its visual relationship with the Andean geographical environment." For the Esplanade of the Arts, a grid of medium-sized trees is implemented, referencing existing liquidambars, to provide shade while leaving an unobstructed void for events. The innovative use of Silva Cell-type elements beneath the pavement "facilitates the healthy growth of trees over the metro slab, overcoming significant infrastructural limitations," demonstrating "an innovative approach to green infrastructure in complex urban contexts."

For the selection of plant species, sustainability criteria were paramount, guiding the choice of species with low water requirements and proven acclimatization in urban environments. A deliberate effort was made to include native species to attract beneficial insects, strengthening biodiversity. The project also prioritizes the preservation and enhancement of existing notable trees within the intervention area, integrating them into the new landscape design. These comprehensive landscape strategies collectively aim to "enhance the aesthetic appeal, ecological function, and microclimatic performance of the plaza, transforming it into a cooler, greener, and more welcoming public space," contributing to climate resilience and the environmental quality of the public space.

6. The tension between the Mineral and the Vegetal
The discussion on the configuration of contemporary public spaces is enriched by the tension between the mineral (paved surfaces) and the vegetal (green identity), a "negotiation or battle" that, according to Rodrigo Pérez de Arce in "Public Arenas and Contested Grounds. On Grass and Paving Stones"[9] has acquired a "character of urgency." We have witnessed the transformation of spaces previously dominated by vehicles into

"filtering gardens, spaces for pedestrians, and promoters of biodiversity and shade." International examples such as the green axes of Barcelona's Eixample, the conversion of Strand and Aldwych Street in London, or the transformation of Place de la République in Paris, illustrate this trend towards pedestrian prioritization and green integration.

However, Pérez de Arce also warns about the inherent risk of indiscriminate inclusion of green, particularly grass, which "can easily hide more complex levels of behavior management." He cites the case of Tahrir Square in Cairo post-2011, where "planting was a means to erase protest," symbolically transforming the square into an object of contemplation, into a "battleground between the arena for mass gatherings versus the search for extensive vegetation."

In this context, the Plaza Baquedano redesign project does not intend to be an exclusive garden or to fill the space with green to erase its identity. On the contrary, through the planting of 200 trees that will form shaded promenades, the design of filtering soils adapted to the local climatic reality, and the inclusion of shrub and herbaceous areas that promote the appearance of beneficial insects, a balance is sought. Likewise, spaces are designated for mass gatherings with stone pavements capable of supporting intensive use. In this way, emphasis is placed on the environmental design of the plaza through the landscape, conceiving vegetation cover as urban infrastructure. This allows for the "consolidation of its monumental identity, re-tracing the geometric and symbolic form of a green center and allowing for the conservation of the monument in its current position."

The benefits of this environmental approach are both visual and functional. They include the ability of trees to reduce greenhouse gases through carbon storage, decrease stormwater runoff through interception and absorption, and mitigate the urban heat island effect by reducing surface and air temperature at a local scale.

This strategy in Plaza Baquedano will allow for "the ecological and pedestrian reconnection of Forestal, Bustamante, and Balmaceda parks," prioritizing civic space and subordinating vehicular use to the benefit of pedestrians, intensifying and diversifying its urban and democratic use.

Conclusion

Considering Rem Koolhaas's reflections in "Whatever Happened to Urbanism" [10], where he posits that a "new urbanism will no longer be concerned with the arrangement of more or less permanent objects but with the irrigation of territories with potential," the intervention in Plaza Baquedano aligns with this vision. The project does not seek a definitive stable configuration, but rather the "creation of enabling fields that accommodate processes that refuse to crystallize in definitive form." Instead of meticulous definition or the imposition of limits, the aim is to "broaden notions, deny limits, not separate and identify entities, but discover unnameable hybrids." The Plaza Baquedano proposal, by integrating and reconciling multiple layers—historical, social, ecological, and functional—aspires to be precisely an example of this dynamic and adaptable urbanism. Public spaces are much more than efficient transit routes; they are also places of encounter and symbolic representations of our political, social, and cultural identity. In this sense, the Plaza Baquedano redesign project transcends a simple urban intervention; it represents a model of integral regeneration that addresses contemporary challenges such as climate change, social fragmentation, and functional obsolescence. The elimination of the roundabout is more than a road strategy; it is an opportunity to better accommodate the diversity of activities that can take place around this renovated space, dynamizing its character and integrating it into the urban fabric. In the coming years, the evolution of urban life around this new space will be observed, aware that the needs of cities are always in constant transformation.

By transforming a vehicular roundabout into a pedestrian and ecologically resilient civic space, the initiative not only restores the pedestrian's hierarchy and fosters community cohesion but also sets a precedent for adaptable urbanism. This new

approach, which balances the site's rich historical memory with the demands of a sustainable future, positions Plaza Baquedano as an enabling field that will evolve with Santiago's needs, demonstrating the transformative power of design to create more equitable, vibrant, and prepared cities for the challenges of the 21st century.

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Hwangtot-gil, Korea's Barefoot Clay Paths Guiding to Health and Nature

topic: Guiding cities through what is alive: Soil management

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Keywords: Hwangto-gil, soil, clay path, walk barefoot, de-pave

Abstract
Driven by a "barefoot walking" craze, South Korean cities are creating 'Hwangtot-gil' (red clay paths) in urban green spaces. These paths, made of Hwangto, allow citizens to connect with nature and promote health. Initially a private initiative, Hwangtot-gil have spread nationwide with government support, serving as an innovative urban green space model that actively manages soil as part of the ecosystem.

1. Introduction
The trend of promoting health and seeking communion with nature has recently strengthened in Korean society, leading to a widespread barefoot walking craze. This has resulted in a nationwide movement to create Hwangtot-gil (red clay paths), with many local governments actively building infrastructure and competing to create "premium Hwangtot-gil". Hwangtot-gil goes beyond simple walkways, creating various environmental, health, psychological, and economic values as a core element of the urban ecosystem.(Figure 1) This paper examines the multifaceted aspects of Hwangtot-gil.[1]



Figure 1. Hwangtot-gil(seoul.go.kr)

2. Information on materials and methods
This study investigates how Hwangtot-gil started and spread in Korea, identifying its current status and characteristics through literature review. The research methods include direct field experience (Daejeon Gyeryongsan Hwangtot-gil and urban Seoul Hwangtot-gil) and literature review. The literature review utilizes public data from the Korean government and local governments responsible for Hwangtot-gil creation and maintenance, as well as relevant papers and media. Additionally, it aims to understand the cultural and social significance of what makes Hwangtot-gil appealing to Koreans and how it is becoming a part of their daily lives. This paper comprehensively explores the diverse contributions of Hwangtot-gil, particularly focusing on its role as urban infrastructure promoting health, a medium for human-nature interaction, and a sustainable soil management model. It analyzes the physiological and psychological benefits of barefoot walking on loess and the ecological benefits derived from Hwangtot-gil's natural material composition, while evaluating its potential within broader urban soil management strategies.

3. Results

3.1. Cultural Implications of Earth, Clay, Soil

Earth is a material used for making pottery, hearths, houses, and fences; it is the topsoil we walk on, nurtures plants, and where we are eventually buried. Ancient Greek natural philosopher Empedocles considered earth a fundamental substance of the universe, and modern French philosopher Gaston Bachelard developed material imagination from earth. Earth is closely intertwined with human life and the planet, and Hwangtot-gil, with earth as its main theme, not only promotes health for those who walk barefoot but also helps enrich their inner selves by fostering interest in the material of earth and material imagination.

Hwangto, in particular, is a material deeply rooted in the Korean psyche, frequently appearing in poets' works and symbolizing the cycle of life. Historical records from Goryeo Dynasty scholar Yi Gyu-bo indicate that Hwangto caves were useful for preserving flowers in winter and for weaving, demonstrating Hwangto's known properties of heat retention, humidity control, detoxification, and healing. The gudeul (traditional Korean underfloor heating system) culture is a prime example of utilizing Hwangto's excellent thermal conductivity and heat storage structure, believed to facilitate physical recovery through body-to-floor contact. Even today, Hwangto is used in various forms such as Hwangto jjimjilbang (saunas), Hwangto apartments, and Hwangto beds, emphasizing its health-promoting functions including far-infrared ray emission (94%), automatic humidity control, air purification (antibacterial), and harmful electromagnetic wave blocking. This illustrates that Hwangto is a friendly material deeply involved in Korean life and health, beyond just a building material.[2]

3.2. Creation and Management of Hwangtot-gil

Barefoot walking paths are natural earth paths or those mixed with loess or decomposed granite, created for the health and healing of pedestrians, allowing barefoot walking. When constructing Hwangtot-gil, artificial hardening agents like quicklime or cement are avoided. As 100% loess surfacing is difficult to manage, mixing with materials like decomposed granite is recommended (e.g., decomposed granite 6 : loess 4). The recommended surfacing thickness is 5 cm or more (5-10 cm), and the recommended width is 1.2 m or more, or 1.8 m or more for two-way traffic. Hwangtot-gil has a porous structure and is made of 100% natural materials such as diatomaceous earth, pozzolan, and silica sand, ensuring eco-friendly soil free from harmful substances and heavy metals.[3][4]

3.3. Origin of Hwangtot-gil: Daejeon Gyeryongsan Hwangtot-gil

Daejeon Gyeryongsan Hwangtot-gil, originally an ordinary forest road, gained nationwide prominence when Mackiss Company (formerly Seonyang), a local enterprise, invested over 20,000 tons of loess from 2006 to create an approximately 14.5 km long barefoot walking path. This company has consistently managed the Hwangtot-gil in optimal condition for over 16 years, investing 1 billion won annually (totaling over 20 billion won of private funds), replenishing 2,000 tons of loess each year, and turning over the soil and watering it when it hardens in the sun. This voluntary and continuous private investment played a crucial role in establishing Gyeryongsan Hwangtot-gil as a "sacred place for barefoot walking".

While Gyeryongsan Hwangtot-gil began under private company leadership, it evolved into a public-private partnership model in 2012 when Daejeon Metropolitan City and Mackiss Company signed a business agreement to make it a famous attraction. Local governments support the social contributions of local companies and collaborate on infrastructure expansion, while local companies contribute to promoting Daejeon and creating economic synergy by developing Hwangtot-gil into a regional tourism product and linking it with festivals. This cooperation was crucial in establishing Gyeryongsan Hwangtot-gil as a public asset beyond a simple private project. [5][6][7] Gyeryongsan Hwangtot-gil is now visited by over 1 million people annually and encourages high citizen participation through large-scale events like the 'Daejeon Barefoot Festival'. Visitors utilize loess piles as mud playgrounds or participate in various weekend programs like forest concerts, interacting with nature. Convenience facilities such as shoe storage and foot-washing stations are provided at the entrance, enhancing user comfort. This voluntary participation demonstrates Hwangtot-gil's function as a community space

contributing to local community revitalization and citizen health, beyond mere infrastructure. [8]

4. Discussion

4.1. Main Benefits of Hwangtot-gil

Hwangtot-gil generates various positive effects through human-nature interaction.

Nature/Environment: Hwangto's permeability promotes rainwater infiltration, reduces runoff, and contributes to groundwater recharge. It helps prevent soil erosion by incorporating plant roots or rye. In conjunction with urban forest creation, it provides diverse habitats and contributes to ecosystem service recovery. Microbes and enzymes (catalase, diphenol oxidase, etc.) in Hwangto perform toxin removal, waste decomposition, and air purification functions. Hwangto's moisturizing effect and green space creation help introduce cool air into the city and improve air quality, alleviating the urban heat island effect.

Health: Acupressure on the foot soles boosts blood circulation and metabolism, neutralizes active oxygen, alleviates inflammation, and strengthens immunity. Barefoot walking strengthens foot and lower body muscles, improves physical balance and agility, and aids in spinal and posture correction.[9]

Psychological Healing: Geosmin in the soil, phytoncides from the forest, and serotonin secretion from sun exposure alleviate anxiety and depression. The earthing effect stabilizes brain waves (increases alpha waves, decreases beta waves) and normalizes cortisol hormones, inducing sound sleep. Brain function activation through walking and nature interaction positively affects memory improvement.

Tourism/Economy: It has emerged as a national attraction visited by over 1 million people annually and has high value as a tourism resource, being selected as one of the 'Top 100 Korean Tourist Destinations'. Increased visitors stimulate the local economy, and demand for personnel for Hwangtot-gil maintenance creates employment.

4.2. Important considerations regarding Hwangtot-gil

Systematic soil management is essential for the sustainability of Hwangtot-gil. 'High-management' Hwangtot-gil, composed of 100% loess, requires significant manpower and intensive management for watering, turning over soil, and removing impurities like fallen leaves to maintain its moist and soft state. When dry, it can harden, increasing injury risk, or be vulnerable to soil erosion during rainfall. Therefore, periodic watering, soil leveling, replenishing lost soil, and removing impurities are necessary. Hwangtot-gil should be constructed in flat areas with a slope of 5% or less, with surface drainage as a principle, installing drainage channels to prevent water accumulation, and ensuring sufficient compaction to minimize soil erosion due to rainwater. Periodic inspections to ensure it is managed below soil contamination concern standards are also important for safety. Such systematic management contributes to maintaining Hwangtot-gil's ecological function and ensuring user safety. And, more verification is needed regarding the medical effects of Hwangtot-gil.[10]

5. Conclusion

Hwangtot-gil goes beyond simply being a health-promoting facility; it plays a crucial role in transforming cities into living ecosystems. This can be viewed as a form of sustainable urban development that simultaneously seeks human health and natural recovery in modern urban environments disconnected from nature. Daejeon Gyeryongsan Hwangtot-gil, in particular, exemplifies a successful public infrastructure developed through the pioneering investment of a private company and the voluntary participation of citizens. For Hwangtot-gil's long-term sustainability, systematic soil management and environmental considerations must be further strengthened. Understanding loess characteristics, applying erosion prevention technologies, conducting periodic contamination inspections, and devising ways to encourage continuous community participation are essential. Hwangtot-gil offers multi-layered value by providing urban residents with opportunities for nature interaction, enhancing urban ecological health, and contributing to regional economic revitalization. To maximize these values, efforts are needed to develop standardized guidelines for Hwangtot-gil creation and management and to research models applicable to various urban environments. Through these efforts, Hwangtot-gil can further expand its role as a healthy and eco-friendly living space that future cities should pursue.

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GENETIC IDENTIFICATION AND PUBLIC PARTICIPATION MECHANISM OF INDUSTRIAL LANDSCAPE BASED ON PLACE ATTACHMENT: XUHUI RIVERSIDE HERITAGE BELT IN SHANGHAI

TOPIC: Guiding cities with society: Use, memory, artistic creation

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Abstract

Under the background of the shift from human land conflicts to cultural spatial rights gambling driven by new urbanization, the value of regional culture and local memory preservation is increasingly prominent. As an important carrier of industrial heritage, industrial landscapes face the dual dilemma of cultural gene breakage and lack of governance mechanisms. The symbolic collage of landscape forms dissolves the spirit of place, the homogenization trend of functional updates weakens regional characteristics, and the intergenerational memory gap exacerbates the crisis of local identity. This study takes the theory of place attachment, which explores the relationship between society and human geography, as the starting point. Taking the Xuhui Riverside Industrial Heritage Belt in Shanghai as the empirical object, it systematically sorts out the historic evolution law of its industrial landscape, explores historical genes and contemporary regeneration paths, and explores the dual mechanism of public emotional identity and social interaction. Research has shown that Xuhui riverside has undergone stages of industrial agglomeration, functional decline, and cultural regeneration since the beginning of the port industry in the late 19th century. It has fully presented a spatial reconstruction trajectory from an "industrial rust belt" to a "lifestyle ribbon". However, it has also been found that there are historic landscape contradictions such as the coexistence of protective decline and developmental destruction, excessive intervention, and rigid patterns. Based on these, this study proposes the concept of "memory anchor point", "functional patching", and "participation empowerment". Through the virtual reconstruction of the digital twin platform landscape and the augmented reality interaction of physical space. It is suggested to optimize the accessibility and narrative coherence of heritage corridors. It advocates for participatory design to stimulate creative community building energy, and construct a dynamic cycle of "social identity", "landscape production", and "behavioral feedback". This study not only expands the explanatory dimension of place attachment theory in the reproduction of historic landscapes, but also provides operational pathways for the preservation of industrial heritage in the context of urban renewal, which has important practical value for building a new type of humanistic urban cultural landmark.

Text

1. Introduction

As an important material carrier of urban historic lineage and collective memory, the industrial landscape of riverside heritage belt not only records technical achievements, production and living styles of specific eras, but also constructs the core realm for public emotional identity and local belonging. However, current large-scale redevelopment practice often prioritizes functional replacement of physical space and enhancement of economic value, lacking systematic identification and precise protection of deep cultural genes embedded in industrial landscapes [1]. Moreover, they neglect socio-cultural values as

emotional bonds and identity symbols, which easily lead to the fragmentation of historic information and the dissipation of collective memory. Consequently, it undermines the formation and maintenance of public place attachment, ultimately exposing renewed spaces to risks of "amnesia" and "inactivation".
Therefore, based on the theory of place attachment, this study systematically summarizes experiences of industrial landscape renewal under this perspective. Focusing on the industrial landscape of Xuhui riverside belt in Shanghai, it systematically analyzes public participation mechanisms and inherent issues during transformation, while exploring optimized design strategies. This study is expected to provide novel approaches for solving the dilemma of "emotional detachment" within industrial landscape, promoting the leap from physical space renewal to sustainable socio-cultural space regeneration.

2. Concepts of Place Attachment and Industrial Landscape

2.1. Place Attachment

Place attachment refers to the emotional, cognitive, and practical connections between people and their environment, with theoretical predecessor being Y.F. Tuan's "Topophilia", which was proposed in 1974 [2]. It mainly encompassed two dimensions of place dependence and place identity. Subsequent researchers have continuously supplemented the classical two-dimensional model, enriching the knowledge architecture of place attachment (Table 1). Among them, the three-dimensional concept based on "Person-Process-Place" (PPP) integrates previous complex theories into "Subject-Kinship-Object" framework model, emphasizing the dual physical and social attributes of the place, making it the most widely used theoretical model at present [3].

Table 1. Different dimensions of definition on Place Attachment.

Dimension	Scholar	Content
Two	Williams	Place dependence + Place identity
Three	Bricker	Place dependence + Place identity + Lifestyle
	Kyle	Place dependence + Place identity + Social bonding
	Scannell	Person + Process + Place
Multi	Hamit	Place dependence + Place identity + Place familiarity + Belonging + Rootedness
	Lally	External evaluation + General attachment + Continuity with personal past + Perception of familiarity + Commitment

Therefore, "Residents' place attachment" refers to the long-term living of local residents in the vicinity of heritage areas; their familiarity with built environment and cultural characteristics of heritage; and their retention of local memories. It includes residents' sense of identification with history and local values, a sense of belonging, and happiness. "Tourists' place attachment" encompasses both local and non-local tourists in Shanghai, who engage in recreational activities in landscape areas. They have direct and profound perceptions of tourism service facilities and commercialization degree. It focuses on tourists' reliance and satisfaction with functional services, as well as their intention to revisit.

2.2. Industrial Landscape

The industrial landscape is an integrated entity that results from interactions between environmental landscape and industrial heritage. It possesses the composite value system in terms of art, history, science and technology, society, and economy values, encompassing both tangible and intangible aspects (Table 2). The "Environmental landscape" reflects reasons for the selection of site location, spatial layout, and interaction with surrounding landscapes, representing both the natural attributes in the visual sense and humanistic attributes within the ideology. "Industrial heritage" refers not only to buildings, structures, or machinery, but also to the collection of interrelated entities with production-related significance [4].

In conjunction with official international charters and documents, this study posits that industrial landscapes fall under the category of industrial heritage and cultural landscapes. Their essence lies in placing industrial heritage within an organic and unified framework of landscapes. This framework not only reflect value characteristics of industrial heritage, but also highlight the cultural core of sustainable human-nature interaction.

Table 2. Definition and components of industrial landscape.

Major	Medium	Component
Environmental landscape	Natural	A. Natural topography and geology; B. Raw production materials (coal and metal ores); C. Organic aggregates (water, vegetation, and soil)

	Built	A. Regional planning; B. Systematic transportation network (highways, railroads, ports, airways); C. Public facility (cultural and educational, commercial and recreational, scientific, medical, greening)
Industrial heritage	Material	Same definition in The Nizhny Tagil Charter for the Industrial Heritage
	Immaterial	Industrial process, corporate culture, rule and regulation, worker organization, value, collective memory, lifestyle, traditional custom

2.2. Cases of industrial landscape renewal from the place attachment perspective

2.2.1. Environmental landscape optimization

The Seattle Gas Works Park adopted the "Museum-style" preservation and display approach to enhance the sense of historic narrative and elevate the spirit of place. Selective restoration of original industrial landscape and integration of new natural elements were employed to minimize intervention on the damaged ecosystem and foster self-recovery. These approaches promoted ecological value of industrial landscape, while endowing it with unique artistic expression (Figure 1).



Figure 1. The Seattle Gas Works Park.

2.2.2. Historic authenticity reproduction and sustainable development

The Shougang Industrial Park subdivided the large-scale industrial land into small-scale urban blocks to create pedestrian-friendly neighborhoods. It inserted structures of diverse styles and scales to eliminate monotony of the single visual element, thereby activating the vitality of small-scale areas. In view of significant elevation differences between the cooling tower sedimentation pond nodes, the design team undertook the multi-level process of functional disassembly and reconstruction in order to convert the sedimentation ponds at both sides into sunken greening, which was designed with the depression for rainwater runoff. It added a steel-framed pedestrian bridge as the transportation link to maintain the continuity of historic scenery and enrich the landscape skyline. In addition, efforts were made to gather popularity and organize major events such as the Winter Olympics (Figure 2). The strategies mentioned above greatly expanded the influence of industrial landscapes in this project.



Figure 2. The Shougang Industrial Park.

2.2.3. Adaptive reuse from rejuvenating community vitality

The Tasset Silk Factory in Lyon, France, had been intensively promoted by the surrounding citizens to retain elements such as factory buildings, water towers and sheds. It formed public activity spaces between the former workers' settlement and the multi-modal transportation hub, in order to serve as potential core landscape nodes and demonstrate distinctive features. In the dimension of ecological sustainability, the preservation and adaptive reuse of industrial landscape was efficiently realized through restoring and highlighting the original character-defining elements; increasing green space and public facilities; and selecting environmental-friendly materials with energy-saving technologies (Figure 3).



Figure 3. The Tasset Silk Factory in Lyon.

3. Materials

3.1. Development history of industrial landscape in Xuhui riverside heritage belt, Shanghai

From ancient times, Shanghai Xuhui riverside was named after the intersection of Zhaojia Creek and Fahua Creek. From 1870 to the early 20th century, the Huangpu riverside area had already gathered a large number of factories and warehouses, with the railway and water freight transportation bustling. Around 1930, light industry, textiles, papermaking, food processing and other national capitalist industries had been established on a considerable scale. At the end of 1990, the government formed the urban production functional area, which was mainly for transportation, logistics and warehousing, production and processing. It gathered large industrial plants, such as the Nanpu Railway Station, the Beipiao Coal Terminal, the Shanghai Aircraft Manufacturing Plant, the Longhua Airport, and the Shanghai Cement Plant. Nowadays, the famous "Xuhui Riverside Heritage Belt" refers to the south extension of the Huangpu River, as formulated in the "Comprehensive Development Plan for Both Banks of Huangpu River" [5]. It has a shoreline length of about 11.4km and an area of 9.4km^2. Currently, the developed section of Xuhui riverside landscape, which is relatively mature and accessible, stretched about 8.4km along the shoreline. It is adjacent to the Lupu Bridge in the north with the Ruihui Port Bridge as starting point, and connected to the Longyao Road Tunnel to the south with the Tank Shanghai Art Park as truncation point (Figure 4), which defines the geographical scope of research area.

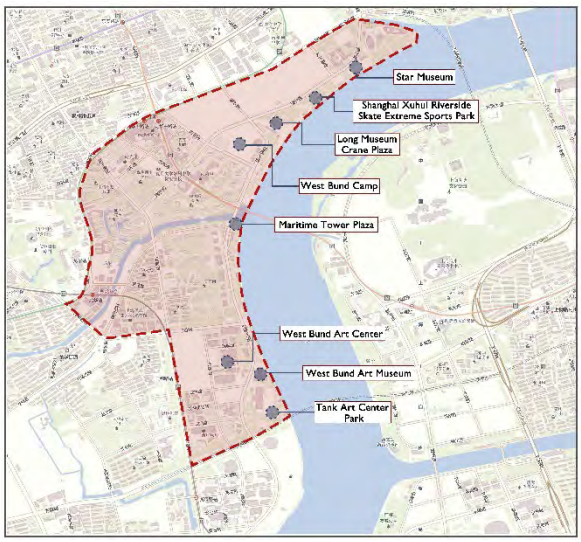


Figure 4. The geographical scope of research area in Xuhui riverside belt, Shanghai.

Reviewing the preservation and regeneration history of industrial landscape in Shanghai, it is predominantly based on local regulations and apply many strategies. Existing projects are managed in accordance with laws, utilizing creative industries to promote landscape revitalization, and pushing forward organic landscape renewal through major urban events [6].

(1) In 2002, the Shanghai government declared the comprehensive development for both banks of the Huangpu River, aiming to improve the quality of public spaces and reshape functional industries. (2) In 2008, taking advantage of the World Expo, the construction of Xuhui riverside landscape had been fast-tracked to enhance public awareness, as well as efficiently coordinating recreational spaces with flood works. (3) In 2012, the "Development Plan for the Areas Along Both Sides of Huangpu River During the Twelfth Five-Year Plan Period" required waterfront to tap into follow-up effects of the World Expo. It took optimization of spatial pattern, cultivation of industrial functions, improvement of infrastructure, and enhancement of ecological environment as key objectives. (4) In 2017, the "Shanghai Urban Master Plan (2017-2035)" explicitly included riverside areas on both banks of the Huangpu River. It advocated for the conversion of industrial architectural heritage into cultural and creative, as well as leisure and tourism functions. (5) In 2016 and 2017, the "Shanghai Urban Space Art Season" established three paths (cycling path, running path, walking path) to open up breakpoints and enhance functionality of activities, so as to achieve the goal of returning the waterfront to the people. (6) In 2019, the "Shanghai Urban Space Art Season" focused on quality of waterfront landscape, industrial sites, and potential for cultural heritage transformation.

3.2. Renewal status of industrial landscape in Xuhui riverside heritage belt, Shanghai

Guided by the "People's City" goal and the "Integration of the old into the new" model, the regeneration of Xuhui riverside industrial landscape belt is functionally oriented to integration of public recreation and cultural creativity. Shoreline planning adheres to the principle of cultural heritage authenticity, preserving high-value industrial elements, and eliminating numerous outdated layouts to reorganize landscape circulation (Table 3). Each section of core shoreline has different themes, such as the plastic walking path along entire riverfront, the elevated pedestrian bridge converted from and industrial-era transmission path, and public recreational areas for ice skating and ball games. It is committed to transforming the "Industrial Rust Belt" into the "Lifestyle Ribbon", thereby creating

unique humanistic imagery and composite values [7].

Table 3. Industrial landscape renewal project along Xuhui riverside.

Industrial heritage	Begin	End	Current function
Nanpu railway station + Gantry crane	1908	2006	Nanpu railway station garden
Beipiao coal terminal + Tower crane	1929	2014	Long museum + Crane plaza
Maritime lookout tower	1980	2014	Maritime tower plaza
Longhua airport	1930	2014	Yuz museum
Shanghai aircraft manufacturing factory	1930	2017	West bund art center
Longhua aviation fuel storage tank	1930	2019	Tank art center + park

4. Results

4.1. Public participation mechanism

The construction center of riverside industrial landscapes has gradually shifted from conservating production in the industrial era to serving people's livelihoods in the new era, as well as from grandiose narratives to life-oriented transformation. The basic role of public participation is to collaborate with government agencies, end-users and their neighboring stakeholder groups to develop design strategies for the target area, which meets the above objectives. Considering that participants of the regeneration towards industrial landscapes in the riverside belt include site history researchers, end-users, and peripheral interest groups, this study designed a questionnaire based on the two dimensions of place dependence and place identity, investigating residents and tourists around the industrial heritage of Xuhui riverside. Questions were designed to address public attributes, the two dimensions of measurement, behavioral patterns, and transformation demands. It used the format of 5-point Likert scale to express place attachment levels.

4.1.1. Behavioral pattern

Through multi-temporal on-site investigations, this study categorized existing activity types with high-aggregation sites in industrial landscapes of Xuhui riverside belt (Figure 5). It was found that, the Xuhui riverside belt combines industrial landscapes with arts and cultural pavilions distributed throughout the section. People mainly engage in sighting, running, walking, basketball, roller skating, group dancing, and parent-child recreational activities (Table 4), which provide rich possibilities for participation and interaction. The industrial landscape in this area takes activity sites as core nodes, with highly integrated linear spatial section, which fully reflect the inclusiveness and adaptability towards various activities. In contrast, within the typical industrial landscape of Yangpu riverside, Shanghai, running paths, cycling lanes, and riverfront trails are segmented by the river or dense greening. While the separation can innovate thematic activities and enhance safety, it simultaneously fragments spatial vitality.



Figure 5. Public activities in industrial landscape of Xuhui riverside belt.

Table 4. Divergence of activities, needs and perceptions of tourists and residents.

Dimension	Tourist	Resident
Activity type	A. Sightseeing, B. Art exhibits	A. Daily exercise B. Dog walking C. Kids playing D. Social interaction
Spatial preference	A. Art gallery B. Wharf C. Social attraction	A. Sports park B. Convenience store C. Rest seat
Core claim	A. New experience B. Cultural consumption	A. Life convenience B. Facility comfort
Attachment difference	Strong symbolic identity (uniqueness > utility)	Strong functional dependence (convenience > aesthetics)
Perceived weakness	A. Art distance B. Constrained depth of interaction	A. Deserted on workdays B. Insufficient commercial facilities

There exists a divergence in the role positioning of industrial landscape within spatial narratives across

two typical areas. Xuhui riverside emphasizes the organic integration of industrial landscape into the contemporary living scenarios, while part of Yangpu riverside overemphasizes visual presentation and historic symbols, thereby weakening their attributes as carriers of daily life. This imbalance unidirectionally channels public attention toward the landscapes themselves, where linear traversing and static observation inhibit the potential for spontaneous and aggregative activities.

4.1.2. Place attachment mechanism

The two dimensions of place attachment and place identity were measured as follows (Table 5). The results indicate that the public's place attachment to the industrial landscape of Xuhui riverside belt varies at the level of several sociological variables.

Table 5. Place attachment scale.

Dimension	Measurement indicator
Place dependence	A. I am *satisfied* with the environment, facilities, activities and services of this regional industrial landscape. B. My *sightseeing* here is *irreplaceable*. C. If I wanted to explore the industrial landscape in Shanghai, the *foremost site* comes to mind is this location. D. Among all the riverside industrial heritage landscapes I have visited, I am *most impressed* with this site.
Place identity	A. I feel *relaxed* and *enjoyable* during my visit to this industrial landscape. B. I would like to *visit again* or *live* in the surrounding area. C. I would *recommend* this industrial landscape to other relatives and friends. D. I have very special feelings about the industrial landscape in this region, it is *irreplaceable*.

At the gender level, women exhibit higher degree of place attachment than men, with significantly higher scores in the dimension of place identity. Due to their generally delicate emotional experience patterns, women tend to develop emotional resonance with industrial landscapes in symbolic sense.

In terms of age, the degree of place attachment demonstrates U-shaped pattern across the lifespan, initially declining before rising again. Specifically, adolescents are more likely to develop intense emotional bonds with landscapes through transient recreational and physical activities. Elderly residents cultivate profound topophilia and rootedness toward local landscapes due to accumulated life experiences. In the context of public identity, residents in surrounding areas have stronger perceptions of place attachment, which is closely related to their long-term and high-frequency use of industrial landscapes. The steady flow of people in the Xujiahui business district and mature neighborhoods along Xuhui riverside belt generates rich living scenarios within the landscape, which promotes the accumulation of emotions. Further differentiated by activity categories, tourists are predominantly attracted by art exhibitions and iconic industrial structures, whereas residents engage in diverse forms of interaction with industrial landscapes, serving as a crucial foundation for heightened place attachment.

4.2. Shortcomings of industrial landscape under the perspective of place attachment

4.2.1. Space creation

(1) The south coastline of Caohejing port has obvious spatial hierarchies due to differences in terrain elevation. Passageways among hierarchies are linear and structured, while hindering the spatial accessibility. For instance, the absence of pedestrian bridges or elevated galleries along both banks of cross-river channel results in breakpoints and fragments riverside greenway. (2) Some areas are overly concentrated on layouts of cultural pavilions and lack small-scale food or retail services, which lead to short period of vitality during daytime and lower utilization at night. A large number of south riverside plots remain underutilized, creating void-like urban interfaces. (3) Industrial equipment components are mostly simplified as "Landscape Sculpture", with weak attributes of climbing and sightseeing activities. (4) The large-scale spaces like the Maritime tower plaza have excessive amounts of hard pavements, which enhances the sense of oppression. Moreover, greening shades and rest facilities are limited and reduce environmental comfort performance.

4.2.2. Industrial atmosphere

(1) The symbolic display of landscape elements is disconnected from narrative, lacking dynamic experiences and functional assignments. For instance, the coal funnel at entrance of the Long Museum has visual impacts, but it does not have any narrative linkage with inside exhibitions or public activities. Water entry structures of wharf employed monotonous static model, thereby losing their aesthetic appreciation value. (2) The selection of materials and colors for landscape pavements and facilities neglects image elements or texture quality that perpetuate original industrial. For example, even though the iconic remains have been

repainted in bright colors, the stark contrasts compromises integrity of overall character.

4.2.3. Ecological suitability

(1) The ecological connection between riverside and hinterland is relatively fragmented. Even though green corridor and slow-moving systems had been established, lacking of sufficient linkage with hinterland corridors has weakened ecological connectivity. (2) Regional synergy of the ecosystem is missing. Coverage of rainwater management and hydrological remodeling is still insufficient in Xuhui riverside heritage belt. (3) Existing researches have emphasized importance of public participation in ecological sustainability, but actual renovation projects are more focused on cultural identity and commercial vitality. It results in the lack of social supports for ecological maintenance of industrial landscapes.

5. Conclusion

To reshape the industrial regional character and context, the Xuhui riverside belt in Shanghai is currently advancing the landscape optimization of core areas and the construction of undeveloped zones. Based on the analysis mentioned above, this study summarizes renewal strategies for industrial heritage landscape under the perspective of place attachment, aiming to build a dynamic virtuous cycle of "social identity", "landscape production", and "behavioral feedback".

5.1. Spatial integration and scale transformation

(1) Efforts focus on building organic links between old and new landscapes, integrating with the surrounding urban fabric and natural riverbanks to form a coherent landscape network through clear path systems, view corridors and node connections. (2) The grand scale of industrial machinery spaces can be transformed into the pleasant pedestrian experience scale, utilizing the volume of cranes and silos to shape landscape landmarks, while creating recreational micro-environments in surrounding areas.

5.2. Enhance hydrophilicity and revitalize industrial relics

(1) It is suggested to design multi-level riverside walkways, accessible ecological revetments, viewing nodes and water-friendly sites, optimizing the microclimate and vegetation configuration to enhance comfort and interest. (2) We can treat industrial remains as landscape genes and spatial accents, adopting revitalization paths instead of simple demolition or complete preservation. For example, the structures with structural safety and landscape value (trusses, equipment base) are implanted with functions (art installation base, exhibition gallery, climbing facility); industrial materials (corroded steel plate, precast concrete part, industrial pipeline) are artfully recycled to transform historical traces into physical carriers of spatial narratives.

5.3. Involvement of industrial culture and empowerment of public participation

(1) Further optimization can incorporate industrial context into new landscape designs by utilizing landscape vocabulary, spatial forms, and small-scale facilities to cultivate an atmosphere that awakens collective craftsmanship. (2) Efforts can emphasize the path of "memory anchor point", "functional patching", and "participation empowerment", which entails identifying key industrial landscapes as core nodes of emotional memory and enhancing their legibility through physical protection, information identification, and digital technologies. Flexibly weave contemporary leisure functions (fitness, cultural exhibition, creative markets, community gardening, science education) to meet the needs of diversified public. Establish a digital twin platform to realize virtual reconstruction of industrial landscape. It also supports public participatory design through online opinion solicitation, virtual scene experience feedback, and community creative workshops, thereby facilitating public engagement in the process of landscape renewal and daily construction. This digital platform improves the accessibility of heritage landscape corridors and the coherence of historic narratives.

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TRADITION OR BETRAYAL OF MEMORY: THE IMPACT OF CHROMATIC INTERVENTIONS ON THE FACADES OF *LARGO DA ORDEM* IN CURITIBA-BR

TOPIC: Guiding cities with society: use, memory, artistic creation

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Abstract

This research examines urban interventions in brazilian historic centers, focusing on landscape transformation and cultural homogenization. The (re)creation of urban landscapes is framed as a complex and controversial phenomenon, wherein urban areas are stylized and commercialized to attract visitors and stimulate the economy. While these interventions bring economic and aesthetic benefits, they also raise concerns about the loss of local identity and cultural mischaracterization. In this context, cultural heritage and landscapes in Brazil, as well as globally, are threatened by homogenization and chromatic "carnivalization." These interventions not only erase historical marks but also lead to pictorial degradations that damage the landscape, heritage, and identity of these cities. The study explores various approaches to the concept of landscape and its relationship with memory and the preservation of cultural heritage, viewing landscape as a collective legacy rich in historical value and memories, bearing traces of the past. Landscape is also interpreted as a text full of meanings and symbols, shaped by cultural, historical, and social contexts. Each individual's interpretation of landscape is influenced by personal experiences and cultural backgrounds, essentially making it "a way of seeing the world". As such, landscape becomes a subjective poem narrating the city's history and evolution over time. Focusing on *Largo da Ordem* in Curitiba, Brazil, the research investigates local perceptions of these interventions and their impact on cultural heritage preservation and the construction of local identity. The findings reveal a lack of historical and heritage recognition among residents and merchants, as well as approval and encouragement for the use of vibrant colors in the landscape. These results underscore the urgent need for an approach that prioritizes the value of cultural heritage. Implementing heritage education programs is crucial to strengthen a sense of identity and belonging, ensuring the preservation of this legacy for future generations. Raising awareness among the population of Curitiba, and Brazilian society at large, is essential to protect and respect the history, culture, and landscapes that make our cities unique and meaningful.

Introduction

This research investigates the growing spectacularization and homogenization of urban landscapes in Brazilian historic centers, phenomena driven by city marketing and the aesthetic logic of globalized capitalism [1]. Cities are increasingly transformed into images and spectacles, promoting an aestheticized reality that turns heritage into simulacra [2]. In the context of an image-based society, chromatic interventions—often sponsored by companies like AkzoNobel—alter historical landscapes with vibrant colors and generic stylizations, often lacking contextual relevance [3].



Figure 1. In Europe and Central America, clockwise: Wroclaw in Poland; Santa Catalina Arch in Antigua, Guatemala; Curaçao, Dutch Antilles; and Burano, an island of Venice, Italy.



Figure 2. Some examples in Latin America, clockwise: Jirón de la Unión in Lima, Peru; Bogotá, Colombia; Cartagena de Indias, Colombia; and Plaza Murillo in La Paz, Bolivia.



Figure 3. In Brazil, just a few examples, clockwise: João Pessoa (PB); Fortaleza (CE); Olinda (PE); and Tiradentes (MG).

While these transformations visually enhance the spaces, they raise concerns about the loss of local identity and the symbolic and cultural dilution of urban landscapes. Landscape, understood as both language and cultural representation, is shaped by historical and social values and bears the marks of collective memory [4]. The growing spatial and chromatic homogenization leads to a "Disneyfication" of urban centers, resulting in scenographic spaces and cultural dilution [5].

In this light, the research aims to understand the impacts of chromatic interventions on heritage and urban identity, taking *Largo da Ordem* in Curitiba as a case study. The investigation navigates the tension between conservation and transformation, advocating for a critical approach that values the cultural uniqueness and historical memory of landscapes [6].

The Hundred Thousand Landscapes: The Relationship Between Landscape, Heritage, and Color

The concept of landscape is multifaceted and dynamic, reflecting diverse individual and collective perceptions. The multiplicity of these perceptions can be compared to the hundred thousand facets attributed to Moscarda in Pirandello's novel *One, No One and One Hundred Thousand*, which symbolizes the diversity of views and experiences that shape the landscape. Nogué [6] expands this vision by stating that landscape is more than a simple representation of the world: it is a cultural construction that reflects the values and symbols of a society.

From a phenomenological perspective, landscape is understood as a sensitive and multisensory experience. One can highlight its engagement with the senses and emotions, or the dynamic relationship between subject and space, in which space "enters into us." It is also possible to differentiate landscape as a cultural "mark" and as the "matrix" of relationships between society, space, and nature, reinforcing its relational nature [7]. Furthermore, one can distinguish between landscape *tout court* and cultural landscape [8], the latter incorporating memories and historical identities, seeing landscape as the result of everyday experiences and cultural heritage.

In the field of cultural heritage, the concept of landscape has evolved significantly. Originally, the term heritage referred to property, but today it includes cultural assets with symbolic value. The Brazilian Federal Constitution (Art. 216) recognizes Cultural Heritage as including historical, artistic, environmental, landscape, and intangible aspects, reflecting cultural diversity.

The landscape can be sees as an expression of historical values and collective memory, incorporating historical marks built through human-nature interaction. Duncan and Duncan [5] understand landscape as a symbolic and cultural

text whose reading is continuous, with the observer acting as author by recreating meanings.
The perception of landscape is subjective and culturally influenced, resulting in multiple readings. Nogué [6] highlights that landscape is simultaneously present and past, a historical legacy formed by previous layers, and summarizes that landscape can be a physical reality and the cultural representation we make of it; the external and visible physiognomy of a certain portion of the earth's surface and the individual and social perception it generates; a geographical tangible and its intangible interpretation. Thus, landscape functions as a "poem" that narrates the history and evolution of a place, shaped by the cultural experiences and readings of observers.
In research, the relationship between landscape, memory, and color is central to understanding how urban chromatic transformations impact the preservation of collective memory and cultural identity, avoiding homogenizations and valuing diversity. The metaphor of the palimpsest emphasizes landscape as a historical layer that demands an "archaeology of the gaze" to reveal hidden meanings.
Collective memory, dynamic and socially constructed, is fundamental to cultural identity and is related to landscape as discourse of memory, history, and culture [8]. Likewise, color in urban heritage acts as a "fossil trait," preserving historical authenticity and influencing the feeling of belonging [9].
Thus, faced with the multifaceted nature of landscape, like the character Moscarda, it is fundamental to choose the appropriate facet according to the investigative objective.

Chromatic Interventions: From the World to *Largo da Ordem*

Chromatic interventions in historic façades have intensified over recent decades as urban revitalization strategies. The international "Let's Colour" program, launched by AkzoNobel in 2009, has implemented over 2,500 color-based projects in communities worldwide, including historic areas. This aesthetic homogenization manifests a recurring chromatic vocabulary—bright, saturated hues—regardless of local history or materiality. The program discourse emphasizes positivity, community engagement, and beautification, aligning with neoliberal narratives of empowerment and participation. In practice, however, it often erases unique cultural traits in favor of universal visual appeal.

In Brazil, this pattern is evident in AkzoNobel's "*Tudo de Cor para Você*" initiative, which has transformed nearly a thousand urban sites, including heritage zones, into lively but often anachronistic settings. These interventions promote inclusivity and local engagement through volunteerism and painter training. Yet, the visual language adopted is frequently disconnected from historical palettes and original materials.
Brendle [3] cautions against such practices, noting their tendency to obscure historical textures and material authenticity. The chromatic standardization, aimed at tourist attractiveness, leads to a pasteurization of visual identity. While aesthetically appealing, this approach risks converting rich cultural landscapes into scenographic, touristic façades.

From Creation to (Re)creation: The Chromatic Transformation of Largo da Ordem

Largo da Ordem (Figure 4), the historic core of the city Curitiba (Brazil), emerged in the 18th century and houses significant architectural landmarks, including the *Romário Martins* House—its only colonial remnant—alongside the *Igreja da Ordem Terceira*, *Casa Vermelha*, and *Casa Strobel* (Figure 5). Urban planning efforts since the 1940s progressively codified its protection, culminating in comprehensive zoning laws in 2000 that embraced both material and symbolic heritage values.



Figure 4. Largo da Ordem today: the Historic Zone in contrast with the evolving urban landscape of the Central Zone.



Figure 5. *Largo da Ordem* in 2023, featuring the Casa Vermelha (red), part of the *Casa Strobel* (yellow), and the Boesia Bar (blue).

Curitiba has long projected itself as a "model city," especially since the 1990s. City branding efforts intertwined urban policy with communication strategies, crafting a public image grounded in innovation and sustainability. Within this framework, *Largo da Ordem* emerged as a focal point for revitalization projects, particularly those employing color as a transformative tool.

The 1995 "*Cores da Cidade*" initiative marked the first large-scale chromatic intervention, a collaboration between the city government and AkzoNobel. This partnership supplied free paint and technical guidance for façade repainting. The project continued into the 2000s with "*Tudo de Cor para Você*" and later "*Rosto da Cidade*," further institutionalizing color as a central strategy in urban revitalization.

While official documents cite the preservation of cultural heritage, the chromatic logic employed often favored visual renewal over historical fidelity. Projects in the 2000s and 2010s repainted entire streets (Figure 6), and repeatedly, *Largo da Ordem* with bright, uniform palettes aimed at enhancing touristic appeal.



Figure 6. São Francisco Street and its colors.

These programs reveal the symbolic and strategic importance of color in shaping the city's image. However, they also expose the tensions between conservation and commercialization. The chromatic homogenization of *Largo da Ordem* undermines its layered historical identity. Colors are often selected based on marketing appeal rather than historical research, compromising material authenticity and memory.

In line with UNESCO's Nairobi Recommendation and the Historic Urban Landscape (HUL) approach, the indiscriminate use of color can threaten the integrity of urban heritage. The case of *Largo da Ordem* illustrates how well-intentioned revitalization projects—when aligned with commercial interests—may prioritize image over substance, spectacle over memory.

Investigation of the Method

Both landscape and the qualitative approach adopted in this research demonstrate a break with positivist thinking, which values objectivity as the production of knowledge. In this context, the central objective of this study was to unveil the subjectivity in the reading of landscape.

To achieve this, data collection involved semi-structured interviews combining guided conversations and the photo-elicitation technique. This approach allowed participants to express and externalize their perceptions and experiences related to the landscape. The interview was structured in three distinct parts: participant identification; exploration and reading between landscape and word; and analysis of perception between landscape and image. Thus, the research sought to understand landscape from the experiences and opinions of participants.

To deepen the understanding of the topic, this study adopted a single case study approach focusing specifically on *Largo da Ordem* in Curitiba. This choice allowed a detailed analysis of the impact of chromatic transformations on the landscape and how these transformations are interpreted by participants. By focusing on the meanings attributed to the landscape by those involved, the research sought to capture the multiplicity of perceptions that shape the understanding and apprehension of landscape.

(Mis)Encounters in the Way of Seeing Largo

The interviews revealed diverse and complex perceptions of the *Largo da Ordem* landscape. Participants highlighted its bohemian, multicultural atmosphere and its historical importance as the city center but also expressed concerns about safety, showing the duality of the place between day and night. Individual and collective memories reinforced

the emotional bond with the space, whose reading incorporated natural, architectural, and artistic elements, showing subjectivity influenced by cultural and personal contexts.

In analyzing photographs of Latin American historic centers, participants divided the cities into two groups (Salvador, Ouro Preto, and Paraty; Santiago, Cusco, and Quito), based on architecture and the coexistence of old and contemporary. They also noticed the aesthetic homogenization of Brazilian cities, reflecting a standardization that threatens the appreciation of local singularities.

The vibrant colors associated with Brazilian identity and Carnival, promoted by the *Tudo de Cor para Você* program, were criticized for simplifying and stereotyping cultural diversity, generating a "carnavalization" that distorts historic centers. Perceptions of chromatic changes in Largo diverged: while some valued the liveliness brought by the colors, others prioritized preserving historical identity.

Residents and merchants emphasized the importance of conserving original facades, security, infrastructure, and tourism promotion, pointing to the need for collaboration between public and private sectors to balance urban development with heritage preservation.

The research identified that chromatic interventions promote a recreation of the landscape but also a cultural pasteurization, compromising local memory and identity. Landscape was understood as a historical text whose interpretation varies according to individual experience, often perceived first by its social uses and only later by its historical dimension.

Finally, a lack of local historical knowledge among residents was evident, indicating the urgency of greater valuation and dissemination of cultural heritage to strengthen the population's connection with *Largo da Ordem*'s identity.

Conclusion

Residents and merchants of *Largo da Ordem* demonstrated little historical and heritage recognition of the place, reflected in the lack of attention to the colors of facades, important elements of local memory and identity. Chromatic recreation can represent a possible betrayal of memory, although this hypothesis cannot be confirmed due to the limitation of historical visual data in color.

The research highlights a gap in valuing continuity between past and present, emphasizing the need for heritage education programs involving managers, institutions, and the community to strengthen the sense of identity and belonging, preserving cultural legacy.

New investigations may deepen the relationship between color, historical value, and contemporary perception of landscape, considering the current social context.

Like Moscarda, landscape carries marks and scars that bear witness to its history and lived experiences, and its memory is always subjective, interpreted through the unique lens of each individual. Moscarda, who rejected a fixed identity to be "no one," symbolizes the challenge for landscape to preserve its multiple facets so as not to lose its essence. Recognizing this cultural uniqueness, through a participatory process, strengthens the bonds between people and place, promoting cultural diversity and sustainable development respectful of heritage.

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THE IMPACT OF SPATIAL TRANSFORMATION ON PLACE ATTACHMENT: THE CASE OF HALIÇ SADABAD PARK

TOPIC: Guiding cities with society: Use, memory, artistic creation

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Keywords: environmental consciousness, place attachment, urban reflections, collective memory, cultural heritage

Abstract
Historically and culturally significant parks play a crucial role in shaping urban identity, collective memory, and place attachment. They serve as living archives of a city's heritage, providing spaces where historical events, cultural expressions, and social interactions intertwine to create a shared sense of belonging. These spaces are not only physical landscapes but also cultural artifacts that embody historical narratives and societal values. As cities evolve, these parks often undergo spatial transformations, which can influence users' emotional and psychological connections to them. Such changes may enhance or disrupt the park's original character, affecting how individuals perceive, experience, and relate to these historically and culturally significant spaces. The balance between preserving cultural heritage and adapting to contemporary urban needs raises critical questions about the sustainability of place attachment in transformed spaces. This study investigates how the spatial evolution of Haliç Sadabad Park affects users' sense of belonging and the extent to which this attachment remains connected to the park's historical identity. By exploring users' perceptions and experiences, the study reveals whether the park's transformations reinforce its historical essence or create a new, evolving identity within the urban fabric.

To explore this relationship, a combination of research methods is employed. Historical analysis is conducted by examining old maps, photographs, and restoration projects to understand the park's spatial transformation over time. Surveys and in-depth interviews with visitors capture their perceptions of place attachment, focusing on their emotional and psychological connections to the park. Ethnographic research and participant observation provide insights into spatial usage and social interactions, shedding light on how users engage with the park in its current form. Content analysis and cultural memory studies further explore historical narratives and the ways in which collective memory influences contemporary experiences of the space. Additionally, frequency analysis of visitor profiles and spatial usage patterns helps to understand the evolving relationship between users and the park over different periods.

The findings of this study will contribute to a deeper understanding of how spatial transformations affect the emotional and social connections individuals develop with historically significant parks. By examining how users interpret and interact with the transformed space, this research sheds light on the broader dynamics of cultural heritage preservation, environmental consciousness, and urban reflections. Additionally, the study highlights the role of landscape architects in mediating between conservation and change, emphasizing their influence in fostering a sustainable sense of belonging. The outcomes will provide valuable insights for future studies on sustaining identity and collective memory in historically significant parks while also offering perspectives on urban design strategies that support the continuity of cultural landscapes in evolving cities.

1. Introduction

In contemporary urban environments characterized by high density and rapid transformation, historic and culturally significant landscapes play a crucial role in shaping urban identity and strengthening collective memory. Public spaces such as parks, gardens, monuments, and heritage structures are not merely physical sites; they function as cultural signifiers that sustain the connection between past and present. Particularly in cities like Istanbul—where layers of history and modernity coexist—these landscapes act as vital mediators for cultural continuity, environmental consciousness, and a sustained sense of place [1,2]. In this regard, heritage landscapes are increasingly acknowledged not just as aesthetic elements but as arenas where people negotiate belonging, meaning, and memory.

1.1. Place Attachment

Place attachment refers to the emotional, cognitive, and behavioral attachments that individuals develop to certain places. This attachment is particularly strong in places of cultural or personal significance and takes on a deeper meaning when historical narratives intersect with everyday practices. In urban parks with historical functions, this attachment is shaped through both physical elements (architectural structures, landscaping) and intangible elements (rituals, social memory). The visibility and accessibility of historical memory in urban space reinforces place identity and strengthens collective bonds [3].

1.2. Cultural Memory

Cultural memory creates a space for continuous negotiation between individuals and societies about the past. This memory is not limited to individual memories; it is also based on a dynamic framework that is reproduced and shared by communities. In this context, historic landscapes within the city should be considered not as fixed structures but as interactive surfaces where identity finds expression through rituals, everyday behaviors, and spatial experiences [4].

However, studies on the effects of spatial transformations in historically important urban parks on users' sense of belonging and perception of historical identity are quite limited. Especially in cities with a multi-layered historical past, modern design interventions often ignore this complex structure. While historical parks are reorganized according to today's needs, it is often unclear to what extent the historical values of these areas are preserved and transmitted. While the literature highlights the tension between conservation and transformation, there is still a need for empirical research that focuses on user experiences and the post-restoration period [5].

This study contributes to addressing this gap by critically examining the case of Haliç Sadabad Park, a historically important landscape that was once a prominent imperial recreational ground during the Tulip Era of the 18th century. The park has undergone extensive spatial transformation through the "Sadabad Project," a revitalization effort that seeks to merge cultural heritage with contemporary public use [6]. The research investigates how current users perceive and experience the transformed space and whether their sense of belonging remains rooted in the park's historical identity or shifts toward a redefined, contemporary function.

Drawing from interdisciplinary perspectives in landscape architecture, cultural heritage, and environmental psychology, the study explores how emotional and psychological connections are formed in hybridized urban spaces. By focusing on spatial usage patterns, memory cues, and symbolic associations, the paper reveals the complex interplay between users, historical narratives, and the evolving urban fabric. From this perspective, Sadabad Park offers a valuable opportunity to explore broader questions of cultural sustainability, place identity, and the role of design in mediating between the past and the present.

2. Materials and Methodology

2.1. Haliç Sadabad Park

There are some important elements that determine a city to be a center of attraction. These can be the city's architectural structures, squares, streets, and avenues, as well as green areas that offer alternative environments to the city's inhabitants, where they can breathe, stroll, and have fun. Gardens, which have become an important part of the city's architecture, are one of these structures. The Sadabad Park in Istanbul is an urban space actively used by urban users. Sadabad Park, where the Kağıthane River meets the Golden Horn, has been a site of legends and urban use over time.



Figure 1. Location of Sadabad Park

The area, which was previously a hunting ground but started to transform with the Sadabad Palace (Figure 2) and Garden, which was built in the 18th century with the westernization moves of the Ottoman Empire and influenced by the French palace gardens, was surrounded by about sixty residences and mansions with magnificent gardens for the courtiers and the Ottoman elite. The 1,100-meter-long ornamental canal, called Cetvel-i Sim (Silver Canal) (Figure 2) and lined with marble, served as a showground for the palace rituals of the settlement, with waterfalls, pools, and various pavilions, and is notable as a park with a strong relationship with the river, with rowboats and boats plying the river (Figure 3). Sadabad functioned as a space of visual representation where not only the aristocracy but also the public could witness palace events. In this context, Sadabad became one of the rare spatial interfaces between elitist representation and mass spectacle in the Ottoman urban landscape [6].



Figure 2. Sadabad Palace and Silver Canal [7]



Figure 3. Sadabad and Kağıthane River [8]

The Patrona Halil Rebellion of 1730 brought the Tulip Period to an abrupt end; most of the pavilions and gardens of this period were destroyed [7]. Although the Sadabad area was rebuilt from time to time in the following periods, it could not reach the splendor of the Tulip Period, and its function and symbolic value gradually diminished. In the 19th and 20th centuries, the region lost its physical and cultural quality largely due to industrialization and urbanization processes [8]. The Sadabad Project, initiated in the early 2000s, came to the agenda as an intervention aiming to revitalize the recreational and cultural identity of this historical landscape. This project is evaluated in the context of both spatial improvement and the reproduction of historical memory [6].



Figure 4. Sadabad Mosque

The main objective of the project is to revitalize the historical, cultural, and recreational values of the Kağıthane Valley and to make the area an attractive public space for both locals and visitors. In this

context, the establishment of Sadabad Park and the reorganization of the Kağıthane Canal were developed as a contemporary landscape intervention that references the historical identity of the area. The park is structured as a multifunctional urban landscape that is used not only as a passive recreational space but also for cultural events, sports competitions, and outdoor exhibitions.



Figure 5. The Park

Today, in addition to all these uses, the park, which has regained its multi-layered structure with the restoration of structures such as fountains, aiming stone, Sadabad Mosque (Figure 4), old palace walls, and palace barn, is used by the city users for various activities (Figure 5). In addition, the park, which has a pier that can establish a relationship with the stream, cannot fully fulfill this function (Figure 6). The next part of the study will include the research methodology and the findings obtained through this methodology, as well as information and observations on how the park is used and felt by the urbanites.



Figure 5. The River

2.2. Methodology

This study was conducted using a qualitative research approach to explore the relationship between the historical identity of Sadabad Park and users' sense of spatial belonging. Two primary data collection methods were employed: unstructured direct observation and a structured qualitative questionnaire.

The observation component aimed to document users' behaviors and patterns of social interaction in the natural setting of Sadabad Park. Due to temporal limitations, observations were conducted over a restricted period, specifically on weekends. Key areas of the park—such as historical structures, seating zones, walking paths, children's playgrounds, and the digital experience area—were selected as focal points. User engagement with these spaces, their spatial preferences, and duration of use were recorded through field notes. Emphasis was placed on users' reactions to historical features, the intensity of use in various areas, and examples of social interaction.

The second component of the study was a structured qualitative questionnaire (Table 1) designed to capture users' perceptions, emotional responses, and personal connections to the park. The questionnaire consisted of 11 questions—10 of which were closed-ended with selectable options, and 1 of which was open-ended. The closed-ended questions addressed themes such as frequency of visits, emotional responses to the park, associations with personal memories, access and accessibility, social interaction, and sensory perceptions (e.g.,

smells). The open-ended question invited participants to share any special memory or personal feeling related to the park.

Table 1. Questionnaire Questions

No	Questions
1	How often do you visit this park?
2	How does spending time in this park make you feel?
3	Does the park remind you of something from the past?
4	Do you think this park reflects the identity of Istanbul?
5	How do you access the park?
6	Do you think the park is accessible for everyone?
7	Is there a physical or emotional element that makes your visit special?
8	Do the smells in the park remind you of something?
9	How often do you visit this park with friends or family?
10	Did you participate in or observe any social activities in the park?
11	Do you have a special memory or feeling about this park?

The questionnaire was administered through face-to-face interviews with randomly selected users at various locations throughout the park. A total of 20 participants took part in the study. Responses were documented in written form. When appropriate, the researcher guided the conversation in a semi-structured manner to obtain deeper insights, particularly in response to the open-ended question.

All responses were analyzed using thematic analysis. Codes were generated based on recurring ideas, emotional expressions, references to the park's historical context, and indicators of spatial belonging. This analysis was triangulated with the observational data to generate a more comprehensive understanding of user experiences. The combined use of structured questionnaires and unstructured observation allowed for a multilayered interpretation of the relationship between Sadabad Park's historical identity and its contemporary use. While observation illuminated visible behavior patterns, the questionnaire—particularly the open-ended question—helped uncover the emotional and symbolic dimensions of users' connections to the park.

3. Results

A total of 20 participants took part in the questionnaire, reflecting a diverse demographic structure in terms of gender, age, and occupation. The sample included both male and female respondents, with ages ranging from 16 to 73, and an average age around 40. Participants came from various professional backgrounds, including students, office workers, homemakers, retirees, and service employees. This diversity allowed for a broad understanding of how individuals from different life stages engage with Sadabad Park.

When asked about their frequency of visits, responses varied significantly. While several participants indicated that they were visiting the park for the first time, others reported coming multiple times a year, or even monthly. A few participants noted that they visited the park frequently with friends or family, highlighting its role as both a personal retreat and a site for social engagement. Regarding accessibility, many respondents mentioned reaching the park either by walking or using public transportation, suggesting it is well integrated within the city's circulation network. Most users perceived the park as accessible for everyone; however, a small number expressed concerns about the comfort and mobility of elderly or disabled individuals within certain areas.

Participants were also asked about their emotional responses to spending time in the park. Many described feelings of peace, relaxation, and happiness, often emphasizing the calming effect of nature and the ambiance of the park. In particular, the smells within the park—such as those from trees, grass, or nearby water—evoked emotional responses and, in some cases, personal memories. This sensory experience was found to enhance the perceived quality of the environment and contributed to users' emotional attachment to the space.

The role of memory and personal history emerged as a significant theme in the responses. Several participants noted that Sadabad Park reminded them of specific periods in their lives, including childhood or moments spent with family. These recollections were often connected to the park's historical elements, such as older architectural structures or long-standing trees. When asked whether the park reflects the identity of Istanbul, many users affirmed this idea, citing its cultural ambiance, layout, and atmosphere as representative of the city's layered past.

Participants were also prompted to identify any physical or emotional elements that made their time in the park special. Among the most frequently mentioned aspects were the presence of water features, shaded seating areas, and the overall tranquility of the environment. Some participants had either observed or taken part in social activities, such as musical performances or informal gatherings, reinforcing the park's function as a dynamic urban space with opportunities for interaction. Finally, in response to the open-ended question regarding a special memory or personal feeling, many described the park as a "peaceful retreat" or a "place of reflection," underlining the deep emotional connections users have with this environment.

Altogether, the findings reveal that Sadabad Park is not merely a recreational area but also a place where spatial belonging, memory, and identity intersect. The interplay of emotional experience, historical association, and daily use contributes significantly to how users relate to and value the space.

4. Conclusion

This study aims to reveal how the spatial transformation of the Park, a historical landscape, affects users' emotional and symbolic ties to the space. Using a combination of observation and open-ended questionnaire methods, this study reveals that Sadabad Park is not only a physical recreational space but also a multi-layered place of experience where individual memories, collective past, and urban identity merge. This study reveals that Sadabad Park is not only a physical recreational space but also a multi-layered space of experience where individual memories, collective histories, and urban identities are intertwined. Moreover, despite the transformation of user identities, the constancy of urban identity is preserved through recurring patterns of use from past to present.

The findings revealed that users' belonging relationship with the park is based not only on current usage practices but also on perceptions and memories of historical identity. A significant portion of the participants associated the park with their childhood memories; this shows the Park functions as a place of memory that keeps the emotional ties with the past alive. In this respect, the park serves as a bridge between time and a nostalgic refuge for individuals.

Sadabad Park in Istanbul offers a relaxing and healing environment with its large green texture, providing a sense of peace and escape from the city. The park's historical design approach maintains its spatial continuity, with aesthetic elements contributing to its identity. Survey and observation data show that the park is predominantly visited by groups and family members, showcasing Sadabad's historical characteristic of being a place of socialization. The park's community-based use functions as a public space for the production and reconstruction of individual and collective memory.

These results reveal that changes to historic landscapes affect users not only on a physical level, but also on an emotional, cultural, and social level. It is possible to consider Sadabad Park as an example of an open space concept that is capable of undergoing change over time without compromising its historical uniqueness. In addition, the preservation of natural landscape features such as densely planted linden trees, vegetation, streams, and ponds is an important element that creates a positive impact on the contemporary users of the park.

In this case, the research provides valuable insights to key stakeholders, particularly urban planners and landscape architects. The example of Sadabad Park shows how a design that considers users' memories and sense of beauty can help keep spatial belonging alive. Adding historical references to modern public space design helps preserve cultural heritage and makes the experience better for everyone. This method emphasizes how important it is to find a balance between preserving the physical and maintaining emotional connection, especially in historic settings.

Future research could comparatively study the transformation processes of similar historic landscapes in different socio-cultural contexts. Furthermore, the temporal evolution of spatial belonging can be examined through long-term monitoring and quantitative data analysis. Comparative approaches that consider the diversity of experiences among different age groups, social segments, and user profiles will contribute to the development of more inclusive and participatory public space policies.

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Revitalizing the Junk Playground - Skrammellegepladsen i Emdrup 2.0

topic: A proposal for bringing the world's first adventure playground into a new era

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Keywords: Skrammellegepladsen, Adventure Playground, Junk Playground

Abstract
Skrammellegepladsen i Emdrup, The Junk Playground in Emdrup (Copenhagen, Denmark), opened in 1943 as a first of its kind - a place promoting free play and minimal adult intervention. Designed by C. Th. Sørensen the playground was meant to emulate the kind of experiences childhood in rural settings might offer - just in a much more concentrated form. This idea was highly innovative at the time and the international movement of adventure playgrounds can be traced back to this location.

Construction of huts, or playhouses, in one kind of another, was always a central part of Skrammellegpladsen but has come to largely dominate the story of the place. It is today mostly known for its creative cabins that are (to some extent) managed by the children. This might be the most obvious shift in the spirit of the place, a reorientation from open ended play with materials to a more construction oriented theme. Unfortunately, much of the original concepts are gone and the site is today a rather typical Danish after school institution, albeit in an interesting surrounding with much history This speaks both to how the ideas of Skrammellegepladsen have, to a certain extent, become part of the wider culture but also to how the core concepts have been hard to keep in the face of institutionalisation.

Thanks to a grant awarded by the Danish Arts Foundation we were able to make a preliminary study of how a revival of Skrammellegepladsen could be done. Through interviews and interactions with key actors (parents, employees, management, children) we could form a picture of dreams and motivations of the place. This, together with a literature study led to our publication "Skrammel 2.0" which stakes out a path towards what could be the future of this institution. Some of our key messages are:

1. Positioning it as a local hub for material flow - Skrammellegepladsen was always built on used materials and donations. As the societal move towards circular material use increases, institutions like this one should be part of the flow. Partnering up both with private businesses and municipal efforts will be necessary.

2. Tapping into the flow of organic materials - we believe that a focus on nature, and building for nature, is a logical next step in the evolution of Skrammellegepladsen. This can be thought of much as the flow of used construction materials, only with organic ones instead. By using the surplus of local parks the playground could be amply provided with branches, mulching and even planting materials by becoming part of the municipal flow of such materials.

3. Seriously considering the polarity between free play and committed adult supervision. At its core, Skrammellegepladsen is not about construction but about children creating their own worlds and having autonomy. However, in this process there are great opportunities for those participating children to seek out and be given knowledge from the adults around them. We believe that both are needed at a higher degree - more hands-off when possible and more focused hands-on when required.

1. Background and Historical context

1.1 Background of this study

Thanks to a grant awarded by the Danish Arts Foundation we were able to make a preliminary study of how a revival of Skrammellegepladsen could be done. Through interviews and interactions with key actors (parents, employees, management, children) we could form a picture of dreams and motivations of the place. This, together with a literature study led to our publication "Skrammel 2.0" which stakes out a path towards what could be the future of this institution.

1.2 Historical context - The Architects

Skrammellegepladsen i Emdrup, The Junk Playground in Emdrup (Copenhagen, Denmark), opened in 1943 as a first of its kind - a place promoting free play and minimal adult intervention.

Designed by C. Th. Sørensen the playground was meant to emulate the kind of experiences childhood in rural settings might offer - just in a much more concentrated form. This idea was highly innovative at the time and the international movement of adventure playgrounds can be traced back to this location.

"... it is offering the children the possibility to create and shape. They can dream and fantasize and make those dreams and fantasies reality, at least a reality that fully satisfies the mind of a child… A Junk Playground can, more or less, offer the urban child the same possibilities as his rural counterpart. There should be branches, old planks and wooden cut-offs, bricks, roof tiles, sewer pipes, defunct cars, boats, wagons, wheelbarrows and whatever else junk that can be mentioned. The children can use it all. Just the simple fact that they can be allowed to dig in the soil, as much as they want, gives them immense possibilities"

C.TH. Sørensen [1]

1.3 Historical context - The Playworker

With the birth of Skrammellegepladsen came the idea of a playworker - an adult that helps and supervises. The first of its kind was John Bertelsen (known as Jonas, present from the

start in 1943):

"I am of course employed as a leader, but on an adventure playground this is hardly the same as the accepted idea of a leader and organizer who works, as it were, from the *outside*. Rather, mine is a function which arises *within the actual framework of the playground* where I am in a position to give the children every opportunity of putting their plans into practice. This initiative must come from the children themselves and when the necessary materials are to be had these give the children the inspiration for play. I cannot, and indeed will not, teach the children anything. I am able to give them my support in their creative play and work, and thus help them in developing those talents and abilities which are often suppressed at home and at school. I consider it most important that the leader not appear *too clever* but that he remains at the same experimental stage as the children. In this way the initiative is left, to a great extent, with the children themselves and it is thus far easier to avoid serious intrusion into their fantasy world."

John Bertelsen 1950 [2]

2. Today's context

2.1 Huts as a key feature

Construction of huts, or playhouses, in one kind of another, was always a central part of Skrammellegpladsen and has come to largely dominate the story of the place. It is today mostly known for building small cabins that are then managed by the children. This might be the most obvious shift in the spirit of the place, a reorientation from open ended play with materials to a more construction oriented theme. Unfortunately, much of the original concepts are gone and the site is today a rather typical Danish after school institution, albeit in an interesting surrounding with much history This speaks both to how the ideas of Skrammellegepladsen have, to a certain extent, become part of the wider culture but also to how the core concepts have been hard to keep in the face of institutionalisation.

2.2 Interviews with occupants of today

We performed semi-structured interviews with managers, parents and pedagogues connected to the site today. There were of course different perspectives and opinions but also many recurring themes. Some of the key findings were:

- Self guided outdoor play and activities as a key component. Instead of telling the children what to do, they all wished the activities to be guided by the wants and curiosities of the children themselves.
- A pedagogical method focused on building and gardening. That these two activities could be the center piece of a way of working with the children.
- A sense of community. That the project is not only about what the individual wants but that there is also a sense of shared democratic principles guiding the decisions made

3. Our Proposal

3.1 (Recycled) Materials

From its first days Skrammellegepladsen has been using recycled materials - this is something we want to keep doing. We believe in it as a tool both because it furthers a circular use of construction materials but also because it opens the door to potentially interesting collaborations.

The pedagogical thoughts under which this institution functions is that the children can be active in shaping their own environments. This means that the activities should not come pre-packaged: instead of toys with a specific type of play intended you have to yourself decide what kind of play to engage in and adapt according to the situations that might occur. This model of thinking also shows itself in the usage of recycled materials. Because this material is not uniform on arrival - it comes in different lengths, widths, thicknesses and conditions. This stimulates the fantasy of the user and might also call for adaptations to the final project to fit the material - rather than the other way around.

Recycled materials, for this purpose, are relatively easy to source and there are large quantities of them - especially if one is not much preoccupied with the material being uniform. What makes these resources difficult to use in the conventional construction industry (their variations in dimensions, quality, and length plus uncertainty of availability on a given date) makes them all the more interesting for our purposes. Another issue for conventional construction use is that the handling of the materials often becomes so time consuming that what has been saved in buying them as used is soon wasted when paying the extra salaries of the workers handling them. This problem also becomes irrelevant in the context of Skrammellegepladsen because materials can be handled, stored and used in the tempo they arrive in. The handling does not become an extra budgetary post but is rather an integral part of the pedagogical work. Activities such as sorting, removal of nails and cutting to length becomes part of the activities and not a heavy side project.

When using recycled materials waste is accumulated already in the first handling - when getting the material ready for use. This makes it different from using new materials that are delivered ready for use. Because of this specificity it is important to include a sort of “landing zone” for materials coming in where they can be processed before getting too far inside the institution. By having this system set up from the start much frustration from poor work flow (where materials are first carried in to then be going out the same way again) can be avoided. In our proposal we have chosen to place this landing zone at the very center and entrance of Skrammellegepladsen because the arrival of new materials is one of the great sources of joy in the institution. By doing so we place a function that might otherwise be conceived as “back-stage” at the front, because the access to materials is what makes the joy to create possible.

3.2 Tools and Techniques

Construction is, in general but also importantly in this context, not just one uniform thing. For the new Skrammellegeplads we have chosen to conceptualize it in three levels. These are physically represented in how far from the building they occur. This also means that they differ in how much adult supervision they entail.

The first level is found under the mobile roof structure. Here we can find a well equipped wood workshop - it is at this level that stationary machines are used allowing for more complicated things to be built and imagined. By consequence this is also where adult supervision is at its highest - comparable to a wood working class in a school setting. This is necessary for safety but also because the level of complexity can be allowed to get fairly high. To have access to this possibility in machinery, also without using them constantly, makes an enormous difference in what can be achieved on site.

At the second level we have placed a series of wooden vertical poles - inspired by what was known as "Kassen" ("The Box" in Danish). Because the most difficult component in construction is to get the vertical elements stable we have chosen to "short cut" this step and thus given the children a stable base to start building from. The aim is to provide a setting where they can easily start building themselves with hand held tools and a little help and encouragement (if necessary) from the adults.

At the third level we are focusing on what could be called bushcraft or making shelters. The focus here is on using natural materials together with ropes and twigs to create soft methods of assembly. The adult interaction is minimal in the best sense of the word - this place is about children creating their own setting. We argue that this type of area, where it's all about free play and free decision making for the children and as a contrast to construction with a specific end goal in site, is central to a place like Skrammellegepladsen.

3.3 Water and Hills

Skrammellegepladsen has always been slightly hidden away, by design. When the site was first established it was considered that the untidy activity going on inside it should not have to be seen by those living around it. There might have been thoughts about protecting the children from outside views, but we have not been able to find proof for this thought in the literature. In our new version we see a quality in creating spaces where children can be left on their own, without a constant monitoring adult gaze. In a large natural surrounding (which was the ideal of landscape architect C. Th. Sørensen) it would be easy enough for a child to hide away, if so wanted. This place however is rather small and we are therefore using topography and vegetation as means to create hidden places. Most of the area is surrounded by earthwork (as part of the original design) starting a few meters inside the fencing thus creating a space in the "forested" area that works well for this purpose.

The topography is also used to collect rain water in an L-shaped basin centrally placed in the new design. This will create a pond that varies in size depending on precipitation thus retaining water - a common feature in contemporary design in the Copenhagen area to mitigate floods. The pond will also open up many new possibilities for outdoors activities at Skrammellegepladsen and will reinforce the original intention of the place - to mimic the possibilities available in a larger landscape setting. By usage of aquatic plants and a pump helping with circulation the pond will also introduce a variety of biodiversity gains - again with a double function for pedagogical possibilities.

3.4 Natural Materials

Founder C. Th. Sørensen's aim in creating Skrammellegepladsen was to offer urban children the same possibilities they would have had growing up in the countryside. The lack of materials to experiment with was addressed by bringing in what was considered waste: cut off branches, used planks, cardboard boxes etc. Keeping in spirit with this wish we propose bringing in green waste from municipal parks - specially what comes from the pruning of trees and bushes. All municipal parks produce quantities of this and the material will be transported under all circumstances. Our proposal is to divert some of this resource stream en route to the municipal composting facility and simply dump it, as a valued resource, at Skrammellegepladsen. All these branches would be used for building shelters and the augmented amount of decomposing plant materials would have a positive effect on local biodiversity. Would it be possible to chip wood on site it could furthermore be self sufficient on wood chips for paths and compost further adding to a more naturalistic environment where the sub-strata would, over time, resemble a forest rather than a highly urban site.

4.1 Conclusions and Discussion

We do believe that a revival of Skrammellegepladsen is both possible and wished for. Indeed, many of the same principles that the place was once founded on are still relevant today - about 80 years later. There is still a need for spaces where children can be allowed to create their own worlds without adult intervention. The possibilities of interaction with the elements and the natural world is still limited to children growing up in urban environments and could be catered for in such a space. The possibility for children to self-initiate play and construct their own fantasies is still seen as a valuable experience to foster independent and inventive adults. However, Skrammellegepladsen is in need of a revival, and we hope that our proposal could be inspirational in making it happen.

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THE NEW ANGONO CULTURAL DISTRICT: PROPOSING A CULTURAL DISTRICT NETWORK FOR THE CULTURE-LED REGENERATION OF ANGONO, RIZAL

TOPIC: Guiding cities with society: Use, memory, artistic creation

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Keywords: culture-led regeneration, cultural districts, cultural placemaking, place identity

Abstract
As one of the most quickly urbanizing countries in the Pacific region, the Philippines benefits economically, leading to increased productivity and poverty reduction. However, urbanization also drives changes in local culture, changing the place identity and genius loci of old towns. These changes in urban landscape patterns are observable in the municipality of Angono in Rizal, often referred to as the "Art Capital of the Philippines" due to its rich creative culture concentrated in its old town center. This thesis explores culture-led regeneration, a concept that utilizes the unique cultural attributes of a city to guide efforts in its cultural upliftment. Through the proposal of a cultural district network in the municipality, its cultural landscape will be enriched to combat the destructive effects of urbanization, strengthening and preserving the cultural character of the town. Landscape design and management of various cultural elements of Angono creates new cultural experiences to be shared by locals and visitors alike, anchored on the existing attributes of the core cultural area of the municipality. This was achieved through interviews and surveys with Angono locals to gather their insights on their culture and evoke key cultural experiences. With the residents' contributions, three spaces within Angono were designed, bringing various existing cultural attributes to the forefront to uplift, enrich, and supplement existing cultural practices. Through the cultural district network, memories and experiences of both people and place are reflected, providing sites that highlight natural forests and community celebrations that incorporate artistic culture in all aspects. With this, a stronger cultural narrative of the municipality can be formed for its residents and in their shared landscape alike.

1. Introduction

1. 1 Defining the Landscapes of Cultural Districts

Cultural districts are mixed-use areas with high concentrations of cultural activities, contributing to a city's identity, especially for arts and creativity [3]. They cultivate creative environments, strengthening ecosystems of support for artists, revitalizing neighborhoods and increasing quality of life [3]. Cultural districts are also called cultural and creative quarters, cultural clusters, corridors, or precincts [1]. Globally, they are managed differently, however, the Philippines lacks a dedicated cultural districts program. Instead, cultural affairs are handled by the National Commission of Culture and the Arts.

1.2 Angono, Rizal as a Cultural Landscape in Transition

The Municipality of Angono in Rizal is called the "Art Capital of the Philippines," as the only municipality hometown to two national artists, and where the oldest artwork in the country was discovered [6]. At present, it is home to a bustling and varied contemporary arts scene [6]. Physical manifestations of Angono artistry are intertwined in the daily lives of its community, and in its numerous festivals. This creative culture extends towards its cuisine and with artworks portraying the significance of Laguna Lake. Presently, Angono is working towards managing its cultural properties and promoting itself as a destination and landmark of art and heritage.

1.3 Culture-Led Regeneration as the Strategic Landscape-Based Approach

Culture-led regeneration utilizes unique cultural assets as stimuli for regeneration efforts, leading to multifaceted outputs tackling various aspects of wellbeing [7]. Aspects of an old city are incorporated into newly introduced elements through cultural planning policies [7]. It also enhances creative industries, tourism and business opportunities, and job creation [4,7]. Physically, artists' creative culture transforms urban landscapes, leading to prosperous city centers [7]. Place image is enhanced along with placemaking, instilling a sense of pride in the community, strengthening city branding and quality of life, reflecting place history in the present living culture [4,7].

2. Rationale

The Philippines is one of the fastest urbanizing countries in the Pacific Region, leading to increased productivity and reduced poverty [10]. However, urbanization drives changes in culture, often seen in gaps in planning, affecting place identity [8]. This shift is sometimes associated with gentrification changing the genius loci of old towns, leading to cultural richness argued to be artificial. In the country, the prioritization of modernity is oft synonymous to development, instead of the conservation of cultural assets. As such, cultural landscapes are then at risk of ecological and sociological drivers of change, leading to possible human and nature-based disasters.

Such urban landscape patterns and challenges are observable in Angono. The local government is working towards the town being a "sanctuary for art" by 2026, with the protection, preservation, and promotion of arts and culture [6]. However, at present, this is not being realized. With urbanization, the town loses tangible cultural attributes, leading to weakened identity.

Uncontrolled development in Angono impacts its built environment, with emerging areas creating new streetscape character in the town [5]. Most landmarks and cultural resources are concentrated in the old town center, with newer developments further away being primarily residences or for quarrying activities [5,6]. These new developments often employ designs that isolate themselves from the identity of an area, adopting a cosmopolitan image, thus negatively affecting cultural sustainability. Moreover, areas experiencing urban decay contribute to locals' diminished sense of community belonging [9].

This continuous development in Angono has led to an incoherent mix in its urban landscape, causing competition with existing landmarks and cultural spaces [5]. These cultural elements, located across Angono, lack a binding landscape. The cultural character of Angono is weakened further by the lack of consideration and inclusion in the town's urban development. Its identifying cultural character at its center has little influence in the new and urbanizing landscape, which, if not properly managed, puts its significant heritage at risk of being lost.

3. Goal of the Study

This study adapts the concept of cultural districts to Angono, Rizal to enrich its cultural landscape to combat the destructive effects of urbanization. Through the management and design of various cultural elements, it seeks to create new experiences through the proposal of a cultural district network of three identified sites anchored on Angono's existing cultural attributes.

4. Methodology

4.1 Cultural Mapping

A tangible cultural inventory map of Angono was created to visualize the distribution of its cultural assets. However, Angono lacks an official inventory, so the map was created using assets listed in survey responses, personal surveying, conversations with locals, and secondary sources.

4.2 Survey on Local Community's Perceptions and Preferences

A conducted survey gathered locals' perceptions and preferences for the proposed development and the positive elements of place identity they wish to highlight. Grenni et. al's study linking place branding and spatial planning through cultural narratives guided this survey with the adaption of the Appreciative Inquiry Framework [2]. The framework is "strength-based," highlighting strengths, advantages, and opportunities. It has five phases:

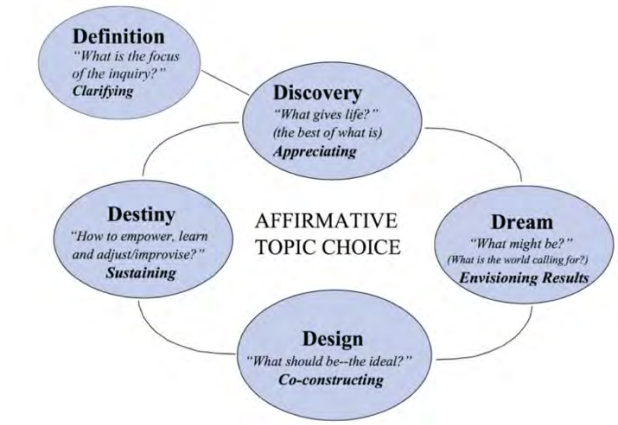


Figure 1. The Appreciative Inquiry Framework

The survey applied the discovery, dream, and design phases in its sections. The first phase, defining boundaries, was applied in the preparation for the survey, and the final phase, delivery, guided the implementation of the data collected.

4.3 Key Informant Interview

An interview with a member of the Angono tourism office was conducted for an overview of Angono culture. It was a basis for a structured cultural narrative for the town that is otherwise passed orally.

4.4 Site Analyses

The institutionally-owned sites were assessed through site visits, conversations with stakeholders, and through secondary data to determine the appropriate interventions to be applied. In addition, these site assessment criteria were employed:

Table 1. Site assessment criteria.

1	Safety from floods
2	Buildability
3	Road accessibility

The specific criteria were chosen as they consider the most common natural hazard in Angono, present topographic character, and accessibility from existing roads. Ultimately, they consider user safety, sustainability, and effects on layouts of areas. They consider the holistic cultural narrative of Angono and the feasibility of developments based on the present state of the sites. Considering these aspects better contextualize the districts to Angono.

5. Results and Discussion

5.1 Tangible Cultural Inventory Map of Angono

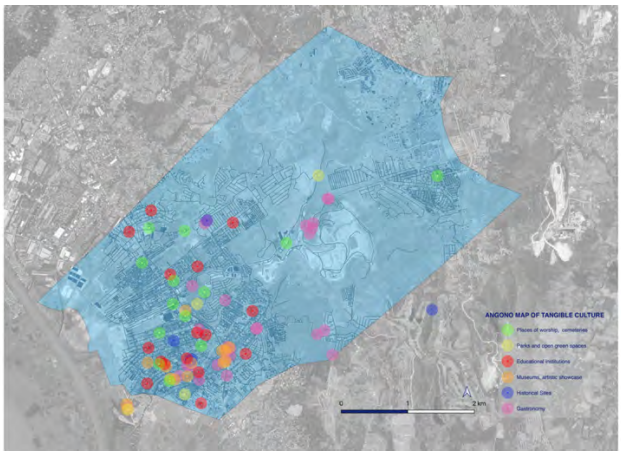


Figure 2. Tangible Cultural Inventory Map of Angono

The map highlights cultural assets clustered primarily at the town center, closer to the Laguna Lake. Additionally, assets located farther from the town center are primarily restaurants and cafés at higher elevations.

5.2 Survey Results

The first section, Discovering Angono, allowed respondents to explore and list down aspects of Angono important to them. Next, Dreaming for Angono focused on creating an idealized version of Angono from their perspectives. Respondents provided their vision for their hometown and interest levels for various activities and spaces related to local creativity, ecology, and cuisine. Lastly, they selected important environmental elements for visiting different sites. The final

section, Designing for Angono, tasked respondents to select actions or strategies they believe significant in achieving the dream they have for Angono.

These results were instrumental in the design of the cultural district network, concretizing preferred spaces and activities. Similarly, they determined community needs or what is lacking in the landscape of Angono. Through the survey, the development will be tailored to suit their needs, especially those requested or suggested by residents.

5.3 Analysis of the Key Informant Interview

The interviewee shared origins of significant aspects of Angono, as well as present-day cultural expressions, including events and the roles cultural groups have in them. They also explored the possible future of Angono culture, including threats such as traditions not being passed and the lack of documentation. As of the interview, the local government has several ongoing initiatives towards sharing the grandness of their culture.

The interview was vital as a foundation for the creation of spaces and activities throughout the design. Moreover, the current events enjoyed by locals and tourists guided the creation of areas to provide ample space and flexibility to handle the audience. Proposed events were also adapted from existing celebrations and tours.

5.4 Results of the Site Assessment Criteria

Table 2. Site assessment criteria results.

		Site A	Site B	Site C
1	Safety from floods	3	1.5	1.5
2	Buildability	1	3	2
3	Road accessibility	1	2.5	2.5
TOTAL		**5**	**7**	**6**

With the previous analyses gathering overviews of Angono or of the entire development, the site assessment criteria explored the specific sites to be developed into the three cultural districts. Each site was ranked per criterion, with the lowest being 1 and the highest being 3. Results show that Site B requires the most interventions, especially on buildability. While Site A had the lowest score, it requires flood management strategies. Specific measures were adopted to address these weaknesses in the proposed design.

6. Synthesis

6. 1 Design Concept

The overall design concept is "SiLunan," combining multiple Filipino words: "sining" (art), "silungan" (shelter), and "lunan" (place). "Sining" honors the creative culture of Angono, focusing on expression. Additionally, "silungan" references the cultural district network as a shelter for the preservation of creativity. Lastly, "lunan" highlights the significance of the physical surroundings in the proliferation of creative culture. It adds meaning and place character to Angono, through collective memory, use, and connection people have with their landscape. Ultimately, the concept celebrates Angono as a landmark for art, and as a living gallery showcasing how creativity is intertwined in daily life. This concept is translated spatially as a parade or showcase of Angono culture. It creates a celebratory atmosphere, where joy, vibrancy, energy, and excitement about local culture is palpable.

6. 2 Bubble Diagrams

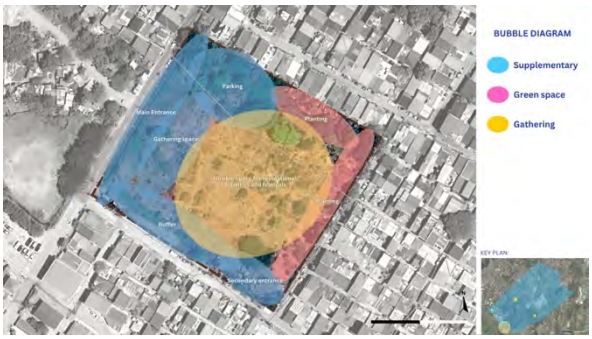


Figure 3. Bubble diagram for Site A

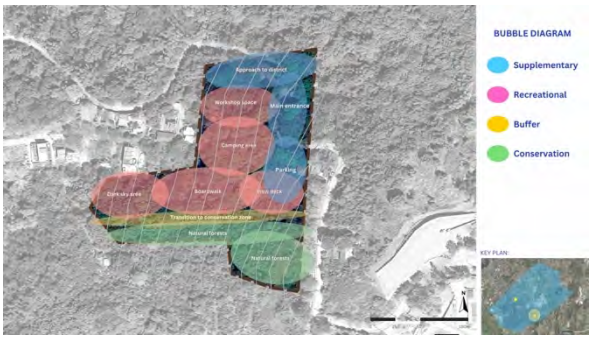


Figure 4. Bubble diagram for Site B

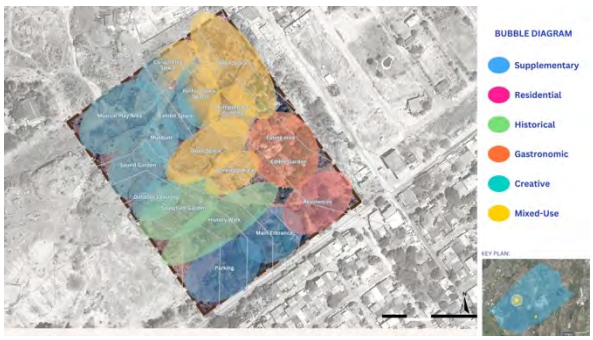


Figure 5 . Bubble diagram for Site C

6. 3 Master Site Development Plan

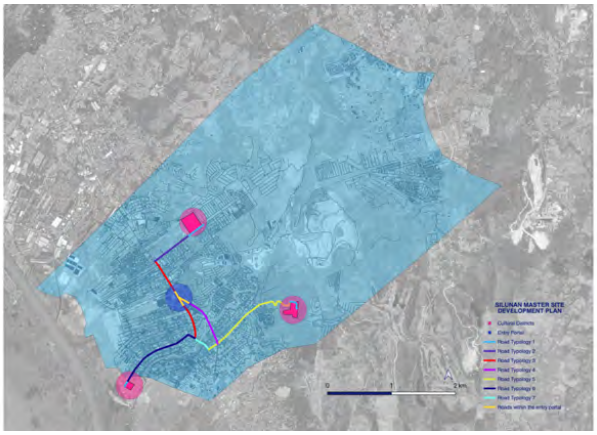


Figure 6. Master Site Development Plan

6. 4 The Entry Portal to Angono



Figure 7. The Entry Portal to Angono Site Development Plan

The entry portal is located along a national road, acting as the beginning of the parade showcasing Angono culture. With this, the designed segment was raised as a speed table, regulating the speed of vehicles to cater towards pedestrians, as celebrations occur in public spaces, such as streets. From here, curvilinear floor patterns and bright colors are implemented. This represents parade routes, accommodating the movement of people. The design, in and of itself, is a form of choreography and fluid movement. This pattern is shared across all the districts.

At the center of the road is an existing island, which houses three sculptures showcasing different aspects of Angono. To create a more cohesive design, only one, showcasing a local legend, is retained, while the other two are relocated. It represents Angono mythology, welcoming visitors to the parade of Angono, and, in its history, the origins of the town.

6. 5 The Cultural Core District

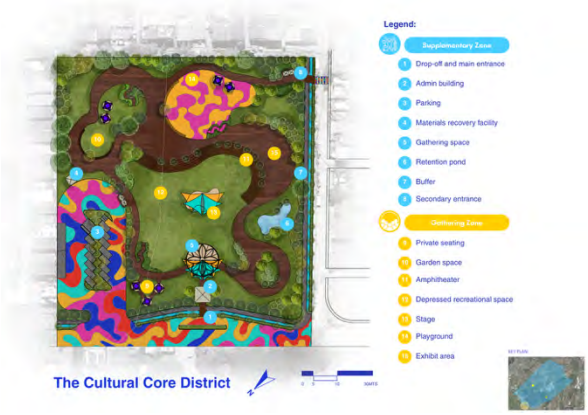


Figure 8. The Cultural Core District Site Development Plan

The Cultural Core District supplements existing cultural practices—fulfilling residents' needs and wants in a landscape for events near the town proper. Considering its high susceptibility to floods, there is an elevated boardwalk throughout the site. This ensures safety and accessibility after periods of inclement weather, even when surroundings are not ideal. It also provides a slightly elevated view of the site.

At the very center is a recessed open area, accessible through a ramp and amphitheater-style seating. This provides recreational green space, which survey respondents desired. This applies a spectator-performer aspect of the parade concept, with the seating facing a central stage. In addition to being recreational, it functions as a gathering space or spillover site for activities and celebrations, utilizing the stage and seating. Lastly, its recessed nature allows it to be a detention pond during storms.

6. 6 The Ecological District



Figure 9. The Ecological District Site Development Plan

The Ecological District showcases the natural environment of Angono, making it more accessible to people. Additionally, it protects natural forests from anthropogenic activity. The district is located at a steep, upland area along a curved road, so its road patterns begin at the northwestern portion of the site, guiding visitors to take caution as they approach the entrance.

The admin building has a café that overlooks the entire site and adjacent forests. Here, users can enjoy scenic views without accessing the recreational zone. It also provides locals with job opportunities and an additional income-generating channel. Moreover, this reflects surrounding land uses, with many establishments being eateries that maximize the views.

Its recreational zone is reached through hiking trails that follow the natural grade of the site to limit developmental disturbances. These also make them more accessible to those who wish to explore the site but are unable to use stairs or navigate steeper terrain. However, if users opt out of the winding paths, staircases are available between the trails. Existing large trees are kept and maintained in the area.

In the southern portion of the district is a boardwalk for visitors to enjoy the pleasant views after a hike. The western end is the dark sky area where campers and users who stay until nightfall can enjoy the nighttime sky that is less affected by light pollution. Larger areas throughout the site do not or only minimally alter the grade of the land. To have ample space for the development while also being safe for its users, retaining walls are used. These follow the natural contours of the district to have functional areas in the land without creating large, flat open spaces or being inaccessible, despite being dedicated for visitor use.

6.7 The Cultural Hub of Angono



Figure 10. The Cultural Hub of Angono Site Development Plan



Figure 11. The Cultural Hub of Angono Aerial Perspective

The Cultural Hub of Angono is the central location for cultural activity in the town. Away from the old town center, it facilitates the spread of culture and creates a dedicated landscape for it. This district focuses on multiple cultural aspects, and acts as a primary location for various events, also functioning as a recreational space.

The residential community that lives within the site is allocated a private area with their own entrance from the main road. Instead of relocating the community, a more formal housing situation was created instead. They will also be offered job opportunities to work within the hub, aiding in its maintenance and functionality.



Figure 12. Drop-off and Residential Zone Spot Perspective

From the main entrance, the hub separates into the various zones and activities. Those interested in Angono history, such as those on field trips or educational tours, go towards the historical zone. Its historical walk has three-dimensional tactile murals providing users, especially those with vision difficulties, a unique way to experience exhibits. The sculpture garden, an artistic interpretation of Angono culture, transitions the historical zone into the creative zone, intertwining the experience with creative culture.



Figure 13. Sculpture Garden Spot Perspective

At the edge of the creative zone is the outdoor classroom and musical playground. Similarly, a sound garden honors the significance of music in the municipality. The main feature of the creative zone is the museum, showcasing the various creative outputs created in Angono over time. Many of the physical elements of festivals are temporary and remade annually, thus the museum also functions as an archive of festival elements, documenting the various creative features crafted by the local people.

Following this are the temporary exhibit spaces, allowing newer artists in Angono to showcase their work. This represents the continuation of their rich artistry, alongside archiving past features, as if it were a parade of Angono creative culture—from its past, present, and to its future in its contemporary artists.

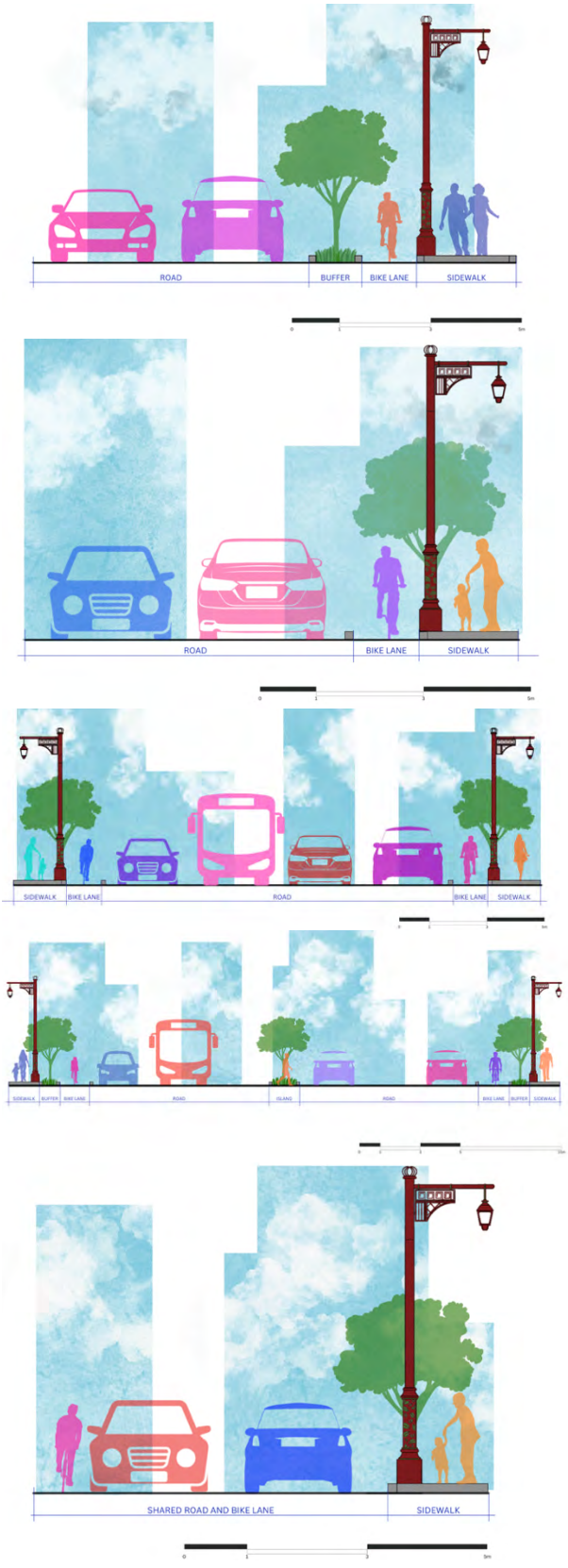


Figure 14. Gastronomic Zone Spot Perspective

Finally, the righthand portion of the site highlights Angono cuisine, with an edible garden, temporary food stalls, and a dedicated restaurant in the district. Other areas are mixed-use, for activities that combine different aspects of local culture, such as in performances or tours and workshops.

6.8 Road Typicals

These seven road typicals in Figure 15 detail treatments for the various road types in the cultural district network. The specific interventions depend on the availability of space along the roads, as well as the appropriate needs for the surrounding areas. These roads act as the physical links between the districts, supporting the concept of a network development. Further, the treatments create a unified identity throughout the cultural district network, thus guiding wayfinding and navigation. This is essential for the flow of people, ensuring functionality and success of the development. It links people to place, and thus the new cultural experiences to be discovered in the New Angono Cultural District.



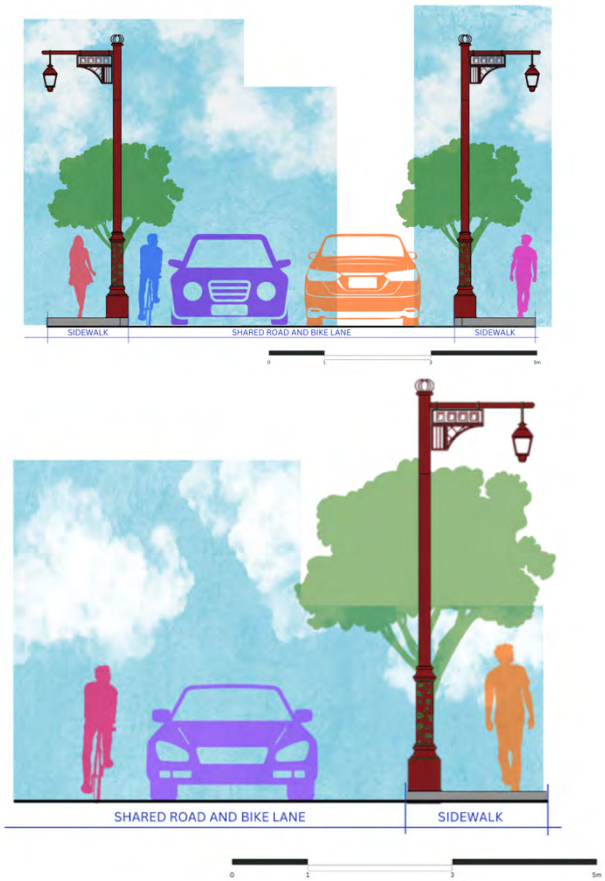


Figure 15. Road Typical Elevations

7. Conclusion and Recommendations

Angono, Rizal is rich in creative culture. This, coupled with its vibrant heritage makes it significant for Philippine art and heritage. However, Angono struggles with balancing its development with the preservation of its culture. Preserving its culture is not new to the town, with the tourism office undertaking projects to document and share its culture. Additionally, residents involved in data gathering responded positively towards local developments supporting their culture.

The created cultural district network thus caters to the needs of people and place—providing users with a landscape for recreational and cultural activities, strengthening place identity in its old town center and forested uplands closer to new developments. This project aligns with the plans the local government has for Angono, and with the developments the residents themselves are receptive to. Furthermore, this study determines the possibilities for other developments showcasing Angono culture to be created. Adapting existing open spaces allowed for the beginning of its regeneration, with their rich culture at the forefront. With this, Angono works towards being

both an art and heritage town, developing into a new cultural district.

However, given the scope and findings of this project, further methods can enhance the investigation of Angono and culture-led regeneration efforts for its holistic development as a new cultural district. To accomplish this, the authors recommend additional involvement of the stakeholder community in all phases of design and planning. Involvement may include co-designing and participative planning to ensure outputs are reflective of the community. Involvement may also engage local artists to create features that are built on their memories and narratives.

Additionally, they recommend expanding the scope of the study beyond the design of identified sites and onto city-scale planning and creation of appropriate regulations. Along with planning, exploring the overall costs required for such a project can assess its feasibility. Lastly, should a cultural district network be developed, it is recommended to continuously assess and evaluate the impacts of the development to adjust interventions that are no longer reflective of the local community.

Acknowledgments
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STUDY ON THE INFLUENCING FACTORS IN WALKING SPACES OF SUBWAY STATIONS AREAS IN COLD REGIONS BASED ON COMMUTERS' BEHAVIORAL NEEDS

TOPIC: Guiding cities with society: Use, memory, artistic creation

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Keywords: subway station area, walking space, cold region, influencing factor, behavior needs

Abstract

The subway, as a key mode of green transportation, significantly influences urban residents' daily commutes. Walking spaces of subway stations areas play a crucial role in addressing the "last mile" issue, drawing attention to the importance of enhancing walking environments. In cold regions, however, the development of these areas remains underwhelming, with generic designs failing to meet the unique demands of harsh climates and diverse commuter behavior needs. Focusing on walking spaces within cold-region subway station areas, this study applies the PSPL survey method to classify and analyze commuters' necessary, optional, and social behavioral needs, constructing an indicator system through the Delphi method, AHP, and multi-source data integration. Grey relational analyses and linear regression analyses identified key spatial factors influencing commuter behavioral needs satisfaction. Results show that necessary behavioral needs are addressed through improving pedestrian network integration, street canyon ratio, and effective sidewalk width; optional behavioral needs are met by optimizing resting and shelter facilities and pavement surface; and social behavioral needs are supported by optimizing POI density and PRD. To better meet commuters' behavioral needs, this study proposes optimized design suggestions for walking spaces within cold-region subway station areas.

Text

1. Introduction

Walking as the core issue in the subway station space, is the main behavior of every traveler

inevitably, through the walking space as a link, can cover the complex and diverse situations, no matter how the subway station distribution, people take the subway travel must be through the walking space, so the subway station area of the construction of the walking space has become an important link in the "last kilometer" of the public transportation travel {Park, Deakin, Jang2015}. The design of walking space is not only related to the mobility and convenience of commuters, but also has a profound impact on their psychological and physiological feelings {Xiang, Cai, Ren, Ng2021, Buttazzoni, Minaker2023}.

In cold regions, the walking space within subway station areas functions not only as a critical connector between commuters and the transportation network but also as a decisive factor shaping their overall travel experience. Cold climates profoundly influence commuters' travel patterns and comfort, particularly during harsh winter months, when elements such as freezing temperatures, wind-chill effects, and icy surfaces compromise walking safety and overall comfort {Kim, Lee, Kim2018}. As a result, these climatic conditions cause commuters to display distinctly different behavioral patterns and needs in walking spaces compared to warmer regions.

2. Materials and Methods

2.1. Analytical Framework

This study follows a three-step approach. Steps 1 (Public Life) and 2 (Public Space) utilize the PSPL method to examine commuter behavioral needs and spatial characteristics. Step 3 employs grey relational analysis and linear regression to analyze the data, uncovering the relationship between commuter behavioral needs and spatial indicators while identifying key influencing factors.

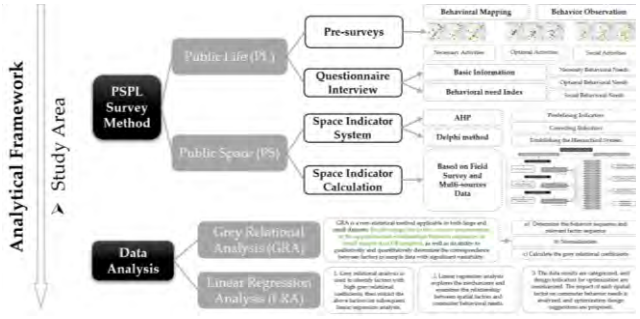


Figure 1. Composition of analytical framework.

2.2. Study Area

In this study, the geographic scope of the subway station area is confined to cold regions, defined as areas where the average daily temperature remains below 0°C for more than two months annually. Existing research commonly defines station areas with a radius ranging from 400 to 800 meters. Given the challenges posed by excessive walking distances in such climates, a 400-meter radius was selected, aligning with commuter behavior and climatic constraints.

The study area encompasses aboveground pedestrian spaces most affected by winter conditions, including walkways, pedestrian crossings (e.g., flyovers, crosswalks, safety islands), and building frontage spaces. Indoor areas, such as station interiors and underground walkways, are excluded due to their insulation from extreme cold.

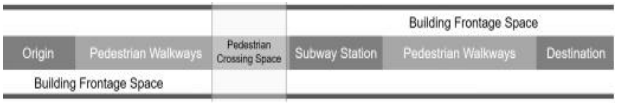


Figure 2. Composition of walking spaces of subway station areas in cold regions based on commuters' travel chains.

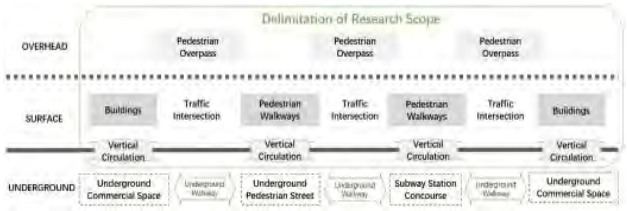


Figure 3. Research scope.

The study focuses on subway station areas in Harbin, a representative cold-region city in northeastern China characterized by long, harsh winters, extended snow cover, and a unique ice and snow culture. To analyze commuter behavioral needs effectively, six station areas were selected based on their primary population characteristics.

Three residential station areas with a predominance of residential populations include Harbin Institute of Technology Station (R1), Hexing Road Station (R2), and Haihe East Road Station (R3).

Three commercial station areas, characterized by a high proportion of working populations, include KAISER REAL Station (W1), Xuefu Road Station (W2), and Museum of Heilongjiang Province Station (W3).

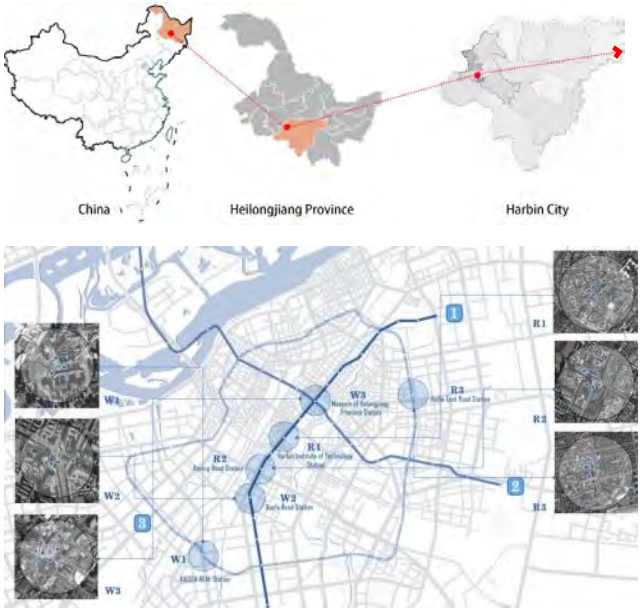


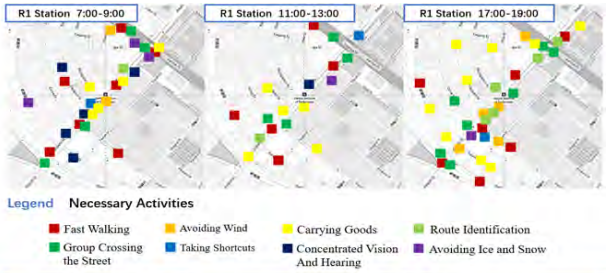
Figure 4. Study area.

2.3. Pre-survey

Behavioral mapping and observation method was employed to examine the behavioral activity patterns of commuters at R1 Station on December 11, 2023, a typical winter working day. Observations were conducted during three key time periods corresponding to commuting peaks: morning (7:00–9:00), midday (11:00–13:00), and evening (17:00–19:00).

To analyze commuter behaviors, Jan Gehl's classification of outdoor human activity was adopted, categorizing activities into three distinct types: necessary activities, optional activities, and social activities. These classifications were further analyzed based on principles of behavioral psychology to explore the diverse behavioral needs within the studied area.

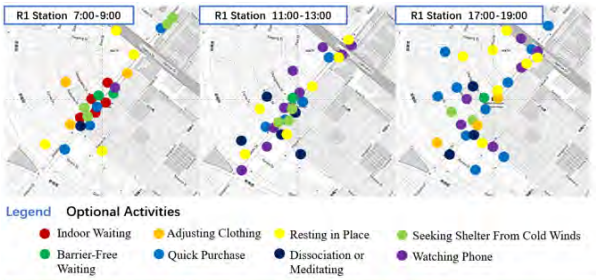
Necessary Behavioral Needs: Necessary behaviors of commuters—such as walking, transferring, carrying items, observing the surroundings, and avoiding obstacles—reflect specific needs and expectations for imperative actions. These needs highlight not only the commuters' pursuit of efficiency but also fundamental requirements for safety, consistency, comfort, and convenience.



Specific Behavior	Needs Explanation
Fast Walking	Urgently reaching the destination, focusing on straight movement
Avoiding Wind	Habitually walking close to walls to avoid cold winds
Carrying Goods	Commuters typically carry certain items, either on their back or by hand
Route Identification	Encountering complex traffic situations and searching for new routes
Group Crossing the Street	Commuter flow tends to accumulate
Taking Shortcuts	Regularly crossing landscapes, green spaces, or barriers to seek shortcuts
Concentrated Vision and Hearing	Limited visibility due to winter clothing and accessories
Avoiding Ice and Snow	Avoiding uncleared icy or snowy surfaces

Figure 5. Pre-survey of commuters' necessary behavioral needs.

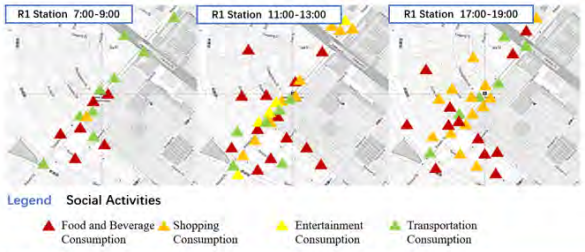
Optional Behavioral Needs: The pre-study identified various spontaneous, non-passing behaviors among commuters, such as waiting near subway entrances, making phone calls, and seeking shelter at bus stops or accessible elevators to avoid cold winds. Commuters also waited for friends or transfers in these areas. Cold weather significantly amplifies these behaviors, increasing the demand for shelter and comfort.



Specific Behavior	Needs Explanation
Indoor Waiting	Waiting inside grocery stores or at entrances
Adjusting Clothing	Adjusting Clothing in Response to Cold Winds During Indoor-Outdoor Transitions
Resting in Place	Resting in places such as squares or sidewalks
Seeking Shelter from cold winds	Seeking shelter from cold winds behind bus or advertising boards while waiting for a bus or taxi.
Barrier-Free Waiting	Waiting to board outside the barrier-free elevator
Quick Purchase	Briefly pausing outside breakfast kiosks to make quick purchases
Dissociation or Meditating	Dissociation or meditating while standing during waiting times.
Watching Phone	Staying in relatively comfortable areas while watching a phone.

Figure 6. Pre-survey of commuters' optional behavioral needs.

Social Behavioral Needs: Commuters' social activities in cold regions predominantly manifest as efficient, flexible consumption (e.g., shopping, dining) within station-adjacent commercial hubs. Driven by the need to minimize cold exposure, commuters prioritize quick access to facilities near station entrances/exits for time-sensitive purchases and services. Beyond material acquisition, these activities fulfill core social-behavioral needs, serving as vital conduits for social connection, pleasure, and personal satisfaction during daily routines.



Specific Behavior	Needs Explanation
Food and Beverage Consumption	Choosing to purchase breakfast, lunch, coffee, drinks, etc., on the way.
Shopping Consumption	Stopping by nearby supermarkets, convenience stores, malls, etc., for shopping.
Entertainment Consumption	Choosing to visit attractions or participate in entertainment activities along the way.
Transportation Consumption	Choosing appropriate transportation modes, such as buses, taxis, etc.
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Transportation Consumption	Choosing appropriate transportation modes, such as buses, taxis, etc.

Figure 7. Pre-survey of commuters' social behavioral needs.

2.4. Questionnaire Survey

Building on a pre-survey of commuters' behavioral needs, this study aimed to gather comprehensive quantitative data on necessary, optional, and social behavioral needs using a five-point Likert scale. The questionnaire consists of two sections:

Basic Information: This includes gender, age, travel frequency, purpose of travel, and the stations passed through.

Behavioral Demand Index: This section includes overall satisfaction with the station area, along with sub-scores for necessary, optional, and social behavioral needs. For example, the pre-survey defined the following behavioral needs:

Necessity Behavioral Needs: "Do you feel that the necessary needs for passing, transferring, carrying, etc., are met when commuting during winter?"

Optional Behavioral Needs: "Do you feel that there are enough places to wait, stay, and rest while commuting in winter?"

Social Behavioral Needs: "Do you feel that the station area meets your needs for efficient shopping, dining, etc., during your winter commute?"

2.5. Indicator System and Calculation Methodology

This study employed the Delphi method and Analytic Hierarchy Process (AHP) to construct an evaluation indicator system. Ten experts from architecture, urban planning, and transportation participated in the study. They were briefed on the research objectives and provided a questionnaire to score indicators on a five-point Likert scale (-2 to 2). Visualization tools were used to analyze the scores, highlighting indicators scoring below 0.7 for revision or elimination. As a result, 2 criteria and 10 indicators were replaced, culminating in a refined system comprising 4 criteria and 20 indicators.

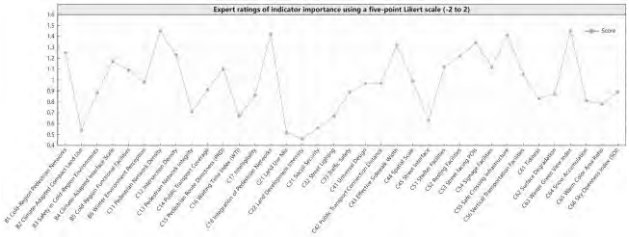


Figure 8. Expert ratings of indicator importance using a five-point Likert scale (-2 to 2)

Target Layer	Criterion Layer	Indicator Layer
Walking Space Quantification of Subway Station Areas in Cold Regions	B1 Cold-Region Pedestrian Networks	C11 Pedestrian Network Density
		C12 Intersection Density
		C13 Pedestrian Route Directness (PRD)
		C14 Pedestrian Network Integrity
		C15 Public Transport Coverage
	B2 Climate-Adapted Interface Scale	C21 Street Canyon Ratio
		C22 Effective Sidewalk Width
		C23 Pedestrian Access Distance
		C24 Sky Openness Index (SOI)
		C25 Space Obstruction Ratio
	B3 Cold-Region Functional Facilities	C31 POI Density
		C32 Resting Facilities
		C33 Vertical Transportation Facilities
		C34 Safe Crossing Infrastructure
		C35 Shelter Facilities
		C36 Signage Facilities
	B4 Winter Environment Perception	C41 Winter Green View Index
		C42 Surface Degradation
		C43 Warm Color Area Ratio
		C44 Snow Accumulation

Figure 9. Indicator system.

Indicator	Calculation
C11 Pedestrian Network Density	Pedestrian network density reflects the ratio of the total length of pedestrian paths within a specific area to the overall area. This metric holds significant importance for understanding travel efficiency and accessibility for pedestrians. $\rho = \frac{\sum_{i=1}^{n} L_i}{S}$ (Eq. 1) Where ρ represents the pedestrian network density, L denotes the length of an individual pedestrian path, S represents the area of the region, n is the total number of pedestrian paths, and i is the index representing each pedestrian path {Lu, Tan2019}.
C12 Intersection Density	Intersection density represents the ratio of the number of intersections to their area in a certain area. $Dint = \frac{\sum_{i=1}^{n} N_i \times 0.25}{S}$ (Eq. 2) Where D represents the intersection density, i denotes the number of off-ramps associated with a single intersection, N represents the number of intersections with the same off-ramps, S represents the area of the region, and n represents the total number of intersections within the station area.
C13 Pedestrian Route Directness (PRD)	Pedestrian Route Directness (PRD) was assessed using Hess's method within a 400-meter radius centered on the station. Values typically range from 1.0 to 1.2, indicating minimal detours and good walkability {Hess1997}. $PRD = \frac{D_r}{D_e}$ (Eq. 3) Where PRD represents Pedestrian Route Directness (PRD), D_r denotes the actual distance traveled, and D_e represents the straight-line distance between two points. Eight endpoints on the circle's perimeter were used to calculate the shortest distances from the center, and their average was divided by the radius to determine the PRD.
C14 Pedestrian Network Integrity	Pedestrian network integrity reflects the overall accessibility within the station area. Higher values indicate enhanced accessibility and more convenient pedestrian movement. The analysis was conducted using depthmapX software.
C15 Public Transport Coverage	Public transport coverage reflects the ratio of the total number of buses stops within a 400-meter radius of subway station to the station area's size. $P = \frac{s_{bus}}{s} \times 100\%$ (Eq. 4) Where P represents public transport coverage, s_{bus} represents the number of buses stops within the 400-meter radius of the subway station, and s represents the subway station area's size.

Figure 10. | Calculation of criterion layer B1.

C21 Street Canyon Ratio	In cold regions, when the street canyon ratio is close to 1, it creates a sense of harmony and balance between the built environment and pedestrian space. Street canyon ratio is defined as the ratio of the width of the walking path (D) to the height of the surrounding buildings (H), expressed as D/H.
C22 Effective Sidewalk Width	In cold regions, the effective sidewalk width is particularly important to avoid obstacles caused by the accumulation of snow or ice, surveyed using a combination of field measurements and satellite maps.
C23 Pedestrian Access Distance	Pedestrian access distance refers to the shortest distance from the exit of a subway station to the nearest bus stop. The analysis was conducted using ArcGIS software. In cold regions, minimizing Pedestrian access distance is particularly important as it reduces the exposure to harsh weather conditions.
C24 Sky Openness Index (SOI)	Sky Openness Index (SOI) represents the extent to which the sky is visible in the street space, indicating the degree of visual openness in an area {Fu, Ban, Jin, Wu2024}. $SOI = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{S_i}{A_i}\right)$ (Eq. 5) Where SOI represents sky openness index, S_i represents the number of sky pixels in a street view image, A_i represents the total number of pixels in the street view image, n denotes the number of samples, and i is the sample index.
C25 Space Obstruction Ratio	Space obstruction ratio intuitively reflects the accessibility of pedestrian spaces. Quantify the proportion of the length occupied by obstacles (such as facilities encroaching on pathways, illegally parked vehicles, etc.) to the total length of the road.

Figure 11. | Calculation of criterion layer B2.

Indicator	Calculation
C31 POI Density	POI density refers to the number of POIs per unit area. In cold regions, a high density of POIs can provide commuters with more indoor spaces and warm places. In this study, an API Key was obtained through the developer mode of Baidu Open Platform, and EasyPoi software.
C32 Resting Facilities	Resting facilities, such as seats, heated shelters, green belts, etc., is calculated as the ratio of the number of resting facilities within the station area to the length of the road.
C33 Vertical Transportation Facilities	Vertical transportation facilities, such as elevators, sunken plazas, and stairs, connect subway stations to surrounding pedestrian spaces, creating a three-dimensional network. It's calculated as the ratio of their number to road length, enhances commuter convenience during severe cold weather.
C34 Safe Crossing Infrastructures	Safe crossing infrastructures, including footbridges, underground passages, zebra crossings, and safety islands, is calculated as the ratio of crossing infrastructures to road length, minimizes pedestrian-an-vehicle conflicts and mitigates snow-related road hazards in cold regions.
C35 Shelter Facilities	Shelter facilities, including street trees, canopies, and bus shelters, protect pedestrians from harsh weather, improving comfort and safety. Their density is measured as the ratio of the number of facilities to road length.
C36 Signage Facilities	Signage facilities assist commuters in navigating complex environments, especially under adverse weather conditions. Signage facilities are categorized into two types: location-based and directional. $p = \frac{s_l + s_d}{L} \times 100\%$ (Eq. 6) where p represents the density of signage facilities, s_l represents the number of Location-based signs, and s_d the number of directional signs, and L represents the road length.

Figure 12. | Calculation of criterion layer B3.

Indicator	Calculation
C41 Winter Green View Index	Winter green view index quantifies the visual proportion of green vegetation, offering psychological warmth and visual comfort during winter. It is calculated by analyzing the ratio of green pixels to total pixels in images taken at key nodes, using tools like Photoshop.
C42 Surface Degradation	Surface degradation evaluates the smoothness and safety of walking surfaces, critical for reducing slip risks on snow-covered pavements. Given the current lack of direct formulas for quantifying surface degradation, this study employs a Likert scale to comprehensively rate surface degradation.
C43 Warm Color Area Ratio	The warm color area ratio measures the proportion of warm hues (e.g., red, orange, yellow) in walking spaces, extracted from street-view images and field photographs. Warm colors enhance mood, provide psychological warmth, and improve aesthetics, encouraging walking in cold climates.
C44 Snow Accumulation	Snow accumulation significantly impacts commuter safety and efficiency, increasing walking effort, fall risks, and traffic conflicts. Despite the prevalence of these issues in cold regions, prior research lacks quantitative data on snow's specific impact on commuter behavior. Therefore, employing a Likert scale for rating provides quantitative insights into the effects of snow accumulation.

Figure 13. | Calculation of criterion layer B4.

2.6. Data Analysis

This study employs Grey Relational Analysis (GRA) to examine the relationship between spatial indicators and behavior needs factors mathematically. GRA is a non-statistical method applicable to both large and small datasets. Its advantage lies in the accurate measurement of the approximation relationships between sequences in small sample data (≥4 samples), as well as its ability to qualitatively and quantitatively determine the correspondence between factors in sample data with significant variability.

While GRA identifies spatial factors most related to behavioral needs factors, it cannot determine the magnitude of their influence, nor can it provide detailed design guidance. To address this limitation, Linear Regression Analysis (LRA) is applied after

the GRA to further investigate how spatial factors affect behavioral needs factors.

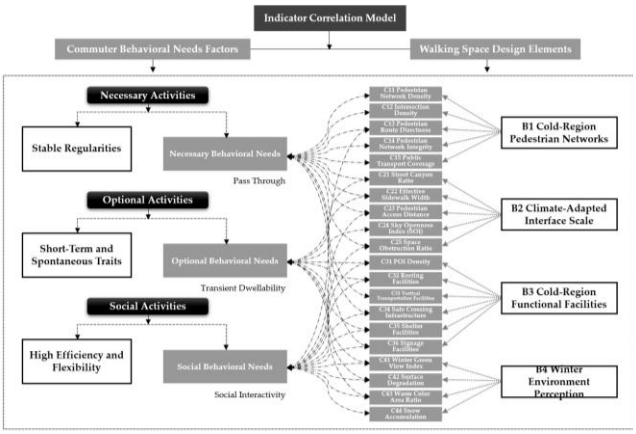


Figure 14. Indicator correlation model

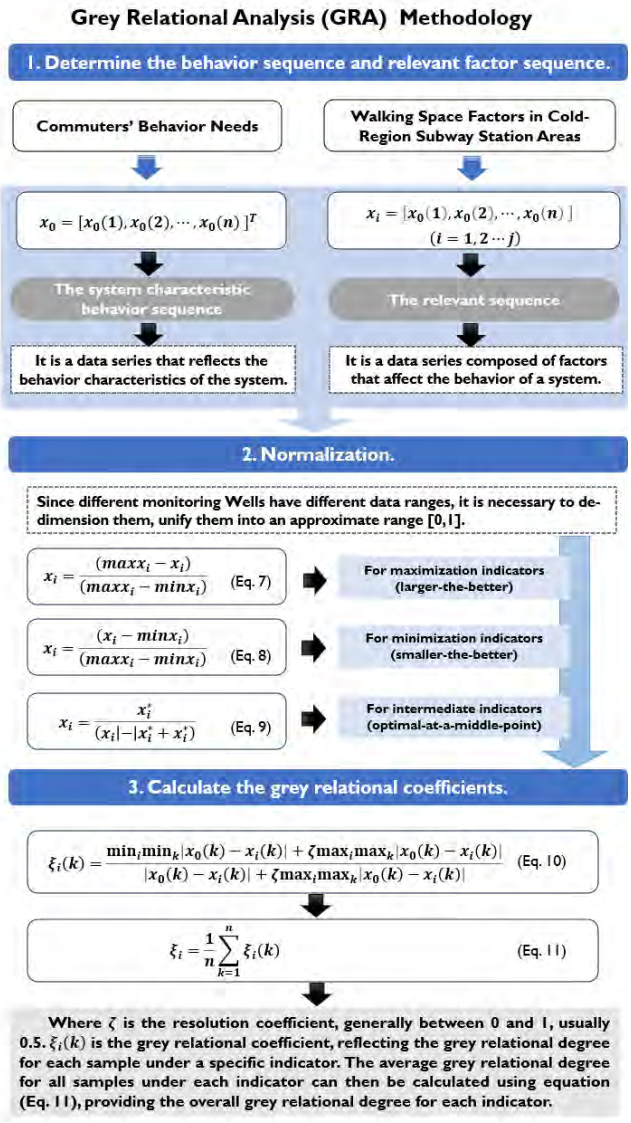


Figure 15. Calculation steps for the grey relational coefficients.

3. Results

3.1. Questionnaire Survey Analysis

A survey was conducted at six subway station areas in Harbin, with 50 questionnaires distributed at each station area, totaling 300 questionnaires. A total of 280 valid questionnaires were obtained, with 20 being invalid. A Cronbach's Alpha coefficient greater than 0.7 indicates high reliability of the questionnaires. The results showed that the Cronbach's Alpha value for this survey analysis was 0.812, indicating that the survey data had strong consistency and reliability, allowing for further in-depth research and analysis.

A statistical analysis was conducted on the 300 commuters surveyed across the six station areas. Approximately 162 commuters were aged between 18-30, accounting for 54%, while 138 commuters were aged between 31-60, accounting for 46%. The study revealed that young people aged 18-30 are the main participants during peak commuting hours, especially during the morning and evening rush hours. Furthermore, the peak travel times were concentrated mainly between 6:00-9:00 and 18:00-21:00, ac-counting for 34% and 31% respectively, which aligns with commuting patterns and reflects the typical commuting mode in cold regions.

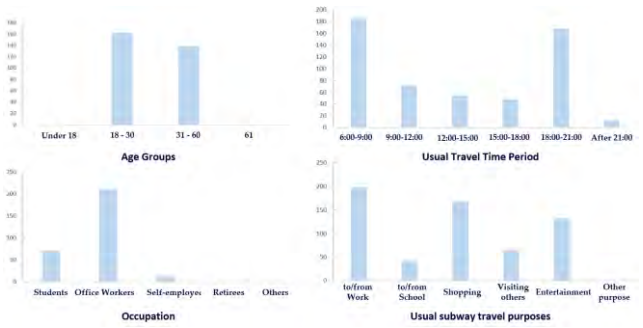


Figure 16. Calculation steps for the grey relational coefficients.

The survey rating results indicate that only three samples, W3, W1, and R2, exhibit overall space satisfaction scores exceeding 1, while the satisfaction scores of the remaining samples fall within the range of 0 to 1. This clearly suggests that there is considerable room for optimization and improvement in meeting overall behavioral needs. Regarding essential behavioral needs, the satisfaction scores of R2, R3, W1, W3, and the sample average all surpass the threshold of 1, with R1 and W2 also achieving levels above 0. Collectively, these results effectively align with the basic requirements for efficient commuting within

the station area. However, in the dimension of optional behavioral needs, none of the station area samples reach the baseline of 1, reflecting a notable deficiency in the design of protective spaces for waiting and lingering behaviors in cold-region subway station areas. As for social behavioral needs, only the W3 sample exceeds a satisfaction score of 1, strongly indicating that there is substantial potential for improvement in creating an efficient and seamless environment for consumption within cold-region subway station areas.

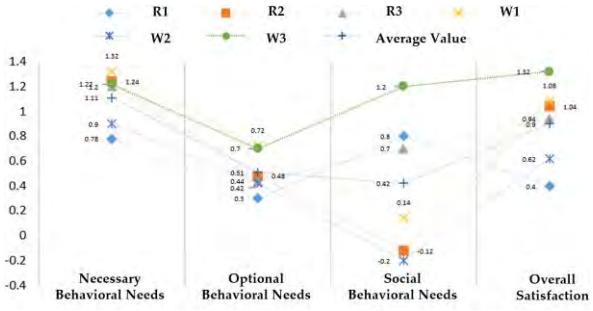


Figure 17. Scoring statistics of commuter behavioral needs

3.2. Influence of Walking Space Factors in Cold-Region Subway Station Areas on Commuter Behavioral Needs

In this study, indicators with coefficients ≥0.6 were identified as key factors with high relevance to the target, providing a robust foundation for the subsequent linear regression analysis.

For Y1 Necessary Behavioral Needs, 12 indicators were identified, ranked in descending order of correlation as follows: C14 > C32 > C22 > C35 > C42 > C21 > C34 > C23 > C24 > C44 > C33 > C25. For Y2 Optional Behavioral Needs, 16 indicators were identified, ranked as follows: C32 > C42 > C35 > C14 > C34 > C22 > C24 > C33 > C31 > C23 > C36 > C25 > C44 > C13 > C12 > C15. For Y3 Social Behavioral Needs, 9 indicators were identified, and the descending order of correlation was: C13 > C31 > C36 > C43 > C33 > C11 > C15 > C12 > C34. For Y Overall Satisfaction, 15 indicators were identified. The correlation ranking was: C14 > C34 > C32 > C25 > C42 > C23 > C22 > C35 > C33 > C31 > C36 > C44 > C21 > C24 > C13.

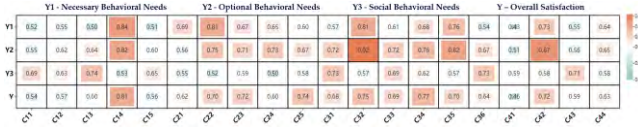


Figure 18. Grey relational coefficients



Figure 19. Rose diagram of coefficients

Based on the significance analysis in the regression model, the primary influencing factors for necessary behavioral needs are C14, C21, C22, C32, and C35. All these factors exhibit positive B values. Among them, C14 demonstrates a more pronounced impact.

Table 1. Influence of space factors on commuters' necessary behavioral needs.

Model	*Raw Coefficients*		*Standardize Coefficients*	*t*	*Sig.*
	B	*Std. Error*	*Beta*		
(Const)	0.146	0.186		0.789	0.474
C14	1.238	0.234	0.935	5.288	0.006
(Const)	0.739	0.107		6.916	0.002
C21	0.517	0.135	0.887	3.835	0.019
(Const)	0.651	0.191		3.413	0.027
C22	0.128	0.050	0.786	2.539	0.064
(Const)	0.820	0.143		5.748	0.005
C32	0.029	0.013	0.752	2.285	0.084
(Const)	0.816	0.152		5.349	0.006
C35	0.008	0.004	0.733	2.152	0.098

According to the significance analysis in the regression model, the primary influencing factors for optional behavioral needs are C14, C22, C32, C35, and C42. The B-values for these factors are all positive, indicating a positive correlation with the behavioral need scores. Additionally, C14 and C35 has a more significant impact.

Table 2. Influence of space factors on commuters' optional behavioral needs.

Model	*Raw Coefficients*		*Standardize Coefficients*	*t*	*Sig.*
	B	*Std. Error*	*Beta*		
(Const)	-0.186	0.192		-0.968	0.388
C14	0.894	0.242	0.879	3.690	0.021
(Const)	0.155	0.145		1.071	0.345
C22	0.099	0.038	0.790	2.581	0.061
(Const)	0.217	0.023		9.367	0.001
C32	0.029	0.002	0.990	14.239	0.000
(Const)	0.214	0.048		4.415	0.012
C35	0.008	0.001	0.960	6.824	0.002
(Const)	0.089	0.074		1.196	0.298
C42	0.478	0.080	0.948	5.981	0.004

The regression model's significance analysis identifies C31 and C13 as the primary determinants of social behavioral needs. The B-values for C31, which quantify the density of POIs related to commercial activities along the street, are consistently positive, indicating a positive association with social behavioral need scores. Specifically, higher POI density correlates with increased demand for walking spaces within the station area. Conversely, the B-value for C13 reflects a negative relationship with social behavioral need scores. Notably, C13 exhibits a relatively greater influence compared to C31, underscoring its critical role in shaping commuters' social behavioral dynamics.

Table 3. Influence of space factors on commuters' social behavioral needs.

Model	*Raw Coefficients*		*Standardize Coefficients*	*t*	*Sig.*
	B	*Std. Error*	*Beta*		
(Const)	5.267	1.048		5.026	0.007
C13	-3.320	0.714	-0.919	-4.647	0.010
(Const)	-0.207	0.161		-1.291	0.266
C31	0.006	0.001	0.926	4.905	0.008

Considering that C14, C22, C32, and C35 have significant impacts on both necessary behavioral needs and optional behavioral needs, an initial classification of these factors is conducted to facilitate the subsequent in-depth discussion of optimization strategies based on specific types of behavioral needs. This classification is based on the magnitude of their respective B-values, which represent the slope of the linearly fitted model and reflect the strength of their influence. Factors with larger B-values, such as C14 and C22, are categorized under Necessary Behavioral Needs for focused analysis. For C32 and C35, which share identical B-values, further classification is determined by the significance level of their impact. Specifically, C32 and C35, with higher significance, are grouped under Optional Behavioral Needs. Finally, based on the comprehensive analysis of the relationship between commuters' social behavioral needs and walking spaces in cold-region subway station areas, the design index factors closely associated with different behavioral needs are identified.

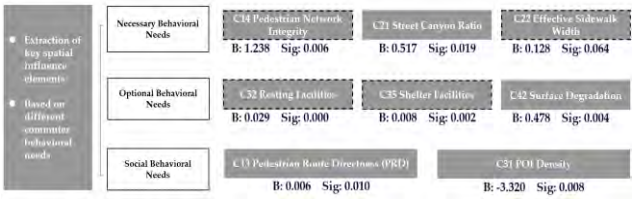


Figure 20. Classification of influence factors based on different behavioral needs of commuters

4. Discussion

4.1 Current Status and Optimization Design Suggestions of Space Factors Affecting Necessary Behavioral Needs

Focus on C14 Pedestrian Network Density: pedestrian walkways within walking space in cold-region subway station areas are primarily located along both sides of motorized roads. These areas lack dedicated pedestrian-only pathways, and existing walkways are often situated beneath viaducts, alongside surface-level traffic, or within underground streets. Commuters' routes are often interrupted by motorized roads or require crossing them, resulting in a generally low degree of pedestrian network integration within these spaces. In this study, the following optimized design suggestions are proposed: 1. holistic design of pedestrian networks; 2. connecting urban areas with flyovers and open blocks; 3. improving path continuity.

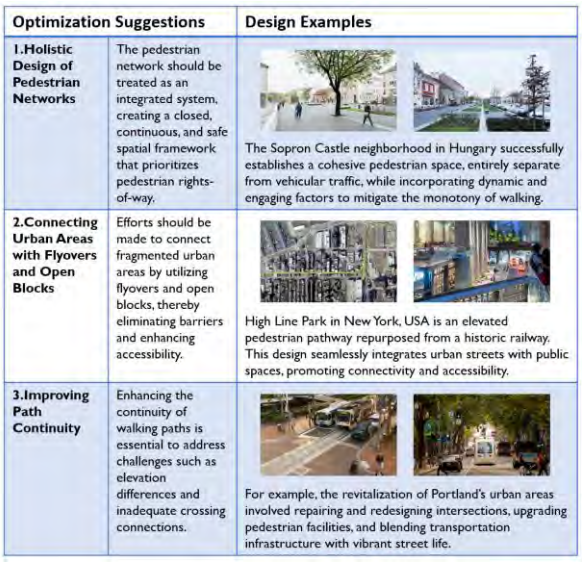


Figure 21. Optimization suggestions of C14

Focus on C21 Street Canyon Ratio: Streets with lower D/H ratios exhibit higher wind speeds and shading effects, which are beneficial for improving pedestrian thermal comfort in summer

but detrimental in winter. According to the thermal comfort calendar for hot and cold seasons, maintaining a street canyon ratio of 2/3 < D/H < 2 is more advantageous in severe cold climates {Sun, Lian, Liu, Dong, Han2022}. However, in walking spaces of subway station areas in cold regions, the D/H ratio is mostly less than 1. This leads to several issues: firstly, insufficient sunlight exposure results in snow accumulation that persists for long periods; secondly, during city snow seasons, a significant amount of snow accumulates in corners, along roadsides, and in landscape green belts, obstructing normal walkways and transit routes. The optimized design suggestions are as followed: 1. adjusting street width; 2. controlling building heights.

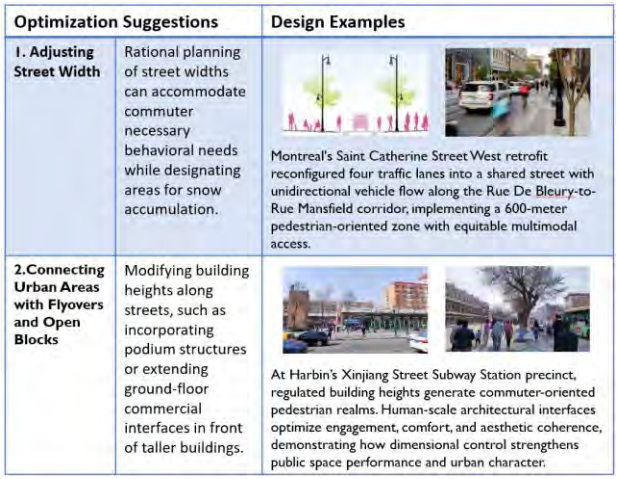


Figure 22. Optimization suggestions of C21

Focus on C22 Effective Sidewalk Width: In walking spaces of subway station areas in cold regions, several challenges exacerbate the already limited sidewalk width. Common issues include road occupation by parked vehicles, encroachment by municipal facilities, and significant snow accumulation during winter months. These factors collectively narrow sidewalks further, creating substantial obstacles for pedestrians. During winter, icy and slippery road conditions not only make walking difficult but also increase the risk of slips, falls, and traffic accidents. Snow piled along roadsides further infringes on walking space, obstructing movement and forcing commuters to share lanes with motor vehicles. The optimized design suggestions are as followed: 1. regulation of parking and municipal facilities; 2. snow melting and drainage.

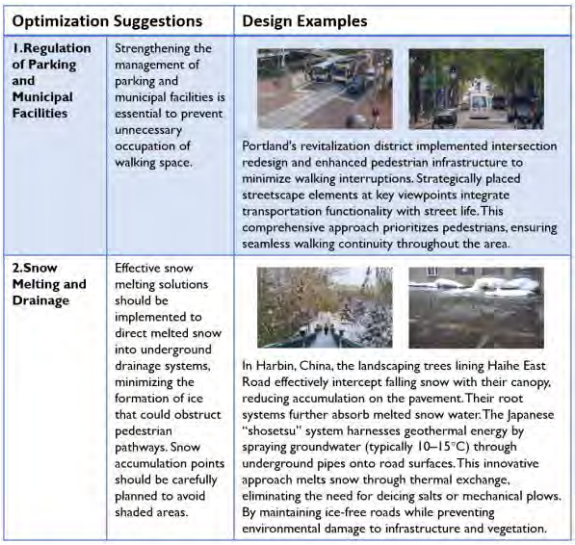


Figure 23. Optimization suggestions of C22

4.2 Current Status and Optimization Design Suggestions of Space Factors Affecting Optional Behavioral Needs

Focus on C32 Resting Facilities: In this study, the density of resting facilities is positively correlated with higher optional behavioral needs scores. However, field research indicates that most cold-region subway stations are situated in older urban environments, where station construction is often mechanically and poorly integrated with the existing city layout. These spaces often lack sufficient facilities and do not provide adequate shelter from the wind or warmth, making it difficult to meet optional behavioral needs for comfort and recreational spaces during cold weather. The optimized design suggestions are as followed: 1. diversification of resting facilities; 2. improved climate adaptability.

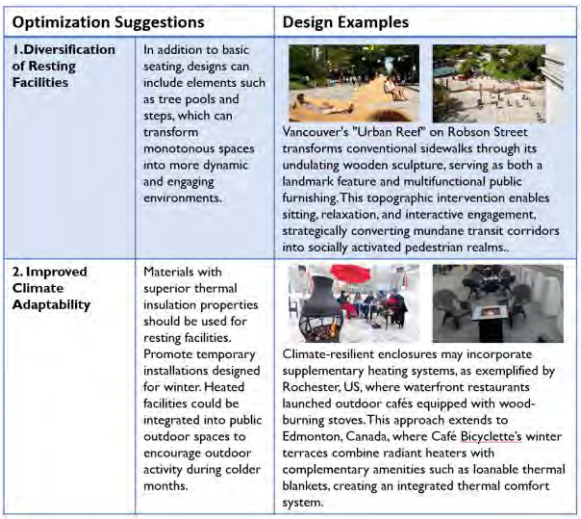


Figure 24. Optimization suggestions of C32

Focus on C35 Shelter Facilities: Shelter facilities play a critical role in enhancing the vitality of winter cities. The pre-architectural space surrounding cold-region subway stations, including the external spaces at station entrances and exits and the interface between buildings and pedestrian walkways, are pivotal in mitigating temperature fluctuations and shielding against cold winds. However, currently, the shelter facilities in these areas are either insufficient or too limited in coverage, failing to provide adequate protection. Existing shelters primarily consist of natural landscapes and artificial structures, such as pavilions, corridors, canopies, and membrane structures. The optimized design suggestions are as followed: 1. installation of windproof and cold-resistant shelter facilities; 2. semi-sheltering solutions for snow-prone areas; 3. indoor commuting routes and building connections.



Figure 25. Optimization suggestions of C35

Focus on C42 Surface Degradation: The walking surfaces in the station area cases are generally in poor condition and uneven, leading to lower behavioral need scores. This is primarily due to the relatively old construction and lack of proper maintenance. Additionally, in extreme climates, some areas feature low-quality surface materials that are prone to damage. Constant snowfall, icing, and the application of industrial salt further erode the pavement, ex-acerbating these issues. Unevenly paved and icy surfaces not only slow pedestrians down but also create safety hazards, increasing the likelihood of trips and falls. The optimized design suggestions are as followed: 1. use of durable and non-slip paving materials; 2. ensure pavement flatness and joint width.



Figure 26. Optimization design suggestions of C42

4.3 Current Status and Optimization Design Suggestions of Space Factors Affecting Social Behavioral Needs

Focus on C31 POI Density: Increasing the density of social amenities in winter cities can help to improve the walking space system and ensure safe connectivity among these spaces, which is particularly crucial given the harsh climatic conditions of cold regions {Korobeinikova, Danilina, Teplova2024}. Winter cities often face challenges such as insufficient connectivity and uneven distribution of POIs, making it difficult to achieve the compact city. These conditions make it difficult to encourage consumption behavior and do not address the challenge of spending extended periods outdoors during winter. The optimized design suggestions are as followed: 1. concentration of multi-functional social facilities; 2. cultural and winter-themed integration.

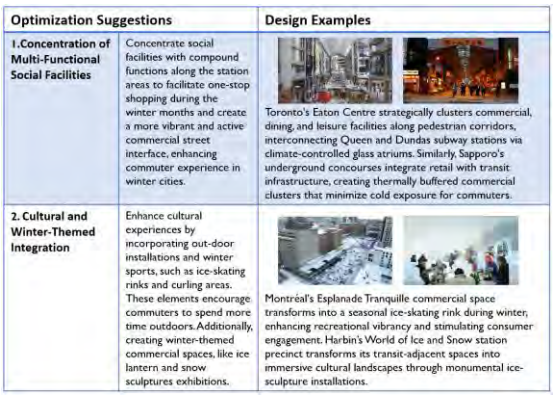


Figure 27. Optimization suggestions of C31

Focus on C13 Pedestrian Route Directness: Hess defines Pedestrian Route Directness (PRD) as typically ranging from 1.2 to 1.5, with significant detour phenomena occurring when the PRD exceeds 1.8 {Hess1997}. The average PRD for the six station areas is approximately 1.46, which is relatively high and indicates that the walking network exhibits notable detour effects. The dis-connected nature of the pedestrian paths, which are not directly accessible, leads to increased detours and inefficient movement. The optimized design suggestions are as followed: 1. urban regeneration and grid-based layout; 2. increased pedestrian network density for pedestrian access.

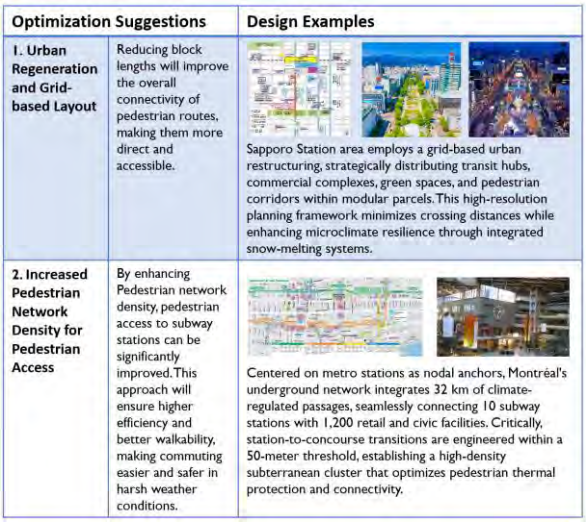


Figure 28. Optimization suggestions of C13

5. Conclusion

This study examines subways as essential green transportation for residents in cold regions, emphasizing the critical function of walking spaces within station areas in resolving the 'last mile' challenge. It identifies multifaceted commuter behavioral needs categorized into three typologies: necessary, optional, and social behavioral needs. This study not only reveals the intrinsic relationship between commuter behavioral needs and walking spaces within cold-region subway station areas but also explores a series of more human-centered design factors. It provides important theoretical foundations and practical guidance for the future optimization of walking spaces of subway station areas in cold regions.

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PERCEPTUAL MORPHOLOGY AND HUMAN USE: A FINE-GRAINED MAPPING FRAMEWORK BASED ON POINT CLOUD ANALYSIS IN URBAN GREEN SPACES

TOPIC: Guiding cities with society: Use, memory, artistic creation

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Keywords: urban green space, 3D spatial morphology, visitor behavior, point cloud, mapping

Abstract

Urban green spaces serve as key venues for daily outdoor activities, shaping both the physical routines and emotional associations of residents and visitors. The spatial quality plays a critical role in influencing how people interact with public landscapes, contributing to their collective use and lasting memory. However, the dynamic and complex morphological structure of such spaces has often been understudied in quantitative terms. To address this gap, this study proposes a refined analytical framework that examines the relationship between spatial morphology and visitor activity preferences, with an emphasis on human perception and behavioral response. The method integrates multi-source data and advanced 3D spatial modeling techniques across three core stages: (a) extracting and mapping typical spatial feature indicators based on human visual perception, using 3D point cloud models; (b) capturing the spatiotemporal distribution and behavior of users through in-field observation, visitor tracking, and panoramic image analysis; and (c) conducting data correlation through mapping to reveal how spatial morphology influences human activities. This method was applied to a 30-hectare park case study, recording visitor activities and analyzing visual perception indicators—including enclosure (EN), edge degree (ED), openness (OP), and depth modulation (DM)—were simulated through point cloud data. Spatial analysis, data association, and quantitative processing were conducted using ArcGIS, Origin and SPSS. The results demonstrate that visitor preferences are shaped by a set of interrelated spatial variables, and indicators exhibited preferred value ranges: EN = [0.45, 0.95], ED = [0.03, 0.16], OP = [0, 50], and DM = [2, 12]. The proposed framework allows for a more granular and predictive approach to evaluating and optimizing urban public spaces. Combining the correlation results and preference intervals, the study proposes morphological optimization recommendations for the parks. By linking fine-scale spatial features with real-time patterns of human use, this research offers a precise understanding of how green space design influences public behavior and interaction, offering an approach that supports both evidence-based design and the evolving experiential needs of urban societies. It contributes to a deeper understanding of how space becomes meaningful through use, and how design can adapt to support memory, identity, and artistic expression in the landscape.

1. Introduction

Urban green space is an important part of open space, and its spatial creation and service functions directly affect the spatial perception and healthy activities of people. High-quality urban green space has a positive effect on improving people's mood and health. How to scientifically recognize the space form and people's preference, and refine the spatial enhancement to meet the people's preference and potential desire has become an important research topic at present.

The distribution of visitors in parks is often uneven, showing certain spatial preference characteristics. Visual perception, as the most direct spatial experience, determines the judgement of safety, attractiveness and comfort in the environment. Studies have shown that spatial morphological characteristics such as prospect, refuge, visibility, openness, enclosure, richness, diversity, and natural are important dimensions and indicators that influence people's perceptual preferences [1,2,3], which reflect landscape spatial characteristics and are also the main points to guide the spatial refinement design. Understanding the public's preferences for landscape space could lead to a mature design that meets the public's needs and contributes to the intensive and efficient use of spatial resources. Urban green space morphology is complex and varied, and people's preference for space is also comprehensive. Taking Prospect-Refuge Theory related studies as an example, as the research deepened it could be found that the evidence of the people's preference for shelter and prospect is not uniform [4]. Combined with practical observations, this paper infers that there is not a simple linear correlation between crowd preferences and spatial morphology, and that spaces can provide comfort and attraction only within certain characteristic intervals.

Previous research has focused on the relationship between landscape preferences and spatial elements [5,6]. Most landscape preference studies tend to divide the space and use the central location pattern to represent the overall characteristics of the space [7], ignoring the characteristics of landscape space as a flowing and gradual whole with ambiguity and continuity. In terms of research methodology, previous studies used photographs for image segmentation and quantitative scoring which is limited by spatiotemporal limitation of photographs [1] and weakens 3D attributes and detailed morphology of space. On the other hand, the images combined with questionnaires or EEG experiments can obtain visitors' preferences for the scene or their willingness to enter the space, but detailed information about their stay and activities in the space is still missing.

With the development and application of 3D technology, some studies have explored 3D spatial characteristics methods based on tilt photography and point cloud data, providing new ways of thinking for landscape spatial morphology analysis [8]. This study proposes fine-grained spatial morphological features and people's activity distribution analysis methods, aiming to explore the impact of spatial form on human activity and what kind of spatial form is more attractive to human activity. Using actual park as a case, the study summarizes threshold ranges to guide refined spatial design, renewal, and facility layout, enhancing spatial attractiveness and health promotion.

2. Materials and Methods

2.1. Study area

This paper selected Nanjing Lovers' Garden as the research sample covering an area of about 30 hectares. The park is free of charge throughout the year and is easily accessible to the public and visitors.

The overall spatial data of the park was acquired by UAV tilt photography, converted into 3D point cloud model. And with the help of Rhino8 software, the simplified point cloud was converted to NURBS to achieve 3D model solid modelling.

This study focused on open spaces in park, which can accommodate people to stay and be active freely. So, we identified the overall model of the Lovers' Garden with the help of ArcGIS, and obtains major spatial units [9], which are used as the research objects for the subsequent spatial characteristics analysis and the investigation of visitors' behaviors (Figure 1).

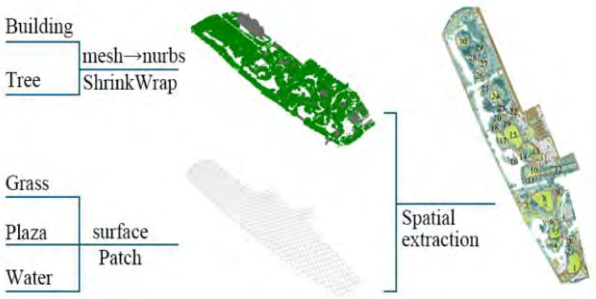


Figure 1. 3D model construction and spatial recognition.

2.2. Data processing

With reference to the previous quantitative methods of spatial morphological characteristics, this study relied on the 3D spatial model and the

Grasshopper platform to simulate the indicators calculation. Firstly, the 3D spatial model was loaded in rhino8 software, and the points were evenly distributed in the 3D space using grasshopper. After projecting the sample points on the ground, the points were translated upwards by 1.6m to obtain the viewpoints that conform to the height of the human eye. Taking each viewpoint as the starting point, lines of sight with a 10° angle are launched in all directions. The lines of sight are intersected with the 3D solid model to obtain the length of each line of sight and the attributes of the corresponding field of view, thus simulating the spatial state perceived by the human eye (Figure 2).

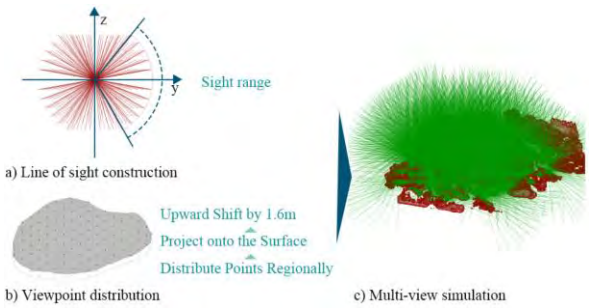


Figure 2. Spatial morphology analysis based on line-of-sight simulation.

Previous studies have shown that spatial visual characteristics related to morphology include dimensions such as coincidence, visual scale, complexity, and naturalness [3], of which openness, enclosure, diversity, visibility prospect, refuge, and other indicators have an important impact on people's preferences [1]. In this paper, four indicators of Enclosure (EN), Edge Degree (ED), Openness (OP), and Maximum Depth (DM), are selected to describe spatial morphology (Table 1).

Table 1. Quantitative indicators.

Indicator	Formula
Enclosure (EN)	$EN = R_0 / R_V$
Edge Degree (ED)	$ED = r_{min} R_V / r_t$
Openness (OP)	$ED = r_t / R_V$
Maximum Depth (DM)	$ED = r_{max} R_V / r_t$

R_V = total number of visible lines of sight in the field of view; R_0 = number of lines of sight with a length of less than 10m; r_t= total length of visible lines of sight in the field of view; r_{max} = maximum length of the line of sight (except the sky portion) at the viewpoint; r_{min} = shortest line of sight length of the viewpoint.

After obtaining the spatial morphological characteristics of each viewpoint, the attribute table function in ArcGIS is used to add the corresponding feature data for each point, to realize the spatial location of the morphological characteristics. And then, the area between each viewpoint is interpolated and filled using the Kriging interpolation tool in ArcGIS to generate a raster distribution map of spatial morphological indicators covering the whole area of the park.

Spatiotemporal distribution characteristics were used to assess visitor activities, quantified by visitor numbers, point locations, density, etc. Weekday and weekend of sunny weather are selected, including four time periods: 7:00-10:00, 10:00-13:00, 13:00-16:00 and 16:00-19:00, to obtain the health behaviors and distribution. According to the SOPARC theory [10], visitor point locations, gender (female and male), age group (children and adolescents, adults, elderly), and activity type (sedentary, walking, and vigorous) were observed and recorded through point elements and point density analysis tools in ArcGIS.

2.3. Relations analysis

The study explored the correlation and influence mechanism of spatial morphology and visitor activities with the help of correlation analysis and statistical analysis tools. First, 5 * 5m fishnet was created in ArcGIS, and the mapping raster data of spatial morphology and visitor density were partitioned and counted by Zonal Statistics. The average value of the raster data corresponding to each grid was calculated and connected to the grid attributes. Through grid attribute table, the values of 4 spatial morphology characteristic indicators and the distribution density of different activity types of visitors were aligned and correlated. Then, Spearman correlation analysis was carried out with Origin software. The associations between spatial morphological characteristics and visitor activities were explored in spatial units. Based on exploring the correlation, the study constructs scatter plots and violin plots to further clarify the numerical intervals of the spatial morphological characteristics of health behavior.

3. Results and Discussion

3.1. Mapping results

As shown in the points and density distribution of visitors in (Figure 3-ab), the densest distribution of visitors was found within spaces 8, 12, 15, and 17, followed by spaces 1, 9, 10, 14, 22, and 24. Spaces 3, 7, 20, 18, 25, and 29 had the sparsest distribution of visitors. Visitors are distributed near the edge of

the space rather than the center, which is consistent with previous research that people tend to stay and act in areas with sheltered areas and better visibility.

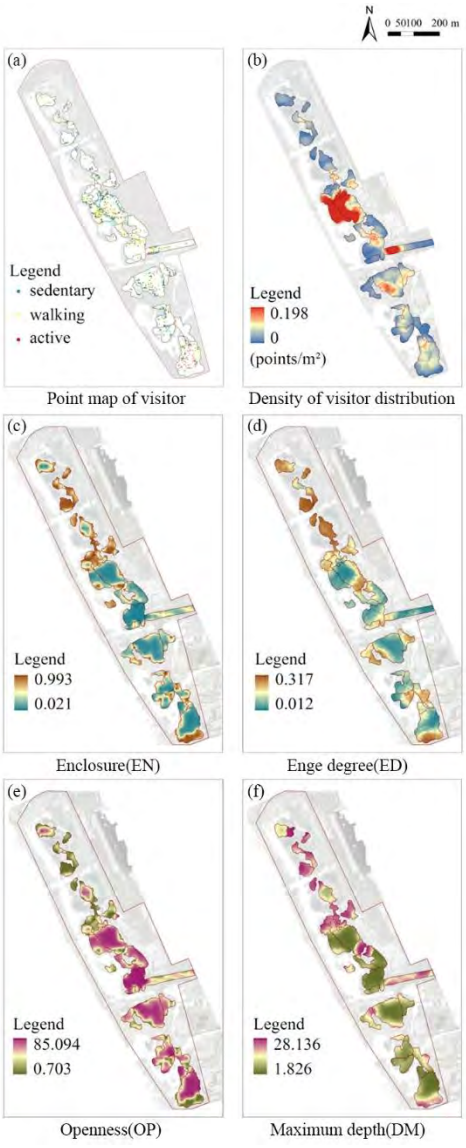


Figure 3. Mapping of visitors' distribution and spatial morphological characteristics.

The mapping results of the 4 spatial morphology indicators are shown in (Figure 3-cdef). From the mapping diagrams, there are significant differences in the spatial morphological characteristics of visual perception in various locations. Taking OP as an example, the theoretical value range of the formula for OP indicator is [0,100], and the actual analysis result value of the park is [0.703,85.094]. From the overall scope of the park, the 4 indicators have spatial distribution differences in the south, center, and north of the park.

The morphological characteristics of landscape space show a continuous gradual change trend. There are not only regional but also inner spatial differences in the indicator values. The OP values of space 8 and 24 generally show a trend of high in the middle and low in the surroundings. The ED values of space 8 are homogeneous and that of space 24 decreases from southwest to northeast, which may be related to the composition of the spatial interface. The study corroborated that the morphological characteristics of the space center do not represent the calculated values of the indicators of all viewpoints in the space. Compared to mapping in terms of points or areas, the mapping results in this study show the difference and change trend of spatial morphology in the park more intuitively and in detail.

3.2. Relationship between spatial morphology and activity patterns

Figure 4 shows the correlation analysis results between the distribution of different activity types and spatial morphology indicators mapping based on fishnet. OP had a positive effect on activity distribution, indicating that healthy activities prefer places where the sky is visible, EN, ED and DM have negative influence on activity distribution, indicating that people tend to be active in places with lower enclosure, close to the edge, and lower spatial extension. In terms of different activity types, the sedentary activities were more affected by ED (0.31), suggesting that people cared more about being at spatial edges; the walking activities were most strongly affected by the association of DM (0.31), and the vigorous activities were most strongly affected by OP and DM.

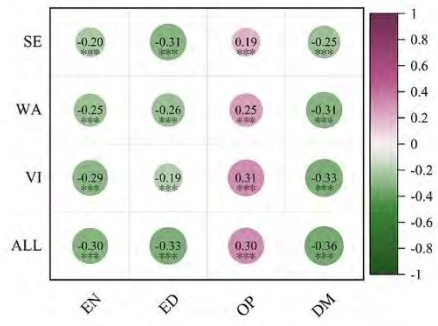


Figure 4. Correlation analysis (SE= Density of sedentary people; WA= Density of walking people; VI= Density of vigorous people; ALL= Density of people).

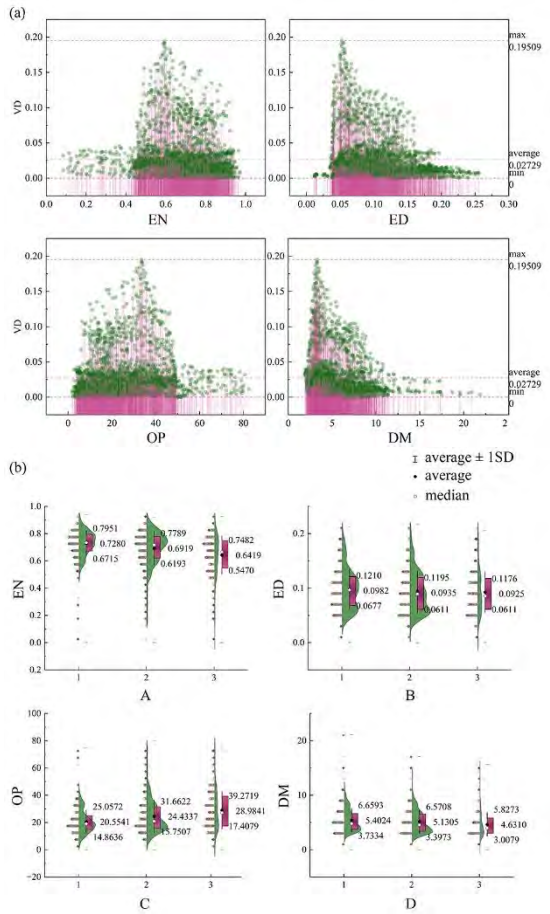


Figure 5. Scatterplot and violin plot of spatial morphological characteristics and people's distribution.

Based on fishnet construction and data linkages, Figure 5 illustrates the scatterplot of data, with interval differences for 4 morphometric indicators, which suggests that people's distribution is more concentrated within a certain interval of morphometric indicator values. This explains the weak correlation coefficients to some extent; the variable relationships do not satisfy linear correlation, but there are clearer inter-area differences.

People are more likely to be concentrated in the EN of [0.45, 0.95], and the highest density corresponds to an EN of 0.6. Visitors prefer to stay around areas with a certain degree of enclosure, which coincides with the need for shelter. For the area with high density of people, OP is in the interval of [0, 50], and DM is mainly in the interval of [2, 12]. The density of people tends to 0 when the ED is below 0.03. People are concentrated at an ED of [0.03, 0.16], the highest density corresponds to an ED of 0.05. These intervals can explain the complexity of spatial preference research conclusions that conflicts and inconsistencies exist in the types of preferences in past research findings [4], and answers the question of "which degree of prospect and refuge would be perceived as comfortable in a natural or an urban context".

Categorized by type of healthy activities, sedentary preferred to occur in spaces with higher EN [0.6715, 0.7051], lower OP [14.8636, 25.0527]. Correspondingly, vigorous prefers spaces with lower EN [0.5470, 0.7482] and higher OP [17.4079, 39.2719] and is more inclusive of spatial morphological characteristics. Vigorous prefers the space of DM at [3.0079, 5.8273], suggesting that clumped spaces with less extension are more suitable for vigorous activity and provide more spacious space. The three activities are similar in their preference for ED, all preferring positions with ED of [0.6011, 0.1210].

3.3. Quantitative-based spatial optimization

Comparing the morphological characteristics and crowd distribution of various spaces within the park, the northern spaces generally have low levels of human activity, while the central spaces are overly dense and require optimization and improvement. Specific optimization recommendations are as follows:

Sort vegetation to enhance spatial openness and connectivity. The northern space units are mostly small and closed spaces. It is recommended that vegetation in some spatial units or adjacent spaces be removed to reduce coverage, enhance spatial openness and visibility, and improve attractiveness and activity capacity.

Enrich spatial types. Compared with the southern and central spaces, the northern space is morphologically homogeneous, which leads to a monotonous experience for visitors during tours. Key spaces can be selected and renovated in combination with node themes to enhance the overall attractiveness of the northern space.

Divide the space and arrange facilities. The central space is large and close to the main entrance, making it a densely populated area with mixed activities. The space can be divided into zones according to morphological characteristics of different activity preferences to guide orderly activities. In addition, infrastructure such as trash cans and seats can also be distributed according to spatial morphology.

3.4. Limitations and prospects

The spatial morphology mapping and people preference relationship research method based on point cloud and line-of-sight simulation in this study is significant for fine-grained and on-site green

space preference research, but there are some shortcomings.

In terms of quantitative analysis techniques, the study could further optimize the parameters of visual simulation and mapping grids within computational constraints, increase the number of sampling points to enhance quantitative accuracy, or explore more refined association mechanisms through machine learning. In terms of considering influencing factors, the survey period and duration were limited. Future studies could consider expanding the questionnaire, increasing research scope, and extending recording time, while also considering the impact of other dimensional factors.

4. Conclusion

This study observes and quantifies the actual distribution of health behaviors in the park through panoramic photography and point recordings in the field, analyzes the spatial morphology characteristics perceived by the human eye through visual simulation based on the 3D point cloud model, visualizes the distribution of people and morphology data through mapping, and explores the correlations and preference intervals between healthy activities and spatial morphology using correlation analysis and descriptive statistics. Taking Nanjing Lovers' Garden Park as an example, the study obtains the following discoveries:

(1) The landscape spatial morphology characteristics are uneven, the overall characteristics of the space cannot be replaced by the morphology characteristics of a point location, and the spatial morphology perceived by the visitors during health behaviors is also changing.

(2) Healthy activities in the space have spatial differences. Open, richly layered spaces are more likely to attract people. Different genders, ages and activity types also have different preferences for spatial morphology.

(3) Visitors' activity preferences are affected by a combination of multiple spatial morphology characteristics, and people have obvious preference for spatial morphology within a certain interval.

In this paper, a fine-grained correlation analysis method is constructed. Through modeling and twinning of site or design, the results can help designers to carry out refined design based on cognitive spatial morphology, provide assistance in simulating people's perception of spatial morphology, establish predictive models for activity distribution, and support design optimization to enhance spatial comfort, attractiveness, and health service efficacy.

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Terrain, Territory, Cartography: Chronomapping Urban Landscape Evolution for the Socio-Ecological Transition

TOPIC: Guiding cities through what is alive: cities as ecosystems

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Abstract

Orbe-Chavornay represents a paradigmatic Swiss transitional landscape, where industrial production, agricultural systems, and transport infrastructure converge in complex spatial relationships. Strategically positioned near the A1 motorway and the Yverdon-Lausanne railway line, this area is home to the Nestlé private sector industrial area, the COOP national distribution hub, and prison facilities, alongside some of Switzerland's most productive agricultural plains. This unique context provides a setting for the study of how urban landscape could be shaped with a view to harmonize economic productivity and ecological resilience in transitional landscapes around the world.

Chronomapping is used as a methodological framework for depicting and exploring the Orbe–Chavornay landscape transformation over the past two decades (Gitai, 2025). The study illustrates how transitional landscapes operate as complex metabolic systems, where industrial waste streams can be repurposed into regenerative infrastructures that mediate between diverse land uses and contribute to climate adaptation across seasons. This specific urban landscape can function as laboratories for innovation that reverse traditional knowledge flows, allowing insights from peripheral zones to inform urban resilience and landscape development strategies.

Three critical challenges specific to transitional landscape are addressed: the treatment of industrial waste as externality rather than resource; the disconnection between industrial thermal dynamics and agricultural microclimate systems; and the absence of integrated planning frameworks that can coordinate across industry, landscape ecology, and land policy. Through four interconnected work packages that examine historical evolution, local knowledge, topological design, and temporal modeling, this research establishes Orbe-Chavornay as a prototype for the intelligent development of resilient urban landscape.

Keywords: 1: landscape architecture Keyword 2: historical cartography Keyword 3: territorial planning, Keyword 4: climate adaptation Keyword 5: Imagination Keyword 6: metabolic landscapes, Keyword 7 ecological urban design

1.Introduction

Definition

Landscape

'Landscape' means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors.' (Art. 1a)

and

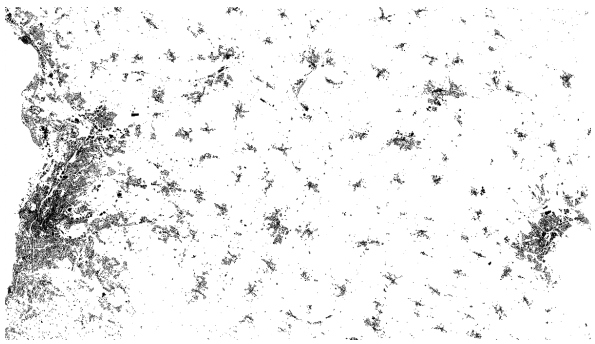
'(..) this Convention applies to the entire territory of the Parties and covers natural, rural, urban and peri-urban areas. (…) It concerns landscapes that might be considered outstanding as well as everyday or degraded landscapes." (Art. 2)

Source : Européen convention of Landscape, Florence, 2009.

Interscape- An interscape is a transitional or in-between landscape that connects and sustains surrounding urban environments and exists as a distinct productive landscape or socio-cultural entity.

Interscapes serve both as connective spaces between different land uses and as places defined by their own aesthetic, social, cultural, and ecological characteristics.

The term is meant to convey transcendence of the city-countryside and urban-rural divide that has long formed perceptions of landscape typology and the physical terrain. It challenges the current socio-ecological frameworks through which landscapes are perceived and shaped. What were once rural landscapes, are now interscapes, a kind of connective and metabolizing tissue between cities.



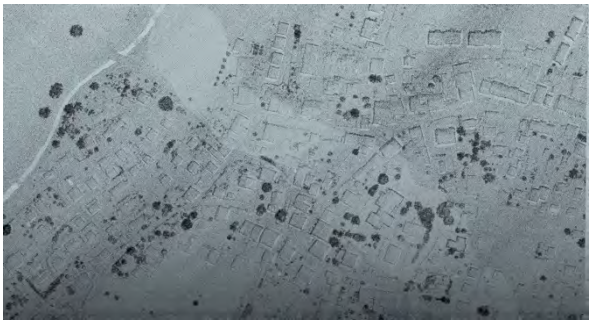


Fig.01.3D lidar Image, La commune de Charvonay, Toposwiss 2025, Switzerland

1.1 The Orbe-Chavornay Transitional Landscape Context

The Orbe-Chavornay corridor exemplifies a distinctive type of contemporary territorial formation that has emerged across Switzerland and Europe—transitional landscapes that resist conventional planning categories while creating new possibilities for integrated development (Bylund, Taka, and Kuittinen 2022). Strategically positioned near the A1 motorway and the Yverdon-Lausanne railway line, this area has attracted numerous industrial facilities and distribution centers, including the COOP national distribution hub, Néstle factory for Nespresso, while bordering some of Switzerland's most productive agricultural plains.

This juxtaposition of urban landscape common entities creates what we term a "transitional landscape laboratory"—a spatial context where diverse land uses, infrastructure systems, and economic activities converge to create unprecedented opportunities for studying integrated landscape planning (McCormick and Hartmann 2017). The presence of the Nestlé private sector industrial area, the prison facilities at Établissements de la plaine de l'Orbe, and the customs house emphasizes the cross-border and transit nature of this evolving territorial formation, creating fascinating opportunities for examining how industrial productive spaces can coexist with agricultural production, ecological systems, and evolving settlement patterns.

As climate adaptation becomes increasingly urgent in the scope of the socio-ecological transition in cities around the world, Orbe-Chavornay's mixed-use character—combining industrial innovation, food production, transport infrastructure, and ecological corridors—offers valuable insights for developing more resilient planning approaches for similar peripheral zones throughout Switzerland and beyond (Kabisch et al. 2019). The area's ongoing transformation presents a unique opportunity to reimagine how such transitional

urban landscapes can be deliberately shaped to balance economic productivity in the context of the socio-ecological transition.



Fig.02: Topographic map of Orbe. In blue: the Orbe plain. Source: topographic-map.com

1.2 Metabolic Landscape and Material Flows

Traditional planning frameworks often treat transitional landscapes like Orbe-Chavornay as problems to be managed rather than as opportunities for innovation (Bulkeley et al. 2016). Industrial facilities are typically viewed as generators of waste and environmental impacts, while agricultural areas are seen as spaces requiring protection from industrial encroachment. This dualistic thinking fails to recognize the metabolic potential of transitional landscapes—their capacity to function as integrated systems where waste outputs from one activity become inputs for another (Jacobsen 2006).

The Nestlé facility in Orbe-Chavornay generates significant quantities of coffee waste daily organic material that represents a substantial untapped resource for landscape transformation (Gulipac 2016). Rather than treating this waste as a disposal problem requiring external management, this research explores how coffee waste can be transformed into landscape infrastructure and soil substitution that creates beneficial relationships between industrial and agricultural systems while addressing climate adaptation needs.

Coffee waste landscape fabrication represents more than just material innovation—it embodies a fundamental shift toward circular design thinking in landscape ecology, urban sociology and new topological urban substrate urban soils (Agriculture 2023, Stork et al. 2023). By transforming waste into functional ecological urban soils, these techniques challenge traditional material hierarchies while creating urban landscapes that actively participate in ecological processes. The abundance and accessibility of coffee waste, combined with its favorable material properties, make it an ideal medium for experimenting with sustainable landscape fabrication techniques that can demonstrate how the byproducts of human activity in transitional landscapes can be transformed into the foundation for more sustainable territorial development.

1.3 Water Management Integration and Microclimate

Orbe-Chavornay's water management systems, which bridge industrial needs, agricultural irrigation, and the socio-urban transition in the canton of Vaud, offer valuable lessons for integrated blue infrastructure planning that extends far beyond this specific context (Wendling et al. 2018). The site's position as an interface between different urban landscape conditions mirrors the challenges faced by urban planners seeking to create more resilient city edges throughout Switzerland and beyond.

The Orbe River system also provides a hydrological foundation for the transitional landscape, connecting industrial, agricultural, and ecological functions through integrated water flows that have been modified over time to support multiple uses simultaneously. Industrial facilities require significant water inputs for processing operations while generating wastewater that must be treated before discharge, while agricultural operations depend on irrigation systems that draw from both surface and groundwater sources, with demands that vary seasonally.

By studying how this transitional landscape has adapted to changing economic and environmental conditions over time, we can extract design principles that reverse the traditional city-to-periphery knowledge flow, allowing innovations from these hybrid zones to inform urban core development strategies (Meyer and Hawlik 2021). Therefore, water management systems create opportunities for developing bioretention areas that improve water quality while processing organic waste, demonstrating how transitional landscapes can become testing grounds for innovations that address multiple urban challenges simultaneously.

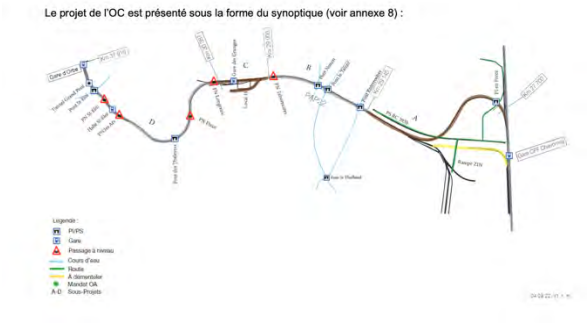


Fig.03: Plan, Modernization project of the Orbe – Chavornay line. The ZI ramp as well as the deconstruction and redevelopment of the track between Chavornay station and Chavornay industry will be carried out in 2027 and must also be subject to environmental monitoring during implementation.



Fig.4:Development plan for accessibility principles to the Orbe-Chavornay hub. Transtec, 2023.

2. Chronomapping Methodology: Four Work Packages for Transitional Landscape Transformation

The project is structured around four interconnected work packages that provide a comprehensive framework for understanding and transforming the Orbe-Chavornay transitional landscape through strategic coffee waste integration and metabolic landscape design (JPI Urban Europe 2019).

2.1 Work Package 1: Documenting Lausanne's Suburban Productive Landscape Evolution

WP1 will document Lausanne's suburban productive landscape evolution to reveal how historical land use changes have created today's microclimate patterns in agricultural zones, industrial corridors, and food production areas to a transitional landscape (JPI Urban Europe 2015). This work package focuses specifically on understanding the transformation patterns that have shaped the Orbe-Chavornay corridor into its contemporary transitional landscape configuration, providing the temporal foundation for all subsequent interventions.

The historical analysis begins with an examination of 19th-century agricultural intensification that established the productive agricultural plains that continue to characterize the area, tracing how manmade instrumentalization of physical terrain alteration and new topological patterns emerged from earlier territorial strategies and land use decisions. The development of transportation infrastructure—first railways and later highways—created new opportunities for industrial and logistics development while maintaining agricultural productivity in surrounding areas, establishing spatial relationships that continue to influence contemporary thermal and hydrological patterns.

The post-war industrialization period brought food processing facilities and other manufacturing operations that established the industrial presence exemplified by the Nestlé facility, creating industrial infrastructure that generates distinctive thermal signatures and material flows including the coffee waste streams that provide the foundation for this research. The microclimate documentation employs both historical climate data and urban analyses to understand how microclimate conditions have evolved as the transitional landscape has developed through the chronography of various historical maps.

2.2 Work Package 2: Sourcing Local Knowledge from Key Landscape Actors

WP2 focuses on sourcing local knowledge from key landscape actors such as farmers and planners from the Orbe area, recognizing that transitional landscapes are shaped by the daily practices and accumulated expertise of diverse stakeholders who possess crucial insights for developing effective transformation strategies that integrate coffee waste processing with existing agricultural, socio-environmental urban development (Pattaroni, 2011, Frantzeskaki et al. 2020).

The farmer engagement process employs participatory research methods including interviews, workshops, and collaborative mapping exercises to understand how agricultural

operators have adapted their practices to the distinctive conditions created by industrial proximity and infrastructure development (Menny, Voytenko Palgan, and McCormick 2018). Farmers have developed sophisticated understanding of how the Nestlé facility and other industrial operations affect local wind patterns, temperature regimes, and water flows, adapting crop selection and management practices accordingly while maintaining high levels of productivity in the factory of Orbe and Henniez.

The research examines how local actors currently manage organic waste and soil amendments, identifying existing practices that could be enhanced through integration with coffee waste processing systems. Municipal planners, cantonal agencies for Vaud vanton, and cross-border coordination bodies (France – Switzerland) possess crucial knowledge about how regulatory systems interact to shape development patterns in transitional areas, while industrial operators provide detailed information about coffee waste generation patterns and temporal variations.

2.3 Work Package 3: Exploring New Topological Microclimate Landscape Structures

WP3 will explore how new topological microclimate landscape structures can shape and manage local climate conditions in croplands, industrial areas, and food production spaces through strategic integration of coffee waste materials that transform industrial byproducts into functional landscape elements providing thermal mediation, water management, and mix use creation benefits (Raymond et al. 2017).

The coffee waste material processing component examines different techniques for transforming raw coffee waste into durable landscape materials suitable for creating topological interventions. Composting processes can transform coffee waste into soil amendments that improve agricultural productivity while creating growing medium for urban landscape soils.

The new urban landscape topological design approach focuses on creating landscape interventions that mediate between the thermal conditions of reusing industrial facilities and structures that surround them, that moderate temperature fluctuations while creating wind shadows that protect crops, with elements shaped through computational design to optimize thermal, hydrological, and landscape ecological performance.

2.4 Work Package 4: Demonstrating Knowledge Transfer Through Urban landscape analyze

WP4 will demonstrate how knowledge from outside the city can be applied to real-world urban planning and ecological landscape design through the modeling of new topological landscape structures and 3D simulations of landscape transitions over time at this specific site, providing tools for visualizing transformation scenarios and enabling knowledge transfer from transitional landscape innovation to urban landscape analyze applications (Atlas of Paris, 2024).

The Urban Analysis of the landscape socio-ecological transition examines how metabolic landscape interventions will evolve over multiple time scales from immediate installation effects through long-term landscape succession and climate adaptation. The knowledge transfer component demonstrates how innovations developed in the Orbe-Chavornay transitional landscape can inform urban planning and landscape design in other contexts, reversing traditional center-periphery knowledge flows (Nevens et al. 2013).

3. Ecological local knowledge as a topological design tool

3.1 Reactivated Greenhouse Networks as Productive Landscapes

The autonomous greenhouse network integration demonstrates how existing agricultural infrastructure in the Orbe-Chavornay corridor can be transformed into ecological park systems that process waste, generate energy, and create optimal microclimates for both human activities and ecological processes (UNaLab Project Consortium 2020). These greenhouse structures are positioned strategically throughout the landscape to create a network of controlled-environment spaces that can process coffee waste through accelerated composting and vermiculture systems while functioning as energy generators through integrated photovoltaic systems and biomass processing.

The reactivated greenhouse networks create a new typology of topological parks that function as productive landscapes, climate modulators, energy generators, and community spaces simultaneously (Imperial College London 2021). This four-dimensional approach to landscape design—integrating time, space, materials, and energy—provides a comprehensive framework for transitional landscape transformation that

demonstrates how agricultural infrastructure can be reimagined to address multiple urban challenges while maintaining productive functions.

The autonomous nature of the greenhouse network means that each facility can operate independently while contributing to the broader landscape system through material and energy flows, creating resilience through distributed functionality while enabling coordinated management of landscape transformation processes.

3.2 Energy Generation and Autonomy Systems

The energy generation through biogas production from coffee waste processing demonstrates significant potential for contributing to facility energy requirements while processing waste materials that would otherwise require disposal (Domenech and Davies 2011). Energy generation analysis reveals that integrated processing systems can provide 20-25% of facility electricity requirements through biogas-powered generation systems, while the autonomous greenhouse network creates additional energy generation through combined photovoltaic and biomass systems.

By utilizing off-grid photovoltaic systems and microclimate technologies, these distributed generation systems offer a resilient energy supply while simultaneously processing waste materials and supporting controlled-environment agriculture. These systems can maintain productivity even under extreme weather conditions. Grid integration analysis indicates that surplus energy generated from integrated coffee waste processing can contribute to regional renewable energy supplies. Additionally, feed-in tariff mechanisms can generate revenue, enhancing the economic viability of these systems and illustrating how transitional landscapes can support broader energy transition objectives.

4. Discussion: Paradigm Shift Toward Metabolic Transitional Landscapes

4.1 From Problem-Oriented to Resource-Oriented Planning

The Orbe-Chavornay research demonstrates a fundamental paradigm shift in how transitional landscapes can address the relationship between industrial production and environmental quality, moving from conventional approaches that focus primarily on mitigating negative impacts to frameworks that emphasize optimizing positive contributions through integrated industrial ecology approaches that transform waste streams into regenerative landscape infrastructure (European Commission 2021).

This paradigm shift has broad implications for how planners and policymakers' approach industrial development in transitional landscapes throughout Switzerland and beyond. The *Chronomapping* approach demonstrates how waste streams can become the foundation for landscape transformation that actively contributes to ecosystem function and agricultural productivity while reducing costs and environmental impacts.

The reuse of landscape metabolism and the transformation of the physical terrain trough time demonstrates how circular economy principles can be applied at landscape scales to create regenerative systems that improve rather than degrade environmental conditions, providing a scalable model that can be adapted to diverse transitional landscape contexts while maintaining core principles of metabolic integration and regenerative design (MDPI 2023).

4.2 Knowledge Transfer and Innovation Diffusion

The Orbe-Chavornay research demonstrates how innovations developed in transitional landscapes can inform urban core development strategies, reversing traditional knowledge flow patterns that typically transfer solutions from urban centers to peripheral areas (Clarity Interpretation 2020). The metabolic landscape approaches developed for micro-climate processing provide insights that can be applied to various urban contexts facing similar challenges with waste management and climate adaptation.

The coffee waste processing techniques and topological design strategies provide transferable knowledge that can be applied to different organic waste streams commonly found in urban areas, while the autonomous greenhouse network concept provides particular potential for urban application, where space constraints and energy costs create incentives for integrated systems that provide multiple functions (Bylund, Taka, and Kuittinen 2022).

4.3 Scalability and Regional Application

The analysis demonstrates that the *Chronomapping* approach developed for Orbe-Chavornay has significant potential for application to similar transitional landscapes throughout Switzerland and

beyond (Gitai, 2024, McCormick and Hartmann 2017).

The framework's integration with agricultural systems provides additional scalability advantages given the common occurrence of agricultural areas adjacent to industrial facilities throughout Europe and beyond. Regional coordination mechanisms can optimize material flows and infrastructure investments while creating economies of scale that improve economic viability of integrated systems.

Conclusion

The Chronomapping framework developed through analysis of the Orbe-Chavornay interscape demonstrates the transformative potential of reconceptualizing transitional landscapes as integrated metabolic systems rather than fragmented zones of competing uses. By positioning interscapes as "laboratories for innovation that reverse traditional knowledge flows," this research establishes a new paradigm where peripheral zones become generators of insights that can inform broader urban resilience and landscape development strategies across diverse geographical contexts.

The convergence of industrial production, agricultural systems, and transport infrastructure within the Orbe-Chavornay corridor reveals the untapped potential of interscapes to function as complex metabolic systems where waste streams from one sector become regenerative resources for another (Bulkeley et al. 2016). The strategic integration of coffee waste processing with water management systems, microclimate mediation, and mixed-use creation demonstrates how the three critical challenges identified in this research—waste externalization, thermal disconnection, and planning fragmentation—can be transformed into opportunities for systemic innovation.

The four-work-package methodology provides a replicable framework for understanding and transforming interscapes through the systematic integration of historical analysis, local knowledge systems, topological design innovation, and temporal modeling capabilities (JPI Urban Europe 2019). This comprehensive approach enables the harmonization of economic productivity with ecological resilience by treating transitional landscapes as dynamic systems capable of adaptation and optimization rather than static zones requiring protection or control.

Perhaps most significantly, the Orbe-Chavornay prototype demonstrates that Switzerland's transitional landscapes—and by extension, similar interscapes throughout Europe and beyond—represent unprecedented opportunities for developing climate adaptation strategies that emerge from peripheral innovation rather than urban core mandates . The reversal of traditional knowledge flows positions interscapes as testing grounds for solutions that can subsequently inform urban planning approaches, creating a new model where the periphery becomes the laboratory for sustainable territorial development.

Through this integration of coffee waste metabolism with adaptive landscape design, the Orbe-Chavornay corridor becomes more than a site-specific intervention—we can see the death of the rural landscape and the born of interscape, it becomes a prototype for a new approach to transitional landscape planning that can be adapted and applied to diverse contexts while maintaining core principles of metabolic integration, temporal adaptation, and regenerative design.

The implications extend far beyond the Swiss context: interscapes worldwide represent opportunities to develop regenerative systems that improve environmental conditions while supporting economic activities, creating new models for sustainable development that emerge from careful observation and strategic intervention in the overlooked spaces that connect our cities, industries, and agricultural systems. The Orbe-Chavornay prototype demonstrates that the future of sustainable territorial development may well be found not in our urban centers, but in the intelligent cultivation of the transitional landscapes that surround them.



Fig.05,06 :3D model of Orbe-Chavornay, chronomapping,Ben Gitai, 2025, Swiss,Faden, William, 1799, source: David Ramsey collection

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INTEGRATION OF DATA VISUALIZATION INTO THE URBAN ENVIRONMENT THROUGH AUGMENTED REALITY

TOPIC: Guiding cities with society: use, memory, artistic creation

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Abstract
Landscapes as shared common spaces have significant potential to support communicative actions for information dissemination. First, by including information, public landscapes allow information to be shared with the public through daily encounters. Second, the practice of acquiring information becomes a shared experience of the public. Although information is currently part of urban landscapes, its involvement is mostly to facilitate the functioning of cities rather than to facilitate informal learning or raise public awareness. However, by making information dissemination an intentional part of landscape design, the existence of an information infrastructure that makes information sharing and acquisition a part of daily urban practice can be ensured. Therefore, this paper presents the design concept and initial design exploration of an information display system that displays data visualizations in urban landscapes using augmented reality technology to make information dissemination an integral part of shared landscapes.

Introduction

Advances in information and communication technologies have led to the wide availability and easy accessibility to information. While this situation facilitates getting information, it does not guarantee that people are getting informed about the subjects that concern the public, as this requires multiple steps such as being aware of them, researching them, finding the right information, and then acquiring it. On the other hand, through the inclusion of information in public spaces, it is possible to enable encounters with information in day-to-day life as part of the daily flow in urban landscapes. One of the approaches used to communicate information in public space is data visualization. Research to date in the field showed that displaying local data in public space enables behaviour change [1], raises awareness about local issues [2] and encourages public discourse about them [3] while using different means to display data visualizations such as hand-drawn visualizations on chalkboards [1], street signs [2] or touch-enabled public displays [4]. While the existing studies show the importance of displaying local data in public spaces, to the best of our knowledge, there is a lack of a more systematic approach to information dissemination that spreads across the city's public spaces and makes information a permanent landscape element in urban landscapes. Thus, this study presents the design concept and initial design exploration of a visualization display system that aims to make information a permanent component of urban public spaces, and in this context, displays 3D data visualizations in urban landscapes using marker-based augmented reality technology. The proposed system consists of physical and digital components. The physical components include information panels that indicate the system and provide information about it, and images that serve as markers to activate the augmented reality data visualizations (ARDV). The digital components are the ARDVs, which communicate data. The initial design exploration of the system was conducted in three sections: the design of the concept, the design

of the physical components, and the design of the digital components. The design concept was developed through brainstorming, sketching, and usage scenario development, which set the road map for the design of the physical and digital components. The iterative design and prototyping approach was followed for both physical components and digital components separately, as well as for the system as a whole. Overall, the initial design exploration defines key considerations, proves the concept, provides design parameters, and creates a roadmap for further exploration of the topic.

1. Design Concept and Key Considerations

The proposed design is a data visualization display system that aims to make information dissemination an integral function of urban public spaces and to create an information infrastructure. According to the proposed scenario, the proposed design will be integrated into various locations in the city. The system will support recurring engagement through the change of he communicated topic and the displayed data visualizations. These changes will happen periodically, while also varying based on the location. This will support regular engagement with the system, which will eventually lead to habit development.

Based on the design concept, four key considerations are defined. First of all, the proposed system, by integrating information into public spaces, aims to make information a part of daily encounters and make it a shared encounter [5]. To achieve this, the design of the system must *guide the user experience and provide interactions between users.* Secondly, the creation of an information infrastructure requires the system to be available throughout the city. Accordingly, the system is proposed as an add-on that will be integrated into various locations, rather than a site-specific design. In order to support integration into various locations, the design must address *the spatial requirements of the system and its adaptability to different areas.* One crucial aspect, however, is the choice of location. Even though the system is aimed to be located in various locations, these spaces should support the use of the system. Public display research shows that interactions are more likely to happen in certain locations, such as where people spend time while waiting [6]. Thirdly, in order to ensure continuous use of the system by the public, the content it displays must be subject to changes and variations. Therefore, the *changeability and differentiability of digital content* must be ensured. Finally, the users of the system are expected to vary in terms of their technical capabilities due to being located in the public space. To provide a functioning system, *the user experience and usability of digital components* must be ensured for the general public.
During the initial design exploration, these key considerations guided the design process and will continue to do so in the next stages.

2. Physical Components and Integration of the System to the Urban Environment

The system consists of two types of physical components. While the first physical component, the information panels, indicates the system and gives information about it, the second physical component, images, activate AR to display data visualizations.

Public display research suggests that, for an interactive display to fulfill its function, people have to notice it, recognize its interactivity, and be willing to interact with it [7]. Hence, the design of the system aims to address these necessities. Since digital elements become visible through people's choice of use, physical elements are responsible for ensuring that the system's visibility and noticeability. Accordingly design of the physical elements, especially the visual features such as colors and graphics, was set as the key parameter for the visibility and noticeability.

The first physical component, the information panel, is responsible for indicating the system, providing information about it, and communicating its interactivity. According to the examination of [7], methods used in public display research to communicate the interactivity of the displays include: analog signage with a brief or elaborate manual, prior knowledge, and call-to-action. Accordingly, the information panel is designed to carry three key information: the name of the system, a call-to-action, and a brief manual. The proposed system is intended as a recurring urban design element that may be encountered in different parts of cities. Therefore, by including the name of the system, the goal is to provide a sense of familiarity and to recall knowledge gained from previous interactions. A call-to-action, such as the directive 'touch screen to begin,' is one of the techniques used to convey the interactivity of public displays [7, 8]. Thus, the required action of the system is intended to be communicated with

the direct statement: "Open the app and point your phone at the posters". Furthermore, it is important to convey to the public how the system works, especially during the first use. Thus, an explanatory text explaining how this use the system is added. In addition, since the system will work with a mobile application, a QR code to download the mobile application and a guide text on how to download the mobile application will be part of the information panel.

The second physical component, images, are the markers that activate the AR. To date, two design issues have been defined about them: their graphical aspect and their placement in physical space. The graphical aspect is related to the recognition of the images through which ARDV is activated. In order to be recognized, the images should have high contrast, a high level of detail, and avoid recurring patterns [9]. On the other hand, ARDV refunctions the images as backdrops when overlaid on them. In contrast to the requirements for poster recognition, the initial testing showed that the readability of ARDVs may be affected by the graphical complexity of the images. Accordingly, during the design exploration of images, designs that will not affect the recognition of images while ensuring readability of ARDVs have been discussed. In this context, an 'empty poster' proposal was prototyped, whose center was left empty to be filled with ARDV.

The placement of the images defines how the system will be integrated into the physical space while also shaping the user experience by determining the angle from which the user looks at the ARDVs. Four placement types were determined and explored during this initial design phase, which will be tested in the further process. These placement types are on-ground horizontal, on-ground angled, elevated angled, and elevated vertical (Figure 1).

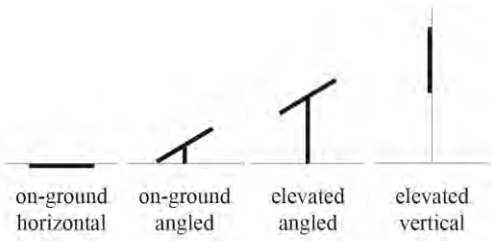


Figure 1. Possible placements of the posters.

The on-ground horizontal orientation is at the same level as the pavement; therefore, it is able to adapt to the physical space without requiring additional installation space. However, it was argued that this may result in daily activities such as walking and standing obstructing interaction with the system. Furthermore, the seamless adaptation to the environment may hinder the recognition of the system. The on-ground angled and elevated angled were considered as they support the natural phone-holding position. Both require additional space to be placed, while the on-ground angled version may also act as an obstacle and pose danger to public during the regular urban flow. The elevated vertical placement, conversely, can adapt to the existing space by being placed on existing vertical surfaces, such as walls, without requiring additional space, which supports the adaptability to various spaces.

3. Design of the Digital Components and AR Development

The main digital component of the proposed data visualization display system is ARDV. The system is intended to utilize personal mobile devices as the display technology and to work with a mobile application that recognizes the pre-defined images and overlays ARDVs on them. This process includes 3D visualization of data and development of AR. The system is designed to be used by the general public. Therefore, in order to ensure the user experience and the usability of digital components, the design of the mobile app and any interactive features must be simple to support to be used by the general public, while data visualizations must be understandable to lay users.

The system is designed to support the changeability and differentiability of digital content to ensure continuous use of the system by the public. This will be realised in two ways. Firstly, through periodic changes. In this way, the system, rather than being a one-time interaction add-on, becomes a system where users can interact regularly and get information about various topics. Secondly, through the variations of content based on the location. Accordingly, users will get familiar with the system through initial interaction and gain the necessary know-how to interact with it at any location they encounter. The changability and differentiability will be realized by matching different ARDV narratives with different images that are distributed in various locations. The same images placed at different locations will activate the same ARDV, while different images placed in different locations will display different content. Overall, by supporting changeability and

differentiability, it is aimed to develop a regular engagement pattern with the system, which may lead to habit development.

In the initial design exploration process, a prototype was developed to test the display of data visualization. Waste was selected as the narrative topic, and the current waste production and projected waste production data of global regions were visualized. The data is collected from the book "What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050" [10], together with the map that shows the regions of the world. ARDV scenes were created through sketching and then 3D modelling using Blender software. As system is intended to be used via personal smartphones, a vertical design was followed to ensure the optimal display of the ARDVs. The 3D data visualizations were then imported into Unity, where AR was developed by using the Vuforia Engine SDK.

The use of personal mobile devices as the display technology makes it possible to benefit from their touch-screen capabilities to incorporate interactive features. Accordingly, tap actions were used to switch between main scenes, which provide general information and detailed scenes which provide region-specific information. The main scene, which is activated through the recognition of the pre-defined image, includes contains a simplified and adapted version of the map showing the regions, a visualization of the daily waste amount per capita for the regions in 2016, the names of the regions, the values of data, data source, and some supporting objects. Detailed scenes provide information about the daily waste amount per capita for the regions in 2016, as well as future projections for 2030 and 2050. They include the region name, visualizations of 2016 values and 2030 and 2050 projections, data values, years, and some supporting text and objects (Figure 2). The names of the regions were set as interactive objects that react to tapping and change the visibility of the objects. This interactive feature was added by creating a C# script in Microsoft Visual Studio.

Accordingly, when the region names in the main scene are tapped, they make all objects in the main scene, including themselves, invisible and make the objects in the detailed scene, where detailed information about each of the regions is given, visible. When the names of the regions in the detailed scenes are tapped, they make all objects in the secondary scene, including themselves, invisible and make the objects in the main scene visible.

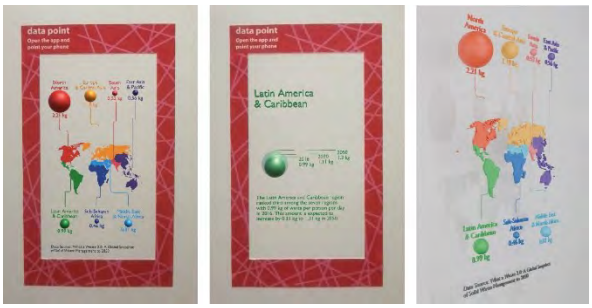


Figure 2. Digital components: from left to right, AR view of the main scene, AR view of one of the detailed scenes, and the 3D model of the main scene.

4. Conclusion

This paper presents the design concept and initial design exploration of an information display system that displays 3D data visualizations in urban landscapes by using augmented reality technology in order to make information dissemination an integral part of shared landscapes, to facilitate informal learning in public spaces, raise public awareness on issues that concern the public, and create a shared experience for the public. This initial design exploration which examines how a systematic approach to information dissemination that spreads across the city's public spaces and makes information a permanent landscape element can be achieved, explore the concept and defines some of the key considerations which are: spatial requirements and adaptability to different spaces; guiding the user experience and enabling interaction between users; user experience and usability of digital components; and changeability and differentiability of digital components. It also provides some design parameters and initial prototypes

It is a necessity for the landscape to be reconsidered and adapted to the new possibilities of the day. The presented system aims to open a new window in landscape architecture by making information dissemination a fundamental part of shared landscapes.

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CULTURAL LANDSCAPES REIMAGINED: MEMORY, ART, AND SUSTAINABILITY IN TIANJIN'S FIVE AVENUES PUBLIC SPACES

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Keywords: Cultural-Natural Landscape, Heritage Conservation, Urban Sustainability, Landscape Memory, Social Cohesion

Abstract

This research critically examines the cultural and historical significance of four European-inspired public spaces within Tianjin's Five Avenues district: Minyuan Square, Marco Polo Square, Liberation Park, and Zhongxin Park. Originating under British, French, and Italian architectural influences during the foreign concession period (1860–1945), these spaces embody significant intersections of historical memory, artistic expression, and cultural hybridity. The study investigates how these landscapes, initially crafted with distinct aesthetic and social intentions, actively shape Tianjin's contemporary urban identity by fostering cultural dialogue, social cohesion, and ecological sustainability.

Utilizing qualitative analysis combined with field research and empirical data collection, this paper systematically evaluates these public spaces across critical dimensions: design characteristics, historical contexts, social functionalities, artistic interventions, and intercultural integration. Methodologically, the study incorporates direct observation, structured interviews, and comprehensive surveys involving local residents, tourists, urban planners, and landscape architects. These methods provide nuanced insights into contemporary usage patterns, community perspectives, and the sustained sociocultural relevance of these historical spaces.

Furthermore, this paper examines the transformative role of landscape architects in mediating the interplay between memory, artistic expression, ecological principles, and urban sustainability within heritage environments. It identifies and evaluates specific adaptive strategies implemented to address contemporary urban challenges, including climate change mitigation, biodiversity enhancement, and the promotion of community health and well-being. The analysis demonstrates how historically significant spaces, once private gardens and colonial-era parks, have been effectively repurposed to meet current urban ecological and societal demands.

In conclusion, this research proposes a holistic, integrative approach towards preserving, reinterpreting, and adaptively reusing historical landscapes, underscoring their enduring relevance and contributions to contemporary urban ecosystems. By combining cultural memory, artistic creativity, and ecological responsiveness, these heritage spaces transcend historical preservation, emerging as dynamic platforms for creating inclusive, sustainable, and culturally vibrant public realms.

1. Introduction

Tianjin's Five Avenues (Wudadao) district, an iconic area distinguished by its extensive European-style urban fabric, represents a vivid example of China's semi-colonial urban heritage. Developed primarily during the foreign concession period (1860–1945), the area became a mosaic of British, French, and Italian influences, shaping its architectural character and spatial organization. Within this context, four public spaces—Minyuan Square, Marco Polo Square, Liberation Park, and Zhongxin Park—stand out as prominent examples of historical hybridity and contemporary adaptive reuse.

Initially crafted to serve specific aesthetic, political, and social functions within the colonial order, these spaces have undergone multiple transformations, becoming key nodes in Tianjin's cultural memory and ecological vision. This paper explores how these public spaces have evolved beyond their colonial origins to support community identity, artistic engagement, and sustainability. Drawing upon interdisciplinary theories and mixed-methods research, the paper positions these sites as exemplars of regenerative landscape practice bridging past and future. The discussion offers transferable insights into reimagining cultural landscapes globally under contemporary urbanization pressures.

2. Theoretical Framework

This research integrates four intersecting theoretical fields:

Cultural Landscape Theory (Mitchell, 2003; Taylor & Lennon, 2011) frames the sites as historically layered environments where human values and spatial practices accumulate and intersect. Schmitz and Jáuregui (2021) emphasize the social dimension of cultural landscapes in fostering civic identity and pluralistic memory. Fairclough and Harrison (2020) stress recognizing landscape as an evolving medium rather than a static backdrop.

Memory Studies (Assmann, 2011; Till, 2005) illuminates landscape's role in encoding and transmitting collective memory, particularly in post-colonial and post-socialist cities. Wüstenberg (2022) highlights how 'slow memory' processes aid urban recovery from abrupt ideological shifts, while Macdonald (2019) explores the interplay between heritage politics and memory resilience. This is pertinent to Tianjin, where multiple regimes and socio-political narratives have sedimented.

Public Art and Urban Space (Miles, 1997; Cartiere & Willis, 2008) supports analyzing temporary and permanent artistic interventions as tools for civic participation. Flinn and Everingham (2024) demonstrate how art in recreation spaces elevates local narratives, and Duxbury et al. (2019) argue that cultural expression in public space strengthens civic agency. Blending artistic practices with local memory becomes key for relational meaning-making in urban design.

Urban Ecological Design (Spirn, 1984; Ahern, 2011) provides a lens for evaluating nature-based solutions within culturally significant spaces. Kallipoliti (2024) contends that ecological design is an evolving historiography linking planetary health with urban practices, and Nassauer and Opdam (2019) highlight the significance of visual and cultural legibility in sustainable landscape narratives. The convergence of heritage protection and ecological renewal is increasingly vital under climate change.

Together, these frameworks enable a comprehensive analysis of how design, narrative, and environmental strategies converge to shape heritage landscape vitality.

3. Methodology

The study employed a qualitative, mixed-methods approach between March and October 2024:

Site Observations: Detailed mappings of pedestrian flows, microclimatic zones, material conditions, and activity rhythms were recorded across seasons, supplemented by spatial diaries and annotated photographs. Ninety-six hours of observational fieldwork were conducted across all four sites.

Structured Interviews: Twenty-six interviews were conducted with local residents, tourists, municipal planners, landscape architects, and cultural workers. Interviews focused on historical consciousness, site usage, and perceptions of artistic and ecological changes. Data were transcribed and coded using grounded theory principles.

Archival Research: Analysis included concession-era maps, 1930s landscape plans, colonial photography archives, and Tianjin Municipal Museum oral history records. This material was essential for mapping temporal narratives and urban morphology changes.

4. Case Studies and Findings

Tianjin's concession-era landscapes represent palimpsests of history, ecology, and social practice. Through detailed examination of four distinct sites within the Five Avenues district, this study uncovers the complex interplay of memory, artistic intervention, and environmental adaptation in shaping contemporary urban vitality. Each case, chosen for its typological diversity and representative revitalization approach, reveals unique strategies for negotiating the past within present-day public life.

4.1 Minyuan Square: Stadium as Memory Catalyst
The transformation of the Minyuan Stadium, an imposing British-built oval structure dating from the 1920s, into the multi-functional Minyuan Square stands as a masterclass in adaptive reuse. This metamorphosis transcends mere physical conversion; it actively repurposes historical infrastructure for 21st-century civic engagement. Below ground, a meticulously curated underground museum leverages the stadium's original foundations, presenting immersive exhibits on the concession period through artifacts, interactive digital displays, and archival footage. This subterranean layer functions as a literal and metaphorical archive, grounding the space in its complex past. Above ground, the oval concourse pulsates with contemporary life: seasonal farmers' markets offer local produce, literature festivals attract bibliophiles, and large-scale outdoor art installations rotate quarterly, often responding thematically to the site's history. Crucially, ecological sensitivity underpins the redesign: permeable resin-bound gravel paving allows rainwater infiltration, significantly reducing surface runoff; integrated bioswales manage stormwater; and strategically placed, low-energy LED lighting minimizes light pollution while enhancing evening ambiance.

Community surveys revealed profound emotional resonance, particularly among residents aged 65+. Many recounted vivid memories of attending sporting events or community gatherings within the original stadium structure, linking the space to their youth and formative social experiences. This potent "affective heritage" (Tolia-Kelly, 2022) demonstrates how the square successfully functions as a "memory-rich landscape" – a living archive engaging multiple senses (the echo of footsteps on the concourse, the visual sweep of the oval, the scent of market produce). Minyuan Square exemplifies how curated memory (the museum, interpretive signage along walkways) coexists seamlessly with dynamic leisure and commerce, creating a layered urban experience where history is not static but actively integrated into daily rhythms and future possibilities.

4.2 Marco Polo Square: Spectacle, History, and Micro-Ecology
Nestled within the former Italian Concession, Marco Polo Square presents a striking neoclassical ensemble, dominated by a central bronze sculpture symbolizing Sino-European amity, commissioned in the 1990s. This square operates dually as a major tourist node, drawing visitors to its architectural grandeur, and a vibrant community hub hosting weekend antiques markets, summer open-air concerts, and seasonal ice-skating rinks. Significant ecological retrofitting is visibly integrated: extensive living walls clad adjacent buildings, providing insulation and habitat; a network of micro-sprinklers embedded in paving stones creates evaporative cooling during Tianjin's humid summers; and biodiversity strips planted with native nectar sources border the central piazza, supporting urban pollinators.

Interviews consistently identified the square as the "soul of the neighbourhood." Residents value its unique capacity to blend monumental history with accessible spectacle. A key innovation is the "Hidden Narratives" project, where local art students use projection mapping onto the square's buildings during festivals, visually narrating the often-overlooked stories of early 20th-century migrant laborers who built the concession. This artistic intervention actively layers the physical space with recovered social histories, fostering a deeper, more inclusive sense of place. The square's model resonates strongly with Barcelona's El Raval "living square" concept (Delgado, 2020), emphasizing flexible programming driven by shared, albeit contested, history. Marco Polo Square demonstrates how heritage can be a platform for inclusive cultural production, where tourism, community identity, artistic expression, and micro-ecological enhancement are dynamically intertwined.

4.3 Liberation Park: From Colonial Estate to Climate-Conscious Community Hub
Liberation Park, the largest site studied, embodies a profound transformation. Originally the private, walled estate of a high-ranking colonial bureaucrat, it was reclaimed as public green space in 1951, symbolizing a new era. Its current design prioritizes ecological restoration and universal access:

reconstructed wetlands act as natural filtration systems; corridors of native species (oak, hornbeam, native grasses) enhance biodiversity and provide wildlife corridors; and comprehensive barrier-free pathways ensure inclusivity. The park is synonymous with morning rituals: large groups of retirees practice Tai Chi in the central meadow, while others engage in community dance sessions or brisk walking circuits along shaded paths. The annual Lantern Festival is a highlight, featuring intricate, environmentally themed lantern installations created by local schoolchildren, explicitly linking cultural celebration with intergenerational environmental education.

Systematic observations documented peak usage intensity before 9:00 am and after 5:00 pm, underscoring its deep embeddedness in the daily routines of adjacent residential communities. Beyond social value, the park serves as critical green infrastructure: ecological audits recorded 58 distinct native plant species and identified 12 key species supporting urban pollinators, including several rare butterflies. Its mature tree canopy and wetland significantly mitigate local microclimates. This substantiates Koparde and Chalke's (2025) argument that integrating biodiverse green spaces within historic urban cores is a highly effective strategy for reducing localized carbon footprints, improving air quality, and enhancing climate resilience through natural cooling and water management. Liberation Park is a testament to heritage landscapes evolving into vital ecological and social assets.

4.4 Zhongxin Park: Beaux-Arts Formality Meets Participatory Innovation

Zhongxin Park, developed under French administration, retains the elegant axial symmetry and geometric parterre gardens characteristic of Beaux-Arts landscape design. Recent revitalization has thoughtfully layered contemporary functions onto this historic framework. Additions include a serene Zen meditation garden with raked gravel and water features; sensory trails featuring aromatic plants and textured surfaces designed for accessibility; and a thriving community urban agriculture plot where residents cultivate vegetables and herbs. A significant participatory design initiative ("Designing Our Park") directly engaged local residents, leading to the implementation of community-proposed features such as additional dappled-shade seating areas under mature trees and aesthetically pleasing solar-powered lanterns along secondary paths.

Survey respondents frequently described Zhongxin Park as a "time capsule," appreciating its ability to evoke nostalgia for the concession era's grandeur while simultaneously embracing experimental contemporary uses. This fusion – the formal symmetry of the original layout softened by lush plantings and informal gathering spots – makes it exceptionally popular for wedding photography and intimate family gatherings. Further enriching this dialogue between past and present are monthly artist residencies. Selected artists create site-responsive installations or performances that engage with the park's history or ecological features, creating an active interface between memory and innovation. This approach vividly embodies Smith and Waterton's (2018) principles of ‘emergent heritage’, where heritage meaning is not fixed but iteratively co-created through ongoing community engagement, artistic interpretation, and responsive management, allowing the park's significance to evolve dynamically.

4.5 Cross-case Reflections: Synergies and Typologies

Collectively, these four sites illuminate Tianjin’s sophisticated negotiation between global aesthetic influences, locally resonant memory, and proactive environmental adaptation. Representing distinct public space typologies – the adaptive stadium-turned-square (Minyuan), the monumental commemorative plaza (Marco Polo), the repurposed colonial estate as ecological park (Liberation), and the formal Beaux-Arts garden embracing participation (Zhongxin) – all are deeply embedded within the city's social rhythms while actively shaping its creative futures. Their evolution underscores the critical importance of context-sensitive, narrative-driven design that allows for both continuity with the past and bold reinvention for contemporary needs.

5. Discussion

The analysis of Tianjin’s Five Avenues district crystallizes three major, interrelated revitalization strategies applicable to historic public spaces globally, particularly those with complex colonial legacies:

5.1 Curated Memory Through Multi-Sensory Design:

Memory within these spaces is not a static relic but actively interpreted, mediated, and performed. This curation manifests physically through interpretive signage woven into pathways, themed guided walks

led by local historians, augmented reality apps overlaying historical images onto the contemporary view, and site-specific performative arts (theatre, dance) responding to the location's past. Landscape architects and place managers function as essential "curators," selecting narratives, designing interfaces, and facilitating experiences that animate the past meaningfully for present-day audiences. This practice aligns precisely with She, Pan, and Zhao's (2025) research on how virtual and blended environments significantly amplify affective engagement with heritage, creating deeper emotional connections. It further resonates with Gregory's (2020) concept of "narrative urbanism," where spatial design consciously embodies and reveals overlapping historical and contemporary timelines, allowing users to physically navigate layers of time.

5.2 Art as an Urban Catalyst for Belonging and Reinterpretation:
Artistic intervention, whether temporary (festival installations, performances) or embedded (permanent sculptures, integrated murals, resident artist programs), proves to be a powerful mechanism for enabling the flexible reinterpretation of site meanings. These creative acts strengthen emotional ties between residents and place, activate underutilized or marginal areas within the sites, and provide platforms for expressing diverse, sometimes contested, histories (e.g., the migrant stories projected in Marco Polo Square). This catalytic role of art echoes Delaney's (2025) observations on how strategically placed public sculpture fosters urban belonging and dialogue in Johannesburg's regenerating districts. The Tianjin case studies confirm the immense value of co-curated place narratives, especially within rapidly changing urban environments where fixed identities are destabilized. Art becomes a shared language for negotiating change and fostering collective identity.

5.3. Ecological Retrofitting as a Driver of Climatic Resilience:
The integration of sophisticated yet often subtle ecological interventions transforms heritage sites from passive cultural assets into active, climate-positive infrastructure. Techniques like smart soil-moisture sensor-driven irrigation, stormwater-channelling bioswales, habitat-creating vegetated berms, and the strategic planting of dense shade canopies demonstrably enhance urban biodiversity, significantly reduce urban heat island effects, manage water sustainably, and sequester carbon. Crucially, these sites also function as living laboratories and learning environments, visibly demonstrating sustainable practices to the public. This aligns with LaGeS's (2018) assertion that cultural landscape masterplans can, and must, integrate rigorous ecological performance metrics without compromising historical integrity or aesthetic value. It further supports Andersson et al.'s (2023) argument that recognizing and leveraging "embedded ecological memory" (the site's inherent or historical ecological characteristics and processes) provides a robust foundation for future-oriented, climate-adaptive urban planning.

5.4 Global Resonance and Pedagogical Shifts:
These Tianjin strategies resonate powerfully with contemporary global trends in urban landscape regeneration. In diverse cities like Melbourne (e.g., the adaptive reuse of industrial docklands incorporating significant public art and ecological restoration), Cape Town (e.g., the Green Point Park integrating biodiversity, heritage interpretation, and recreation on a remediated site), and Seoul (e.g., the iconic Cheonggyecheon Stream project, which transformed a neglected, covered watercourse and post-industrial zone into a thriving linear ecological corridor and cultural spine, reviving both natural systems and cultural narratives), similar heritage-environment-community hybrids are emerging. These sites function as vital nodes for community-making, ecological buffering, and cultural expression within dense urban fabrics. Tianjin's approach mirrors this global paradigm shift: moving beyond rigid preservationist narratives focused solely on protecting physical fabric, towards dynamic adaptive reuse that proactively integrates ecological functionality, layered memory practices, and participatory placemaking. This shift is increasingly reflected in landscape architecture pedagogy worldwide, equipping the next generation of practitioners with the interdisciplinary skills needed to blend compelling spatial storytelling with robust biodiversity planning and genuinely democratic civic engagement.

6. Conclusion

This paper demonstrates that Tianjin's Five Avenues district offers a model for reimagining cultural landscapes through integrating memory, art, and sustainability. These public spaces function as dynamic systems where heritage catalyzes creativity and ecological adaptation.

While their colonial origins pose ethical questions, their adaptive reuse illustrates how inclusive planning, participatory processes, and cultural hybridity can redefine urban identity. As Chinese cities balance historical conservation with innovation, these examples offer replicable insights, suggesting a move beyond tradition-versus-progress binaries towards nuanced synthesis.

Future research should investigate long-term governance models, particularly the role of co-design in sustaining vibrancy. Evaluating the impact of interventions on marginalized groups—such as migrants, the elderly, and youth—is equally crucial. How can public space better serve intergenerational justice, especially under climate stress? Ultimately, the study affirms that successful cultural landscapes continually reinvent themselves, fostering shared meaning and environmental justice across generations. Within such landscapes, the designer's role encompasses storyteller, systems thinker, and civic collaborator

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Bridging Memory and Contemporary: Street Disco as a Socio-Ecological Public Space

Topic:

Reclaiming Infrastructure as Commons: A lost site, Liesenbrucken Bridge

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Abstract

In contemporary cities, landscape projects must transcend singular functions to become inclusive, multipurpose, and sustainable spaces that serve diverse communities. As landscapes shape our everyday living environments, their design should balance ecological resilience, social cohesion, artistic creation, and collective memory, ensuring that each aspect contributes equally to the vitality of public spaces. By integrating history, culture, and ecology, landscape interventions can transform underutilized spaces into dynamic public realms that support community engagement and environmental stewardship.

This study explores the design of a contemporary urban space through both research and a design proposal, presenting a methodology for achieving a balanced approach to ecological resilience, social engagement, and cultural continuity in urban landscapes. The project area, on the Liesenbrücken Bridge in Berlin, a historically significant yet underutilized urban landmark that connects two parks and neighborhoods. Currently, the bridge is hindered by limited accessibility, lack of visibility, and a fragmented green system, which disrupts its potential as a vibrant public space can physically link the parks. The objective of the project is to reveal the potential of the Liesenbrücken Bridge by transforming it from a lost state into a usable condition while enhancing connectivity, celebrating its historical and cultural significance, and integrating ecological sustainability. The design aims to transform the space into an inclusive, multipurpose urban area that fosters community engagement, ecological balance, and artistic expression.

The research focused on the site's historical and cultural significance, with the Liesenbrücken Bridge symbolizing Berlin's divided past. To enhance its visibility, the design incorporates lighting and artistic installations that highlight its connection to the nearby Berlin Wall segment. Inspired by Berlin's UNESCO-recognized techno culture, *Street Disco* reimagines the abandoned bridge as a pedestrian-friendly space, linking two parks and reconnecting neighborhoods. The design also includes *Discotheque*, a cultural kiosk and music collection space celebrating the city's musical heritage.This feature transforms the space into a vibrant and inclusive social hub that fosters community interaction, encourages collective experiences, and enhances its role as a cultural gathering place and community center.

The second key part of this research was a plant study, where a detailed survey of the existing vegetation and ecological features was conducted to understand the natural habitat. This led to the creation of a map to guide the ecological design, ensuring that the proposed changes would enhance the area's biodiversity and environmental sustainability. Informed by the findings, the design incorporates *'Terraluma',* a green installation beneath the bridge, featuring air- and soil-purifying plants that foster ecological continuity, integrate native species, and create a habitat for local wildlife. This space also provides a visual and sensory experience for visitors, enhancing the urban landscape's ecological value.

Through thoughtful integration of ecological design, historical significance, and artistic expression, the project reestablishes the Liesenbrücken Bridge as a key urban space that connects communities, enhances public engagement, and celebrates both the past and future. The design exemplifies how landscape architecture can create multifunctional, sustainable spaces that contribute to the broader social and environmental fabric of the city.

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1. Introduction

Today, urban environments are increasingly defined by fragmentation, social disconnection, and ecological degradation. As a result, the role of landscape architecture started changing, moving away from only aesthetics or functionality. Public spaces are not just physical settings for daily life, they are multi-dimensional tools that carry cultural knowledge, support ecological balance, and reflect the changing demands of urban communities.The design of these spaces are expected to respond to deeper social and ecological concerns, meanwhile preserving collective memory and creating new visions for more inclusive and sustainable futures. In this context, landscape architecture becomes a foundation and a metaphor for shaping socio-ecological relationships.

The Street Disco is a speculative urban landscape design project that proposes to transform a neglected part of Berlin's infrastructure, the "Liesenbrücken Bridge", into a dynamic socio-ecological space rooted in the city's techno heritage. The study is inspired by Berlin's unique techno culture, which has recently been recognized as part of Germany's intangible cultural heritage by UNESCO (BBC, 2024). This recognition underlines how deeply the techno contributes to Berlin's identity, especially since it emerged in the post-Wall era as a symbol of freedom, collectivity, and a new phase. Today, Techno is more than a music genre; it is a form of expression and a way of social connection, representing freedom, experimentation, and collective identity. Street Disco uses this cultural background as a generative force for imagining how to shape the public space.

The aim of this project is to rethink the potential that lost spaces can offer when they are reclaimed to connect memory, ecological repair, and contemporary culture. Rather than focusing on a singular function, the project operates as a dynamic device that connects cultural layers based on the memory of the city while activating new forms of engagement, collectivity, and ecological awareness. In this dual perception, it exists as an archive of history and at the same time works as a catalyst for future interaction.

Through this approach, it embraces the site's different dualities: being abandoned but having potential, symbolizing memory and reinventing the future, as being infrastructure and touching nature. The Liesenbrücken Bridge, which was once a connective structure within Berlin's complex geopolitical past, is now reimagined as a spatial interface that invites movement, gathering, and sensory reconnection with the city.

This design approach is rooted in urban design theories, which study underutilized and overlooked areas in contemporary cities. The lost spaces are critical opportunities for transformation and to reclaim these spaces does not mean simply reusing them, but also reintegrating them meaningfully into the fabric of the city through adaptive reuse and contextual design. (Trancik, 1986) Street Disco follows this way of thinking by proposing an intervention that reshapes the unused infrastructure as a responsive urban device and links it with the community through a living memory.

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2. The Disco Manifesto

Disco is generally known as an entertainment form, a genre, a place and a collective body movement through music. But etymologically, the word traces back to "discothèque," derived from the French word "bibliothèque." (Oxford English Dictionary, 2024) Initially it was used to refer to record libraries in the 1920s; curated archives of sound, culture and memory. This means, while disco represents nightlife, it also acts as an archive of resonance, a library of lived experiences with rhythms of resistance.

The Disco Manifesto roots on this etymology and proposed disco as a landscape strategy: a rhythmic infrastructure where ecology, culture, memory and public life are choreographed through design. The strategy is about creating coexistence within the urban realm through rhythm, temporality, ecology and social habits.

The conceptual framework of this study takes the dance floor as democratic, ecological and cultural agent. In this case , Disco becomes a metaphor for shared rhythms of public participation which serve as collective memories. This manifesto rejects static forms in cities and proposes dynamic interventions such as temporary interventions that occur within urban environments.

2.1. Cultural Production for Reclaiming Lost spaces

The manifesto defines cultural production as a spatial act, viewing dance floors as social condensers and rhythm as a form of architecture. In this landscape strategy, cultural practices challenge the definition of public space as a mere space of circulation or consumption, and propose space as a means of togetherness, improvisation and resistance. Consequently, disco is a form of participation; a method of reclaiming the city through cultural means.

2.2. Music as a Space Identity: Memory, and Belonging

In disco manifesto music takes place as a medium for memory and identity where with its historical depth, simultaneously spatializes the experience. It contains local archives of the culture, community playlists, oral histories, and event documentation. This method produces a cultural feedback loop, in which music acts as both an archive and a creator of new memories. Through soundscape it uses place-making methods and reshapes lost sites with cultural institutions. Public space, here, is not static but rhythmic and responsive to the community's movements, voices, and presence.l

2.3. Ecology of Gathering: A Socio-Ecological Urbanism

Disco Manifesto considers culture within the ecology. Here, rhythm exists also as wind, seasonal changes, urban biodiversity, and even human movement. Designing for rhythm means designing for coexistence on many levels; between species, in systems, or spanning time scales. Disco thus serves as a means of eco-cultural re-sensitization, and it fuses "green" and "culture" into a shared landscape of care, attention, and rhythm. Gathering is no longer social; it becomes ecological, intertwining the act of being together with the responsibility of maintaining urban ecosystems.

2.4. Light as Rhythm Generator

In Disco Manifesto, light is an element which is used as a rhythm-maker. While it functions as the safety for the pedestrians, the light also marks time, motion and mood. Design of this element creates layered visibility, a form of spatial choreography that changes between day and night. At night, the space transforms. Without rigid programming, it enables spontaneous events: pop-up concerts, street dance, night walks, or simply being. Here the design of public space is intentionally minimal yet open-ended. It invites appropriation and redefinition by the public.

The ethos of the manifesto is that public space should be dynamic ,flexible, inclusive and in continuous motion. It should activate the memory, stage nature as a collaborator and allow rhythm to guide behavior: temporal social and ecological. As Tonkiss (2013) argues, urban commoning often emerges from improvisational forms of use, where formal design meets informal culture. This theoretical framework is applied to a specific case: the transformation of Liesenbrücken Bridge into Street Disco.

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3. Case Study:
" The Lost Site: Liesenbrücken Bridge"

3.1. Research

3.1.1. Memory of the Site: Berlin Wall History

The Liesenbrücken Bridge holds significant historical resonance, as it is situated adjacent to the remains of the Berlin Wall. Once a sign of division, the area is now filled with spatial narratives of surveillance, rupture, and demarcation. Yet, like many border infrastructures, it is now an urban zone overgrown, underused, and largely invisible. This project aims to design through research with the strategies of Disco Manifesto. According to first research studies, the historical background and current character of the site are examined. It is viewed that the site defines a

junction ecologically and culturally: It is an ecological junction that functions as an essential link in Berlin's green network, it serves as a cultural junction with its physical connection to the Berlin Wall.

Although it has potential as an urban junction, it remains fragmented and inaccessible in its current state. The project, by enhancing this potential and its natural ability to connect, highlights memory as an active element in modern urban design.

3.1.2. Cultural Background: Berlin Techno Scene

According to a 2024 BBC report, the cultural revolution that began in the abandoned warehouses and squats of Berlin after the fall of the Wall has been globally recognized (BBC, 2024). The techno music that emerged from these reclaimed spaces provided a sonic language for freedom and identity. The recognition of Berlin techno as an Intangible Cultural Heritage by UNESCO parallels other city-music identities, such as reggae in Kingston or hip-hop in New York (BBC, 2024).

This cultural movement also brought about spatial transformation. Clubs, squats, and informal spaces formed a space for new rituals of collectivity. In this spirit, the Street Disco project engages techno as an aesthetic reference and as a spatial and social ethic. This approach also is seen in Lefebvre's (1991) theory of rhythm analysis, where sound and spatial rhythms intersect to create urban experiences.

3.1.3.Site-Specific Observations

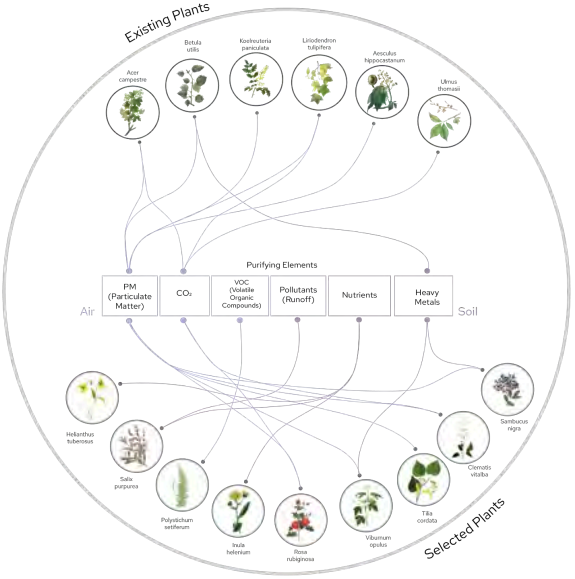
In addition to the literature review and contextual analysis concerning the site's historical, cultural, and ecological background, site-specific investigations were conducted to inform the design through direct spatial analysis. As a part of case study a field study carried out on 26–27 September 2024 included photographic documentation, soil testing, plant species mapping, and observational walks. These studies aimed to identify spatial dynamics, environmental conditions, and design opportunities specific to the Liesenbrücken Bridge and its surrounding environment. The research focused on identifying both the existing potential and the current limitations of the site.

The site has notable opportunities, such as having self-seeded vegetation that shows ecological vitality, offering high potential to serve as a platform for multisensory spatial experiences through light, elevation, and sound thanks to its dynamic nature and strong spatial and material contrast, and the existing ecosystem creates a basis to form eco-friendly design proposal.

In contrast, the site's limitations can be listed as follows: limited accessibility to the bridge due to the inadequate infrastructure of the stairs, the fragmentation of the green corridor between Park am Nordbahnhof and Humboldthain, and the lack of visibility to interpret the historical significance of the site.

Vegetation mapping conducted during the site visit identified a range of species, including Buddleja davidii, Solidago canadensis, Clematis vitalba, Diplotaxis tenuifolia, and Liriodendron tulipifera. Many of these species are known with their phytoremediation qualities and are well-adapted to urban environmental stressors. Soil quality assessments provided the fundamental information for the adoption of remediation strategies focused on air and soil enhancement.

Figure 1. Terraluma Planting Studies



These findings played a decisive role in designing the ecological component of the Street Disco project, especially

the Terraluma intervention. The selected plant species and spatial design were formed through the site analysis and ensuring environmental continuity and context-sensitive ecological restoration. The design process is based on in-situ observation and empirical studies, and the project itself is an example of a responsive urban transformation project where existing ecologies, infrastructural remnants, and cultural histories converge as drivers of spatial intervention.

3.2. Project: Street Disco

3.2.1. Project Statement: *Reclaiming Infrastructure as Commons*

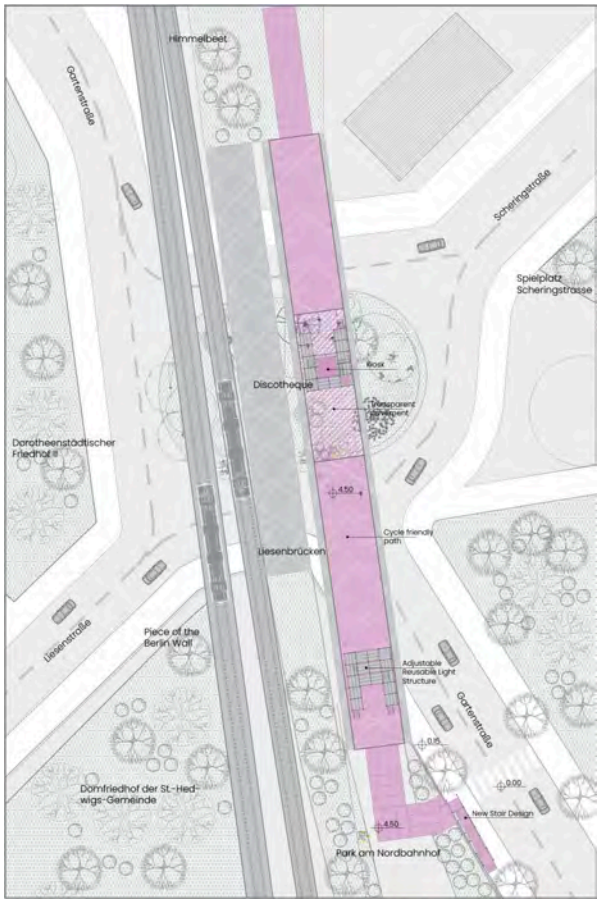
In contemporary urbanism, abundant or overlooked infrastructures, such as disused railways and bridges, are not seen as remnants of history but are viewed as potential urban structures for social, ecological, and cultural encounters. This reflects the idea that social contexts shape infrastructure and carry meaning, allowing communities to reinterpret it. (Bresnihan & Byrne, 2015; Simone, 2016). They become a fully functioning, accessible, and participatory urban infrastructure that creates a platform for civic society.

This process of reclaiming space is fundamentally a collective effort to reclaim a land that has been neglected for a long time, abandoned, and deprived of its political significance. Such as David Harvey (2012) and Don Mitchell (2003) argue that public space has never been easily granted; instead, it is a final product earned through struggle, negotiation, and the right to claim visibility and presence. In the context of urban commons, reclaiming land is a political act that produces a spatial outcome. It is a declaration of who has the right to reshape the city, be present, and act. In this sense, ownership gained through everyday practices (such as dancing, planting, listening, and caring) goes beyond legal ownership; it becomes a lived form of stewardship, more of a spatial authorship.

As Stavros Stavrides (2016) states, commons are a form of collective production, a threshold of encounter rather than a wall of exclusion; they are sustained by people's capacity to co-produce space. Reclaiming, then, is not about restoration or remediation of the land or fixed to a determined identity, but about opening it up to multiplicity, collective memory, and emergent forms of belonging.

Street Disco is a project that aims to reinvent the Liesenbrücken Bridge with the re-owning methodology while redesigning it into a shared space, a cultural and ecological commons. Rather than treating the bridge as a relic of infrastructure, the project reframes it as a site of collective authorship, where communities can engage in memory-making, perform public life, and co-create meaning. Drawing from Berlin's techno heritage and history of spatial transformation, Street Disco positions the bridge as both connector and stage: linking divided parks and neighborhoods while inviting new rhythms of movement, memory, and belonging. The project's methodology weaves together cultural production, ecological remediation, and participatory spatial practice, creating a vibrant node where historical narratives and future imaginaries converge.

Figure 2. Street Disco Design Plan Level Discotheque



The main approach is to design the space by considering each characteristic of the site. This approach results in a layered design where each layer functions in conjunction with the others while also serving its own purpose. This approach creates two spatial interventions: Discotheque, a cultural kiosk that archives and activates sound-based memory, and Terraluma, a planted ecological installation beneath the bridge that fosters urban biodiversity and sensory engagement.

3.2.2.Discotheque

"Discotheque" is a lightweight cultural kiosk design positioned on the bridge. This kiosk functions as both an archive and an activator for events, audio archives, and informal exchange, echoing the city's history of squatted cultural institutions. It contains local archives of techno culture, community playlists, oral histories, and event documentation. It is capable of hosting mini DJ parties, listening sessions, and workshops about sound and space. The kiosk acts as both a repository and a creator of new memories. It facilitates place-making through sound, blending infrastructure and cultural institutions.

Figure 3. Discotheque in the Night



Brandon LaBelle (2010) emphasizes sound's capacity to generate intimacy and belonging within public space, transforming listening into an act of place-making. Within this context, Discotheque operates as a spatial and ideological strategy rooted in sonic urbanism, embracing music as a method of shaping space, collective memory, and social interaction.

The kiosk's presence on the bridge affirms that public space is not defined solely by circulation or visual form, but by shared atmosphere and acoustic experience. By this reinterpretation, Street Disco reclaims infrastructure as commons, where community presence is heard as well as seen.

Design Implementation: The kiosk is designed to be constructed as an open and flexible light structure, at a key midpoint on the Liesenbrücken Bridge, visible, approachable, and intentionally open and inviting. Its modular design allows it to expand for different events and community uses, constructing a responsive approach to public space.

Inside of the kiosk planned as an evolving sound archive composed of community-submitted playlists, oral histories, event recordings, and ambient compositions reflecting Berlin's techno legacy and local soundscapes. Interactive listening stations allow visitors to explore these materials or contribute their own, generating a feedback loop between space and community.

Figure 4 . Mirror under Discotheque



The under surface of the kiosk is a mirrored facade that reflects the landscape below, the Terraluma, creating a visual and conceptual continuity between the upper and lower levels of the site. This mirror is epistemological: it invites viewers to perceive the simultaneity of surface and depth, presence and memory, everyday life and ecological process.

3.2.3.Terraluma

Terraluma represents the ecological counterpoint to Discotheque, grounding the project's cultural expression with a method of environmental restoration and multispecies care. It is a spatial strategy rooted in the idea that urban ecologies are dynamic, layered, and relational. Drawing from theories of socio-ecological urbanism and landscape repair (Spirn, 1984; Corner, 1999), Terraluma envisions the act of planting as both a design tool and a political gesture that acknowledges the agency of non-human life in shaping urban space.

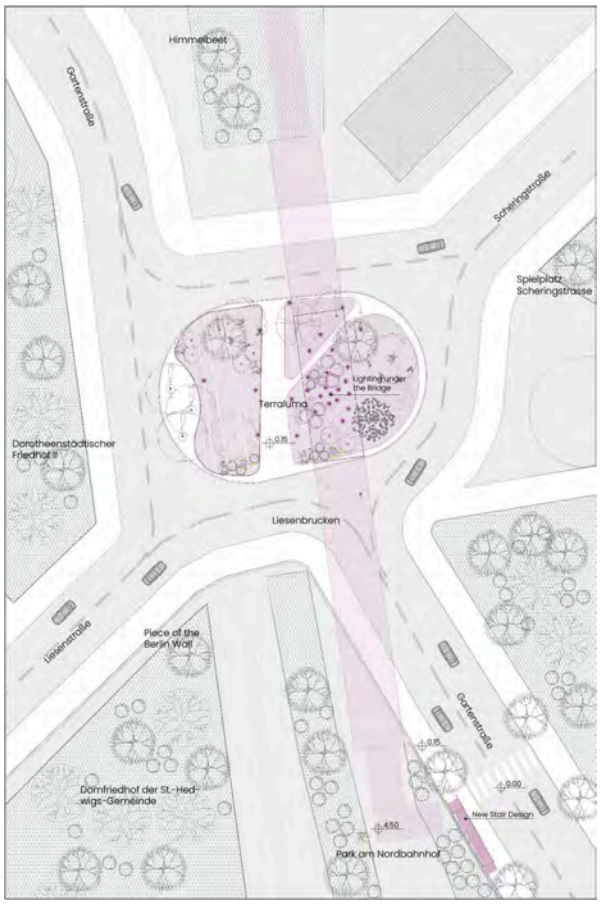
"Terraluma" is a combination of the latin word "terra" which means earth with the english word "luma" (lumen) that means light. This name is reflecting its dual function as both a habitat and a sensory interface. The design area of Terraluma is a roundabout beneath the bridge that operates as a living infrastructure which purifies air and soil while creating a corridor for biodiversity. The ecological logic is instrumental where the planting strategy is informed by a detailed survey of existing vegetation and soil conditions, using phytoremediation and native species integration to remediate the urban ground and support local wildlife.

Terraluma frames light as rhythm and it weaves nature and culture together into a shared, experiential landscape. Just as Discotheque reclaims public space through sound and memory, Terraluma reclaims it through soil and breath offering a space of attention, recovery, and ecological presence. By analysing the cycles of growth, decay, and regeneration Terraluma positions environmental processes as central to the design.

Design Implementation: Today, beneath the Liesenbrücken Bridge, there is a forgotten traffic roundabout. The strategy of Terraluma is to transform this area into a layered, ecologically productive ground that purifies the environment and invites multispecies presence. The design approach built on a site-specific plant survey conducted in and around Park am Nordbahnhof and Gartenstraße, the planting strategy incorporates air and soil purifying species known for their phytoremediation, habitat supporting and pollinator attracting properties.

The planting design includes plants such as; Solidago canadensis and Amaranthus hypochondriacus for their resilience and ecological benefits, Liriodendron tulipifera for air purification, and Diplotaxis tenuifolia and Clematis vitalba for ground cover and biodiversity enhancement. These species, many of which are already naturalized or existing on site, are curated into an adaptive system that contributes to climate resilience and urban greening.

Figure 5. Street Disco Design Plan Level Terraluma



The mirrored ceiling of Discotheque visually reflects this lush underworld, permitting visitors above to see this green system, establishing vertical ecological communication and creating a continuous spatial dialogue between upper and lower realms. This gesture transforms ecological infrastructure into a shared visual experience. It blurs distinctions between built form and living system, surface

and depth.At night, with soft lighting woven among the vegetation, the space is being animated while preserving habitat sensitivity and creating a "disco ball" effect that connects Terraluma to the rhythm of the bridge above.

The part of the bridge which is over the top of terraluma is covered with a transparent material where also micro-seating elements constructed from reclaimed materials that invite people to enjoy the view and offer moments of pause, reflection, and sensory engagement. Terraluma is an active ecological interface designed to clean, connect, and cultivate. As part of the Disco Manifesto vision, it affirms that environmental care is not separate from public life.

On the surface of the bridge, semi-transparent pavement elements have been used to offer framed views into Terraluma below. This design aims to turn the act of walking into a spatially layered experience. As pedestrians move across the bridge, they visually engage with the plants, and light beneath their feet, folding sky, structure, and ground into a single perceptual field. This design choice reinforces the continuity between levels and blurs conventional thresholds between infrastructure and landscape, movement and stillness. In doing so, Terraluma becomes not only an ecological intervention, but an embodied one, inviting the public to see, feel, and reflect on their entanglement with urban nature.

4. Conclusion

Street Disco is a case study project of the Disco Manifesto, which proposes a new kind of urban choreography where unused infrastructure becomes a potential performative public space, and cultural memory is activated. The project reclaims the bridge for contemporary needs of belonging, gathering, and planetary care.

The socio-ecological principle of the Disco Manifesto can be observed in Terraluma of Street Disco, the planted area under the overpass, where selected vegetation purifies micro-pollutants in a synergistic fashion, while its lighting design creates connections between different layers.

Figure 6. Discotheque in the Daylight



Street Disco gives spatial dignity back to a neglected infrastructure, drawing inspiration from Berlin Techno, which gives a new meaning to abandoned factories.It exemplifies how design, memory, and music can co-compose a more inclusive and sustainable urban future.

As cities confront crises of climate, housing, and belonging, landscape architecture must step into new roles: being a dynamic archive of the cities, staging encounters, reclaiming lost sites, and resisting for the commons. This case study of the Disco Manifesto is an example that a project can create a place and a proposal: that the city's forgotten spaces hold the rhythm of its next revolution.

In that sense, Street Disco offers an open score for the city to dance its future into being.

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‘ENCROACHMENT’ THAT ENRICHES:

Reimagining India’s Streetscapes through Diffuse Design

TOPIC: Guiding cities with society: Use, memory, artistic creation

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Abstract

Indian cities, already home to millions of aspirational Indians, are rapidly growing and constantly negotiating identities and inequities across the urban phenomenon. One such highly contested design element is the sidewalk. An “ideal” sidewalk, as seen in multiple design guidelines, is wide and clear of obstructions. The streetscapes in Indian cities, however, are ripe with activity - all sorts of vendors, hawkers, and social interactions are observed on the sidewalk. As India moves towards design standards for walkability, the most observed effort is violently labelling these stakeholders as ‘encroachments’, disregarding their value, and then ‘sanitizing’ the sidewalks by removing the said encroachments. Author argues that what is seen as ‘encroachment’ is actually a marker of resilience in Indian cities - sidewalks that host essential services and serve as third spaces already exist as the foundations for India’s “15 Minute Cities”. Through documentation and stakeholder interviews, the author studied Pune’s sidewalks and the communities that are supported by them. It is important for designers, to acknowledge the people-led design of the sidewalk as a legitimate act of placemaking and thus reimagine a new template for Indian sidewalks where pedestrians and vendors can coexist. Diffuse Design is a participatory design model proposed by researcher Ezio Manzini where the expert designer’s role is to assist and execute the existing genius of the public to create resilient spaces. Future of Indian streetscapes and urban places, this paper contends, lies in celebrating the nuances, functions, and social networks that make them dynamic and supportive of a sustainable future.

1. Introduction

The global weather patterns are changing, attributed largely to the emission of greenhouse gases (GHGs) from human activities like the combustion of fossil fuels for vehicular traffic. Consequently, the call to pivot from car-centric cities to denser and more human-scaled ones has become central in the conversations around urbanism. The idea of “walkability” has drawn particular interest across the globe to help ensure that people do not feel the need to drive, especially for short distances to fulfil their daily needs. Conceptual models like Carlos Moreno’s 15 Minute Cities, where all the essential urban services are within a 15 minute walk or bike ride, are no longer just ideas; today, they now inform policies and the design of urban spaces in many rapidly urbanizing countries.

India is one such landscape in flux. A country of labels, India is home to over 1.4 billion people and is labelled “a third-world country”, “part of the Global South” and “the most populous country on the planet”. But nothing quite captures its aspirations as the label of “a developing country”. Since its independence from the British colonial rule in 1947, India has made commendable strides in areas like agriculture, food security, and alleviating extreme poverty. With aspirations, however, come emissions. Even though India’s current per capita carbon footprint is notably lower than that of many countries in North America and the European Union [1], the rapid urbanization of India is bound to have a significant impact on the global zero emissions target. This growing urban population, against the backdrop of the increasingly

catastrophic effects of climate change, warrants an immediate reflection on India's urban walkability.

2. Walkability

From the initial explorations to understand neighbourhood design as a promoter or inhibitor of physical activity in late 1990, the subsequent adoption of the term 'walkability' to describe a set of desirable urban characteristics, to the more recent reevaluation of the term for being limiting in its outlook, it is apparent that walkability as a concept is well-discussed. Studies measuring the physical and social health benefits of walkable neighbourhoods [2] have rendered it indispensable from the conversations around urbanism and have established the need for urban design that promotes this state of walkability.

3. Sidewalk: A Unit of Walkability

The fundamental and most visible dimension of walkability in cities is the sidewalk. Sidewalks, largely understood as the roadside strips dedicated for pedestrians, have existed across time and cultures. Paved and unpaved; made of wooden planks, cobblestones, pavers, and more recently concrete; lined with trees, storefronts, or blank walls; unobstructed or rather packed; smooth or crumbling: sidewalks exist is many forms, and sometimes they do not exist at all. It is these unique characteristics that invite multiple activities, making the sidewalk a battleground for walkability. In their defining piece of literature *Sidewalk: The Conflict and Negotiation Over Public Space*, Loukaitou-Sideris and Ehrenfeucht discuss the morphology and the sociology of these edge conditions where people don't just walk, but "display individual and group identities and observe others" [3]. The celebrated urban activist Jane Jacobs too called sidewalks "the main public places of a city" [4]. Though Jacobs most definitely never visited India, her assertion about the sidewalks holds true for Indian sidewalks, or footpaths as they're called in India.

4. An Indian Sidewalk

From December 2023 to January 2024, I undertook a design documentation project as the travel research fellow funded by the Department of Planning and Landscape Architecture at the University of Wisconsin-Madison. The aim was to observe, document, and study the everyday acts of placemaking in India's urban and rural landscapes. Everyday acts of placemaking, here, refers to the processes through which individuals and communities, organically and consciously, engage in the alteration of their surroundings to meet their needs; though often reduced to "vernacular" or "informal", these are manifestations of creative agency, thus legitimate acts of design.

During my observations in my city of Pune, where I was studying how people align themselves with the nature in the city, I noticed an audumbar tree (*Ficus racemosa*) shooting up through the brick and concrete of the sidewalk, all decked up with the festive yellows and oranges of marigolds. The community of street vendors had claimed the tree and were celebrating the festival of Datta Jayanti. Under the inviting shade of the audumbar, men and children with matching orange caps were chatting with each other and welcoming passers-by to join. A pooja, with all the ceremonial paraphernalia, was meticulously arranged under the audumbar, on the footpath [Fig. 1]. The appeal of the scene compelled passers-by to pause, admire, and sometimes seek blessings. And if that were not enough, there was piping hot khichadi (a savory rice dish) being offered to everyone as prasad (offering) [Fig. 2]. It was worth noting that this humble road-side celebration had brought the community, and even the strangers, together and facilitated social interaction with relative ease.



Figure 1. Celebrations on a sidewalk in Pune, India (Image by Author)

Though heartwarming, such scenes are by no means a rarity in India, a densely populated and pluralistic society. Indian streets are indeed vibrant landscapes in and of themselves. Festivities, fireworks, processions, artwork, color, trinkets, and street food, Indian streets are ripe with activity. It is a part of the urban experience. Why, then, should this sidewalk celebration warrant such attention, let alone an extensive discussion?



Figure 2. Food as a catalyst for social interaction (Image by Author)

As an aspirational society and an economy racing towards the $5 trillion-mark, India's urbanization rhetoric is largely driven by cars, highways, and "smooth" traffic. Owning a private vehicle is a status symbol, and smooth roads to drive on are a measure of a city's development. As a result, any activity that occupies the streetscape for any function other than vehicular traffic is increasingly being branded as a nuisance. In the universal car-centric fashion, everyone, but the private vehicles, is being blamed for the traffic woes. Buses are underfunded and fares doubled due to 'inefficiency'; bicycles are banned from main streets in major cities like Kolkata because they are a 'nuisance', and street vendors are 'obstructions' and 'encroachments' that slow down the traffic and cause congestion.

5. Encroachment & Street Vending

The term 'encroachment' itself is interesting as it is universally contested through the lens of ownership and legitimate claims to public spaces. Who owns the street and the sidewalk and who has a legitimate claim to it and for how long are moral and logistical predicaments. Academic exploration of informal street vending, a highly contested use of the sidewalk, has been on the rise. In their comprehensive review of the existing literature on street vending, Peimani and Kamalipour identify eight key themes such as policy environment, typology, spatiality of street vending and public space design, individual/collective agency, gender and so on. Informal street vending in the global South, they observe, is a conflict of sensibilities in that "the elite often consider informal street vending harmful to the image of an ordered city" [5].

The vocabulary we use to address these groups ought to be especially sensitive in India, where an overwhelming 90% of the working population is involved in the informal sector, of which street vending makes up a sizeable portion [6]. Language is also important in shaping our understanding of and actions towards our shared physical environments. In the city of Pune, for instance, the official language, along with English, is Marathi, spoken by about 83 million people. The Marathi word for encroachment is 'atikraman' (Marathi: अतिक्रमण). Derived from Sanskrit roots, it literally translates to 'extending beyond one's prescribed limits'. By the current prescription in Pune, for example, street vendors that are not registered with the Encroachment Department of the Pune Municipal Corporation fit the bill. This label of 'encroachment', many academics have observed to be inherently violent and accusatory. It gives the impression as though the vendors, who claim public space for economic activities, are serious anti-social elements taking over the city and causing absolute anarchy. This slippery slope shapes the popular culture and opinion around these stakeholders on the sidewalk, paving the way for the demands to "sanitize" the streets, "clear" the sidewalks of these encroachers, and "make way" for traffic, pedestrian and vehicular.

Peimani and Kamalipour also discussed the typologies in street vending, ranging from legal dimensions (legitimate or illegal) and functional offerings (food, goods, and services). My observations in Pune show similar distinctions. Pune's official list of registered street-vendors includes an assortment of goods being sold and services being offered along the streets, on the sidewalks of the city. Mobile and leather repair shops, tea shops, paan shops, barber shops, goggles and belts shops, paper and recycling shops, tailoring shops, auto-repair shops, clock-repair shops: the list keeps going. This database, much like the streets of India, hosts countless garland-sellers, food-sellers, footwear-sellers, undergarment-sellers, beverage-sellers, coconut-water-sellers, fruit-sellers, vegetable-sellers, fish-sellers, bangle-sellers and many more.

One may immediately notice an overwhelming variety of essential urban needs being fulfilled and day-to-day functions being performed, all on the narrow strips along the streets [Fig. 3]. The sheer volume is evident when one is reminded that these are just the registered vendors; there exist many more that operate under the label of atikraman.



Figure 3. Multiple functions of an Indian sidewalk as observed in Pune, India (Image by Author)

6. India in Flux: Back and Forth

Despite the day-to-day language around them, the importance of street vendors in the operation of Indian cities and the need to include them in the walkability conversations has not gone entirely unnoticed. There have been conversations around acknowledging their existence, respecting their agency, and making space for them on the sidewalks. In 2011, the Institute for Transportation and Development Policy (ITDP) published a guidebook for India's streetscapes, where it talked about the importance of street vending and pushed for standards that would 'formalize' their position on sidewalks – by design [Fig. 4].

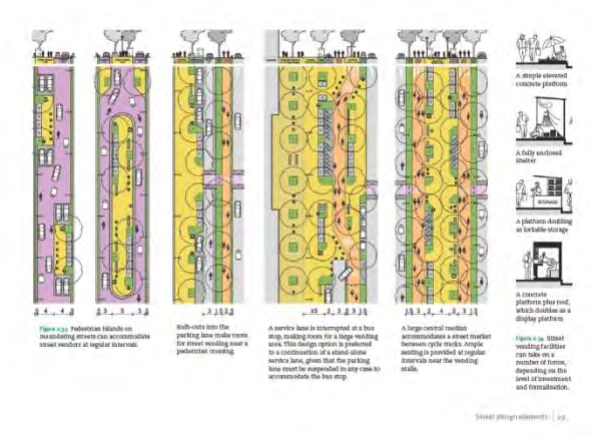


Figure 4. A reimagined street section for India, ITDP Guidebook, 2011

India's politics and governance has changed significantly since these guidelines were released in 2011. Ambitious infrastructure and urban renewal programs like the *Smart Cities Mission* have sought to address and assist India's urbanization trajectory. Unfortunately, ITDP's inclusive approach was largely missing in the recent "Streets for People Compendium 2023" released by the Smart Cities Mission. Through case studies, the Compendium sought to develop a framework for Indian streets. However, a shift from ITDP's approach, it ended up using language like 'encroachment' when referring to roadside activities and words like 'pushback', and 'clearing' when talking about street vendors [7]. For transit streets, the solution proposed was to relocate the roadside vendors to dedicated flea markets. It is evident from the renderings that the sidewalks were meant exclusively for movement (walking and biking) and not for activities like street vending. The approach was to "clear and relocate", not involve and coexist [Fig. 5].



Figure 5. A Proposed Street Section from the "Streets for People Compendium 2023" published by the Smart Cities Mission, India. Note how the sidewalk use is prescribed. Any deviation is bound to be labeled as 'encroachment' – it was never budgeted into the design.

Pilot projects have been constructed according to similar "ordered" visions for India's streets and sidewalks: wide pedestrian paths guarded by bollards, dedicated bike lanes, planting strips, even bays for buses and occasional street-side parking. Despite there being no space dedicated for street vending, these meticulously planned sidewalks are now dotted with street vendors, exercising their agency and utilizing the city as a resource [Fig. 6].

6. Sidewalk As an Assemblage

The sidewalk remains a contested urban element because it is seen only as a means of unobstructed pedestrian movement and not as a place - an assemblage resulting from the interactions between multiple elements like pedestrians, vendors, storefronts, pavers, bollards, signs, stray dogs and cats, trees, and birds atop. Kim Dovey has popularized the idea of urban environments as assemblages, arguing against the "reduction of place to text, to materiality or to subjective experience", as in any singular element [8].



Figure 6. Vendors sit in the planting strips on a sidewalk in Pune, India (Image by Author)

In the case of an Indian sidewalk, the conflict arises from the failure to consider that services on the sidewalk are as much the sidewalk as the pedestrians on it. The assertion that limiting the sidewalk to be an unobstructed path for the sole purpose of getting from Point A to Point B risks making cities less walkable down the line. Relocating street vendors to few dedicated flea markets will limit essential services to few spots in the city, essentially siloing the urban functions and forcing people to drive. Less visual interest, activity, and eyes-on-street along the sidewalks will make them unattractive, unsafe, and thus less walkable, further promoting car-dependency. Moving forward, this is a two-step recipe for a car-centric and more congested urban India. Therefore, it is imperative to afford legitimacy to street vending, embrace it all over again, and begin envisioning a future where sidewalks continue to be robust assemblages, populated by diverse actors and bustling with many coexisting activities. Envisioning such a future is a significant undertaking, which researchers like Mulgan call a "intractable social problem" where "the classic tools" of policy and economy "are grossly inadequate" [9]. An alternative vision and approach is therefore necessary to reimagine India's streets.

7. Diffuse Design: An Overview

In his book "*Design, When Everybody Designs",* Italian designer and researcher Ezio Manzini proposes tapping into "distributed intelligence" and promoting social innovation to achieve resilient systems in today's hyper-connected world that poses some serious unprecedented challenges [10]. Defining design as combining "critical sense, creativity, and practical sense", Manzini argues that, with the rapidly changing social and technological contexts, everyone is constantly designing to meet their needs, whether the conventional definition and hierarchical wisdom recognizes it or not.

Manzini proceeds to make a distinction between "**diffuse design**" and "**expert design**": the former is the practice of one's innate design abilities, whereas the latter is possessing the tools and cultural vocabulary to practice design as a profession. The distinction, Manzini argues, is not as important, as is the interaction of these identities in together shaping the environment. To design for complex issues, Manzini suggests, **problem-solving**, largely the domain of expert designers, and **sense-making**, where communities render meaning to landscapes through their actions, cannot be vastly separate processes. To reimagine Indian sidewalks, then, is not just about achieving optimal flow of traffic (problem-solving) but also about elevating sidewalks to the level of third places, engaging in community-led placemaking, and preserving the unique character of Indian streets (sense-making). Manzini demonstrates the conventional approach to design using a matrix and notes how emerging design practices are blurring the boundaries between these axes.

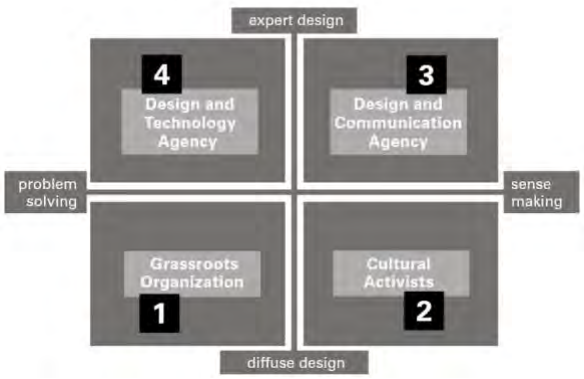


Figure 7. Manzini's Design Mode Map, from Design, When Everybody Designs (p. 40)

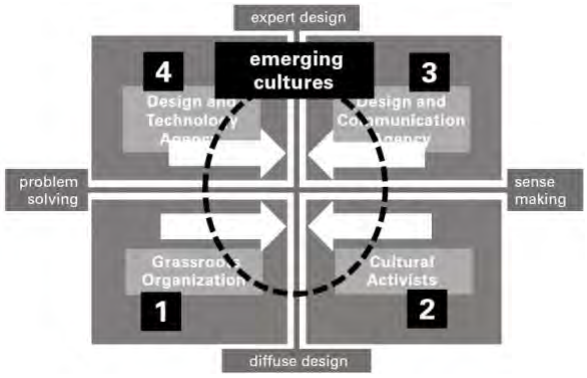


Figure 8. Manzini's Emerging Cultures Map, from Design, When Everybody Designs (p. 44)

It is within these emerging cultures, I contend, lies the approach for the expert designers to engage in the co-design of a new vision for India's sidewalks and streetscapes.

8. The Role of an Expert

Based on multiple radically innovative case studies, Manzini describes the tasks for the expert designer can perform in co-design process. Based on Manzini's descriptions, I now attempt to consolidate a list of roles a classically trained expert designer can undertake within a creative coalition with non-expert designers:

1. **The Documenter:** who identifies, maps, documents, and sheds light on grassroot instances of diffuse design and aspirations.

2. **The Convenor:** who identifies existing synergies and organizes scattered individuals or groups with similar goals.

3. **The Mediator:** who proactively engages in navigating different, sometimes conflicting, goals and preferences.

4. **The Creative:** who conceives long-term and large-scale visions as well as original design proposals.

5. **The Facilitator:** who applies specialized skills, tools, and technologies to enable and realize community aspirations.

6. **The Researcher:** who studies localized design initiatives both as immediate solutions and as prototypes for a continuous experiment in the urban realm, producing a body of knowledge that can inform future design.

7. **The Educator:** who makes the design research and dialog accessible to other experts and non-experts to facilitate communication and collaboration.

8. **The Activist:** who uses their voice, language and cultural access to be trigger broader conversations to gather further support for such design coalitions in spheres of power and policies.

These roles, informed by the unique skills and capabilities of formally trained designers, could provide a more legible pathway to operationalize Manzini's idea of design coalitions for social innovation in the urban realm.

9. Applying it to the Sidewalk

Manzini describes a place as "[physical] space endowed with sense", a tangible element of our built environment that is meaningful to an individual or a community. To shape such spaces, Manzini suggests "**planning by projects**": undertaking people-led, place-based design initiatives that expert designers can help promote and sustain. The organization of street vendors on a sidewalk in Pune is such a community and their annual place-based ritual around the *audumbur* tree, Manzini would agree, is a design initiative worth noticing, celebrating, and upholding through design.

To promote and sustain such initiatives, the first step is **recognition**, followed by building **relationships** between the local communities and the expert designer. Next is **prototyping & experimentation** of place-based programs and initiatives through an "open and open-ended co-design process", where open means participatory and open-ended is a call for a research-oriented approach that encourages innovation, nimbleness, and the ability to pivot based on results.

Indeed, multiple placemaking prototypes, micro-interventions, and community-led projects are desperately needed to generate data that can inform the discourse on India's sidewalks. Currently, there is a significant gap in the literature on the state of Indian sidewalks, what the people truly want, and what sort of initiatives exist on the streets that normally go unnoticed. Manzini's prototype approach, I believe, can generate a body of work and design precedents rooted in the Indian context that can then inform broader policy conversations and suitable

guidelines for a new typology of sidewalks. Expert designers are essential to this cause and may involve themselves with the two types of projects defined by Manzini.

A. Framework Projects: where the goal is to develop a larger conceptual framework that will inform on-ground projects and initiates. These can include:

1. Mapping Initiatives
2. Field Observations
3. Relationship Building Exercises
4. Vision Planning
5. Educational Outreach etc.

B. Local Projects: where the goal is to solve specific design challenges, achieve tangible localized results and use them as prototypes to validate the conceptual frameworks and encourage additional local projects. These may look like:

1. Public Art Installations
2. Tactical Urbanism Interventions
3. Fairs and Markets
4. Technological Applications etc.

It is an exciting vision for the future that has experimental and collective creativity at its core. It invites multiple professions like landscape architects, architects, urban planners, graphic designers, industrial designers, user experience designers, software designers, and so on, to engage with their immediate communities and tinker together and create a body of work that can help develop guidelines for resilient spaces. Doing so will set a radically innovative tone for the design of urban spaces, rejecting the knee-jerk, and frankly outdated, reaction to "sanitize" and "control" and embracing the complexities of lived experiences in a rapidly changing world.

10. Conclusions & Moving Forward

This paper is a reflection on India's unique sidewalks through a theoretical lens that often limits its focus to Western contexts. The need to bring these spaces into the mainstream dialogue around urbanism is urgent as the global community aspires for a shared climate-resilient future. By applying an academic aperture to what is largely seen as "nuisance" and "disorder", this paper has sought to reframe India's sidewalks as complex and vibrant units of urban life that are a direct result of everyday acts of design by users like street vendors. In doing so, it hopes to afford some legitimacy to contested practices like street vending and calls for a collective reimagination of these edge conditions in conflict.

To that end, this brief exploration may serve as the beginning of what could be a series of ethnographic studies, rich documentations, comparative studies, and analyses of Indian urban landscapes. It offers a new vocabulary to look at India's sidewalks and street vendors by localizing Ezio Manzini's principles of diffuse design. Based on Manzini's literature, 8 roles are also identified for the expert designers to engage with diffuse design in their communities. It invites engagement



Figure 9. A Vision for the Future
(Sketch by Author)

by providing multiple avenues where landscape architects, architects, urban planners and all other designers, in India and beyond, can start identifying, supporting, and popularizing the existing community-led design initiatives around them. It also is a call to conceive new partnerships and build prototypes that can serve as the basis for new guidelines to design Indian cities – this time, rooted in empathy, partnership, and the genius of the everyday Indian.

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EVOLUTION OF THE UNESCO SITE OF THE ROYAL SALTWORKS INTO AN ISLAND OF BIODIVERSITY INSPIRED BY GILLES CLÉMENT'S PLANETARY GARDEN

TOPIC: Guiding cities with society (art, design, consultation): use, memory, artistic creation.

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Keywords: Planetary garden, Heritage, Ecology, Creativity, Transmission

Abstract

Biodiversity provides irreplaceable services to humanity: oxygen, food, medicines. Today, the global use of resources poses major problems: climate change, collapse of biodiversity, but we do not have a second planet. Gilles CLÉMENT's thinking, notably expressed through his concept of planetary garden[1] according to which the Earth is - like a garden - a closed and finite space that it is up to man to maintain and preserve, can play a role of compass. It was by drawing inspiration from both his work and that of the visionary architect Claude-Nicolas Ledoux, who sought in the 18th century to reconcile apparent opposites - minerals with plants, people with nature, beauty with utility, the city with the countryside - that an initiative was born at the Saline royale d'Arc-et-Senans to open a laboratory for landscape professions on 13 hectares under the leadership of the Mayot & Toussaint agency, associated to ALEP architects, Soberco Environment and Sébastien Appert.

In 2022, for the first time in 250 years, the development of the "Great Circle" thus made it possible to transform the UNESCO site of the Saline royale, renowned for its semi-circular architecture, into an island of biodiversity in the form of a complete circle inspired by the "Ideal City" that the architect Ledoux had dreamed of in the 18th century around his factory in Arc-et-Senans[2].



Figure 1. Start of landscaping work at the Royal Saltworks in Arc-et-Senans (France).

The originality of this project is to be supported and carried out by and with learners from national landscape schools and agricultural professional establishments, by combining high quality landscapes, architectural heritage, circular economy, creativity and ecology. Each year, the 30 gardens, some 12,000m², which now make up the "Great Circle", are an opportunity to bring together, from their design to their completion, interdisciplinary teams bringing together gardeners, architects, artists, ecologists, teachers and more than 400 students from around twenty schools in France, Switzerland and Belgium, awarding diplomas in the field of landscaping.

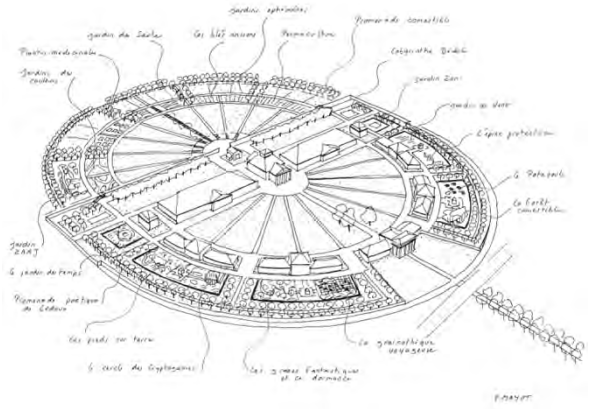


Figure 2. Landscape project of the 'Great Circle' at the Royal Saltworks in Arc-et-Senans (France).

Here, the gardeners observe and accompany nature, rather than seeking to domesticate it, to promote biodiversity. The challenge is to awaken individual and collective potential, to share knowledge and techniques to produce with the living, and not against it, in order to give everyone the tools to live better, to cooperate and build together a more sustainable and more united future.

Everything in this project proposes, enriches, and fertilizes possible futures: a melting pot for experimenting, a tool for transmitting, an agora for sharing, a theater for reinventing[3].

Realizing the design of the "Great Circle" imagined by Ledoux made it possible to pursue 4 objectives:

1. Double the surface area of the Saline royale by developing 30 gardens on 13 hectares;
2. Create an ecological corridor consisting of a double alignment of 200 trees along the royal avenue, connecting two "Natura 2000" protected areas;
3. Develop a platform for experimentation and sharing of knowledge between students, professionals and the general public;
4. Highlight the remarkable built heritage of the factory, in particular by creating two belvedere footbridges allowing, from a height of 5m, a view of the entire circle.



Figure 3. Landscaping of the 'Great Circle' at the Royal Saltworks in Arc-et-Senans (France).



Figure 4. 'Circle of cryptogams' garden at the Royal Saltworks in Arc-et-Senans (France).

Acknowledgments
The authors thank the gardeners, teachers, and students who care for the gardens of the Royal Saltworks, as well as the patrons and public and private partners who support the project.

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MOBILIZING THE HISTORY OF LANDSCAPE AS A RESOURCE FOR URBAN PLANNING: THE EXPERIENCE OF THE GRANDALPE PROJECT

TOPIC : Guiding cities with society: Use, memory, artistic creation

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Keywords: history of landscaping, urban renewal, open space, art, landscape mediation

Abstract

There is a challenge in revealing pre-existing landscape and artistic heritages in urban renewal projects, in connection with ambitions for ecology, well-being and the participation of residents and users. Paradoxically, these aspects may be considered unevenly or even partially in current operational contexts (Bodénan and Béchet, 2023; Blanchon, 2021; Pôle ressources, villes et développement social, 2021; Hertzog, 2015).

To this end, we are experimenting with a methodology involving local stakeholders, users and residents on the Grandalpe project in Grenoble. Our hypothesis is to develop this diagnosis based on conceptual tools for interpreting the urban landscape: landscape entities, landscape motifs... (Raymond, Luginbühl, Seguin and Cedelle 2015; Callens, 2023; Delbaere, 2017).

The initial design of the so-called "grands ensembles" inherited from the second half of the 20th century was in part led by landscape architects, often accompanied by artists (Blanchon, 1999) and based on a strong structuring by open spaces (understood here as undeveloped spaces where nature predominates). Approaching the project through open spaces also makes it possible to respond to current social demand for public spaces and nature, and to biodiversity issues (Clergeau, 2020).
In light of this observation, this paper highlights the importance of historical diagnosis and its use for project co-construction (Corboz, 1983, 2001; Vadelorge, 2017; Blanchon Caillot, 2009).

We will draw on current applied research involving a university research laboratory (IPRAUS), a group of landscape and urban planning agencies (Agence AIA-T, Atelier Foïs) and a local authority (Grenoble Alpes Métropole) as part of the GrandAlpe urban project.

This project concerns twentieth-century heritage landscape ensembles already recognized, as is the case for the Villeneuve de Grenoble park designed by Michel Corajoud), (label "remarkable contemporary architecture") and others little recognized despite their importance, as is the case for Ingrid Bourne's landscaping for the Villeneuve d'Echirolles (Blanchon, 2018; Bourne, 2000), or not considered as open spaces in urban plans including business zones (Novarina, 2023). This legacy remains to be mobilized in the GrandAlpe urban renewal project, by improving its recognition based on in-depth consultation processes, and the ambitions carried by the Grenoble Metropolis on the greening of the city (canopy plan).

In this context, the experiment develops new historical knowledge about open spaces, based on archives, fieldwork and interviews, synthesized through landscape entities and landscape motifs. Graphic documents will be produced, including cartographies based on research and projects in this field (Chemetov, 2010; Khirfan, 2010; Callens, 2020). This knowledge will be incorporated into operational documents (guide plan, sector study, specification booklet) and mobilized to co-construct the project narrative with stakeholders and residents.
The results of this experiment will enable us to identify the potentials and limits of the proposed methodology, and more broadly to discuss the place of landscape expertise in the context of renewed synergies between territorial memory, ecology, art and consultation, as a resource for the project.

Text

This paper focuses on the history of open spaces as a resource for urban renewal projects, looking at 20th-century initiatives, and addressing both:

- contemporary environmental issues
- and a collaborative approach involving local stakeholders (elected officials, technical experts, residents…).

The methodology of this research is through observant participation (Soulé, 2007). It combines:

- the development of a historical reading method with an *ad hoc* corpus
- testing the latter in a project process with local stakeholders

It involves a university research laboratory (IPRAUS), a group of landscape and urban planning agencies (Agence AIA Territoires, Atelier Foïs)[1] and a local (public) government (Grenoble Alpes Métropole). This research work is being tested within the framework of the GrandAlpe master plan, over the long term of its elaboration and monitoring (2024-2028 or 2032).

We will present the stakes linked to heritage in our applied research, the context of the experimentation with stakeholders, and then its implementation. This will enable us to present our initial results. We will suggest a renewed contribution of landscape expertise to the project process, to meet the challenges of an ambitious and pragmatic socio-ecological transition, that makes sense for the urban territory.

1. A significant field of study for 20th-century heritage: the Villeneuves of Grenoble-Echirolles

Developing a historical approach for the GrandAlpe project raises the question of understanding the landscape heritage of the 1960s and 1970s, to structure sustainable urban renewal projects that promote social cohesion and well-being (Bodénan and Béchet, 2023; Blanchon, 2021)

This project area of approximately 400 hectares has a rich history (Novarina, 2023), with the implementation of significant and artistic projects in the 1960s. This heritage is partly recognised, as we can see in the "Parc de la Villeneuve" in Grenoble, designed by Michel Corajoud and labelled as 'remarkable contemporary architecture', along with the Arlequin and Baladins architectural complexes. However, other projects are far less well known, such as the Saint-Maurice's landscape project for the Olympic Village, or Ingrid Bourne's work for Villeneuve d'Echirolles (Blanchon, 1999; Bourne, 2000). Moreover, we look at other landscape projects that are not considered as open spaces in the urban projects, but hold value to our research, such as new planted avenues and industrial areas.

These open spaces are fundamental to the concept of the 'Ville-Parc'[2] and have guided urban renewal projects for the past decade. This responds to a social demand for nature and well-being (Clergeau, 2020). Nevertheless, this unique landscape heritage tends to be reduced to environmental issues relating to

[1] The previous experiences of the contributors to this research-application, between practice and research, were structuring in framing the historical reading, its methodology, and its use for the project:

- Alexandre Callens is an associate member of IPRAUS and an architect-urban planner at AIA-Territoires. He has conducted applied research on methodological issues. (Callens, 2022, 2023)
- Carolina Foïs, a landscape architect and founder of Atelier Foïs, has developed projects focusing on water management, heritage of slabs from the 1960s and 1970s, and landscape projects on roof terraces. (Fois, 2020)
- Valérian Rocca is a trainee historian at AIA-Territoires as part of his master's degree in "Historical diagnosis and urban planning". This master's program raises the question of the interfaces between historical and heritage expertise in operational processes. (Vadelorge 2017)

[2] For the landscape architects and urban planners in charge of the GrandAlpe masterplan, the 'Ville-Parc' is defined as a network of open spaces which resonates with the park system concept inherited from F.L.Olmsted and J.C.N.Forestier

vegetation (canopy cover, urban biodiversity, de-impermeabilization, etc.). No attention is paid to the overall design and ideas behind these landscape projects and is not explored in depth.

To address this issue, we, as landscape architects and urban planners leading the GrandAlpe master plan, have undertaken applied research that is aimed at gaining a better historical understanding to develop the project. We will begin by focusing on Ingrid Bourne's developments, given the limited publications on the subject and her significant contribution to the entire Villeneuve d'Echirolles area, and, more broadly, to the Grenoble Metropolitan area. However, this focus is integrated into a larger study on the evolution of the GrandAlpe area, to contextualise these landscape developments and to include existing and potential future historical studies.

2. Experimenting the "Ville-Parc" narrative co-construction

The Grenoble metropolitan area, who commissioned the master plan, is interested in our approach. Historical studies have been conducted, and others are ongoing. Furthermore, it is seeking to better define what makes the heritage of the GrandAlpe urban area, through a study commissioned by the Grenoble region's urban planning agency (AURG). They are studying how to mobilise historical knowledge at hand and how to translate heritage stakes into the 'Ville-Parc' master plan.

Our applied research provides a partial answer. It is based on the principle that the master plan is not intended to freeze a set of heritage requirements applicable to various short-term operations. Rather, it is intended to provide a framework for long-term discussions on heritage elements and that can enrich future projects. Historical knowledge is seen as a foundation that can interest and mobilise the many stakeholders in the area (three municipalities, multiple operators, etc.) and the community to develop a common project. The aim is therefore to co-construct a retro-prospective narrative (Sgard, 2008).

Concretely, this means providing historical information prior to any study and gathering feedback from stakeholders. The project is then developed on a progressive synthesis of these exchanges. They have so far been tested in the traditional setting of interservice workshops (uniting all the technical services of the local government), technical committees and steering committees, with the aim of diversifying these modes of exchange on the long term (urban tours, workshops with residents, etc.).

3. Structuring a historical reading associated with project insights

Developing a historical narrative is a conventional step in urban projects. They often include a section on the evolution of the area or an inventory of what already exists, such as the inaugural master plan for the Île de Nantes. (Chemetov, 2010).

However, our approach quickly raises methodological questions, given that this is an in-depth historical study that may incorporate additional heritage studies and is part of a cooperative project.

In other words, it involves organizing and interpreting in a specific way the vast body of work produced by the city historian: bibliography, photographs of the site, oral surveys, documents relating to ongoing projects and archive documents. On this last point, it is worth noting the wealth of material in the Bourne collection at the Échirolles archives and the École Nationale Supérieure du Paysage de Versailles-Marseille.

For this project, we have chosen to create an evolving document that includes:

- The definition of periods in the history of the territory to identify the main phases

- The use of landscape project tools to frame the collection, the graphic production and the interpretation of data

3.1. Three periods of territorial evolution and associated project guidelines

To better understand the open spaces of GrandAlpe and introduce Ingrid Bourne's landscaping, we consulted historical maps and aerial views as well as the main urban plans associated with this area. This led us to define three periods of evolution for GrandAlpe:

1. From the 19th century to the 1960s: the landscape of the flooded plain reshaped by water management structures and agriculture

2. Between the 1960s and 1980s: the urbanisation of Villeneuves, the ring road and the adjacent economic zones

3. Since the 1980s-1990s: urban renewal

This interpretation of GrandAlpe's geographical and historical foundations raises certain project ideas that were discussed during interviews that were conducted as part of the urban planning agency's heritage study: the territory of water (a former marshland with unique biodiversity), the surrounding farmland, and the public-spaces-for-all that began with the Villeneuves (Tixier and Bonnot 2025).

3.2. Entities and landscape motifs to identify elements that require intervention

For each of these periods, corresponds significant landscape entities resulting from natural and geographical dynamics (watercourses, wet meadows…) or anthropogenic dynamics (roads, slabs, parks, buildings, etc.).

To detail the different spatial configurations, we used landscape interpretation tools namely:

- Motifs, defined as a combination of certain landscape elements

- Landscape or geo-historical entities, as coherent and identifiable areas, and composed of several motifs sharing common characteristics in terms of ambiances

We are interested in this tool because it allows us to identify elements on which we can act within the framework of a project.

3.3. Producing an evolving document describing the evolutions of the territory

Our evolving document is therefore organised into three parts, each detailing the main periods of development in the area. These parts consist of:

- An introductory section (which may be revised) detailing the existing, lost or transformed landscape entities for the period in question, in relation to the geo-historical entities of the master plan. It is based on cartographic work on the GrandAlpe scale using Geographic Information System program (GIS), based on old maps, aerial views, and existing GIS data. Urban planning maps and written sources provide additional information to interpret the evolution of this territory.

- An evolving section detailing landscape entities relating to this period through fact sheets. These consist of a selection of mainly visual archive documents (old photographs, plans, sketches, etc.), which can be annotated and supplemented (photos of the existing situation, project plans). We have detailed these files with landscape designs by Ingrid Bourne. They can be supplemented with additional historical studies.

This document is not an end itself. It is intended to be a resource for producing historical interpretations and discussing them during the project process. This is how we tested it, selecting elements to present ahead of our discussions on the project. We will detail a few examples of how this evolving document can be used with the political and technical stakeholders involved in the project.

4. Focus on a few landscape entities and patterns and their use in the operational context

4.1. Water paths: Landscape patterns inherited from the 19th century to the 1960s

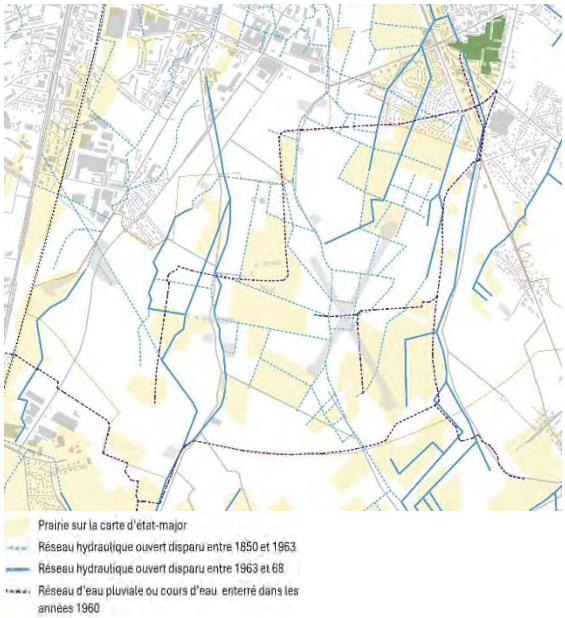


Figure 1. Map of the period 1850-1968: the agricultural and natural landscape before urbanisation

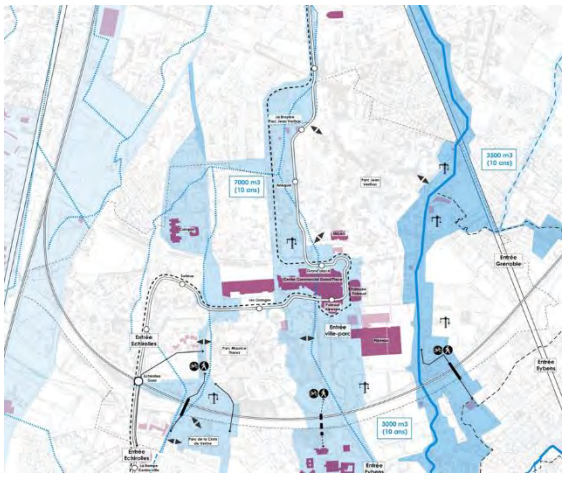


Figure 2. Map of 'water paths' entities

The introductory maps of the three periods of development of the GrandAlpe area were presented at a committee meeting with technical experts and local authorities.

The agro-natural period map enabled discussions on the topography, water management and associated vegetation. Landscape entities such as watercourses and ditches have been altered over time (Figure 1). The Vederet watercourse (located to the east) and the underground rainwater network that appeared with urbanisation are both close to their former historical path. In addition, north-south thalwegs, associated with roads leading to the town centre, have persisted over time.

This observation has made it possible to define entities known as 'water paths' (Figure 2), within which and open and landscape management of rainwater are to be established as part of policies to disconnect from the rainwater network. These spaces would allow the restoration of meadows and species native to the alluvial plain, creating new ambiances. While this principle is agreed upon by technicians, it raises implementation and management issues that are currently being addressed in interservice workshops.

4.2. Landscape entities and patterns inherited from the urbanisation of Villeneuves between the 1960s and 1980s: Infrastructures and inter-neighbourhoods' connections

The mapping of the evolution of the 1960s and 1980s has enabled us to discuss the landscape elements corresponding to this urban planning: road infrastructures (south ring road and Cours de l'Europe), deserted roads associated with car parks, buildings, slabs, galleries, and parks (Figure 3).

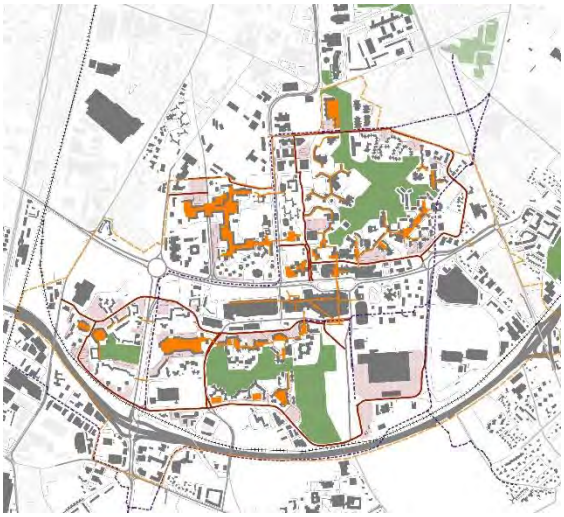


Figure 3. Map of the period 1968-1987: urbanization of the GrandAlpe area

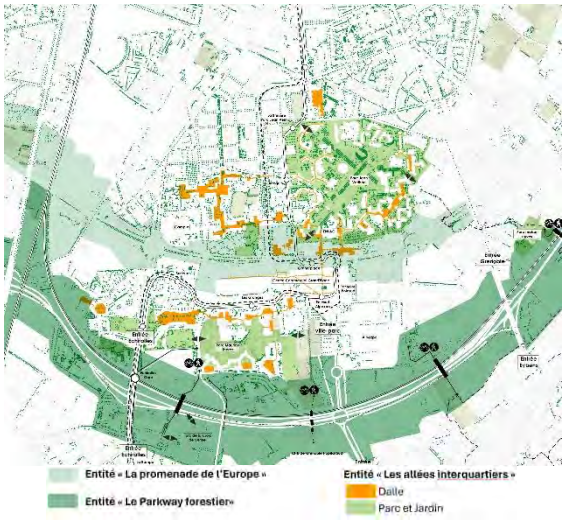


Figure 4. Map of the entities 'Promenade de l'Europe', 'Parkway forestier' and 'Everyday walkways'

These elements are interlinked in different ways depending on the operations and their date of construction. This creates a diversity of landscape patterns, which we propose to reconfigure in the master plan. Three geo-historical entities allow us to frame this work (figure 4):

- The 'Everyday walkways' entity's main stake is to enhance the qualities of the slabs and galleries, and to requalify the car parks and their access roads.
- The 'Promenade de l'Europe' and 'Parkway forestier' entities aim is to connect these infrastructures with the 'everyday walkways' (new paths and crossings), while developing the ecological network.

These principles are widely accepted by technical experts and elected officials because they are consistent with ongoing projects. However, identifying and describing in detail the history of landscape elements, which make up patterns and entities, leads to changes in the design of local projects, as we will see later.

4.3. Current reflections related to urban renewal since 80's-90's as part of the project

4.3.1. Cours de l'Europe

The historical study we have conducted on the "Cours de l'Europe" remains at this stage preliminary. It has enabled us to identify three main motifs that make up this route in the Bernard plan, with a western, central and eastern sequences (Figure 5).

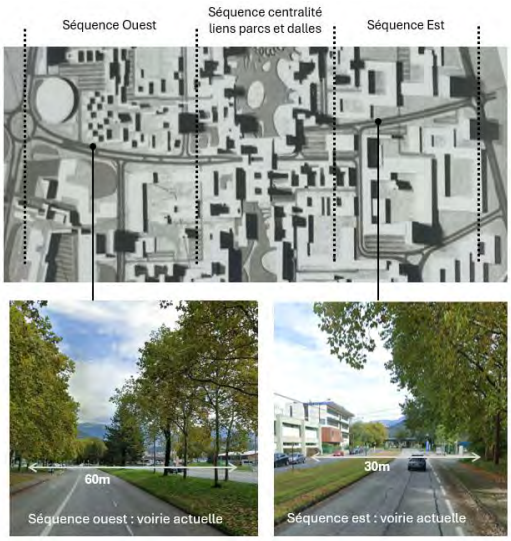


Figure 5. Scale model of the Bernard plan (André Zanassi, 1965) and current views of the Cours de l'Europe

These motifs and sequences are distinguished by contrasted widths, distinguished links to parks and different types of surrounding building implementation. Although the Bernard plan was not implemented as such, these sequences and motifs correspond to three distinct periods of works (from west to east: 1968-73, 1973-78 and 1978-83), and they all have singular atmospheres. Far from being anecdotal, this observation helped to define the division of study areas with the technicians, differentiating the qualities and issues specific to each sequence.

4.3.2. Pathways and developments for the future FabricAlpe project

On the western section of the 'Cours de l'Europe', the future FabricAlpe project aims to create links between this road and the 'everyday walkways' of 'Les Essarts'. As part of our project, we presented an archive plan by Ingrid Bourne and photographs of prefabricated elements resulting from her collaboration with Jacques Mati (Figures 6 and 7).

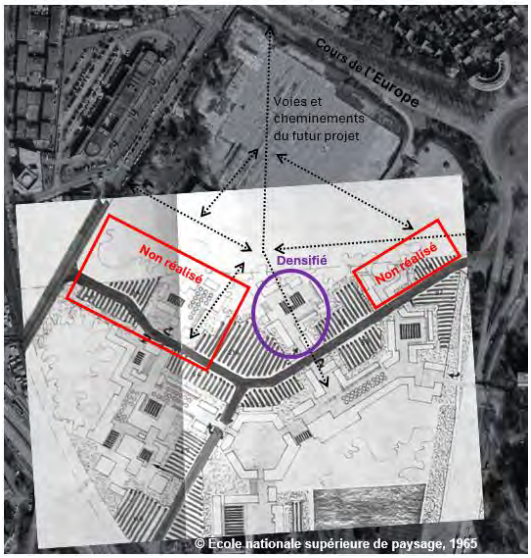


Figure 6. Extract from Ingrid Bourne's landscape plan for the Les Essarts neighbourhood, based on an aerial view from 2024, showing the routes of a future project.



Figure 7. Photos of prefabricated elements designed by Jacques Mati with Ingrid Bourne (left), and paving by Ingrid Bourne with initial sketches (right)

This approach has helped highlight the work of Ingrid Bourne, who was not known to the urban planners and technicians currently in charge of the urban renewal projects in this area. Considering ongoing projects:

- We highlighted the gain of creating a pedestrian link to the west of the urban territory, with a goal of orienting it more towards the residences located to the south-west. This link was included in Ingrid Bourne's initial project and makes sense for inter-neighbourhood connections to the Cours de l'Europe.

- We emphasised the value of the prefabricated elements in the residential area (retaining walls, paving, stairs, etc.), which characterise the landscape project designed by Ingrid Bourne for the Villeneuves d'Echirolles. These elements have begun to be demolished, but their preservation and/or reuse are project ideas that would be worth exploring considering environmental issues.

- We finally discussed the reconfiguration of the elements that make up the landscape motifs in this area, while paying particular attention to the existing tissue and to the design process for the Villeneuves. Following our discussions, it was agreed that we would include a section on heritage issues in the consultation document (open competition) for the selection of the landscape architect for this area.

4.3.3. Place de la Convention



Figure 8. Photographic evolution of Place de la Convention, landscape architect: Ingrid Bourne

The importance of developing the project based on the knowledge of existing landscape entities was strongly debated with technicians from various departments during the preparation of the master plan.

The photographic reconstruction of the Place de la Convention in the Essarts neighborhood at Echirolles provides a good example of this (Figure 8.). That can be easily observed:

- The disappearance of the graphic work created by Ingrid Bourne on the paving of the slabs, with the recent installation of asphalt surfacing.

- The disappearance of the contrasting facades that were alternating concrete and wood (echoing the materials used for the Olympic Village buildings), with the recent installation of white PVC joinery.

- The disappearance of the artwork that was in the centre of the square, which has been moved elsewhere in the neighbourhood.

The technicians recognised the loss of quality in this square. While economic constraints have undoubtedly played a role in this development, were there no other options available? These changes seem to contradict the environmental benefits of organic materials and the need for an image makeover in this unappreciated neighbourhood. Several ideas have been put forward to improve the situation in future, including:

- sharing historical knowledge throughout the project to preserve, reinterpret or restore certain qualities of the original 1960s–70s design.

- including a ban on PVC joinery in favour of bio-based materials in the next urban renewal funding contract.

4.3.4. Salvador Allende

Ingrid Bourne's work also concerns road infrastructures. In this regard, the presentation of a photographic evolution of Salvador Allende Avenue also caught the attention of the technicians (Figure 9).



Figure 9. Photographic evolution of Salvador Allende Avenue, landscape architect: Ingrid Bourne

They identified the challenge of improving links between the infrastructure and the parks in the surrounding area, in a context where shrubbery has closed off the landscape. Project ideas were discussed to be able to restore the visual transparency of the initial project, with the development of prairies and changes to vegetation maintenance.

These ideas are linked to the specific location of this avenue within the 'waterways' area. In this context, project principles have been proposed (Figure 10). The meadow areas could be extended to ensure aerial rainwater maintenance, while contributing to the de-impermeabilization of the infrastructure. Such a project could evoke the wet meadows of the agro-natural territory that existed before urbanisation. In addition, species related to the former alluvial plain would allow for the development of biodiversity and atmospheres specific to this territory.

This project proposal, which is intertwined with a historical reading of open spaces, illustrates how the plural memory of the territory can be mobilised in a future urban and landscape project.

Giving meaning to places and acting for socio-ecological transition

To conclude, we initiated this historical approach just under a year ago, at the beginning of an urban project that could last up to eight years. We therefore foresee multiple evolutions in our working methods, including:

- A deeper historical focus, for example on the history of Europe or on business parks, etc.
- Discussions with residents about the heritage of GrandAlpe, the details of which are yet to be defined: surveys, on-site tours, original graphic materials, etc.
- The use of old photographs in the Grenoble Alpe Métropole landscape photography observatory, given the effectiveness of these visuals in raising awareness, as we have seen with local stakeholders.

Nevertheless, beyond future avenues for development, we believe that some initial results are worth discussing.

The first concerns the contribution to a better understanding of the GrandAlpe area based on open spaces. We have placed the history of specific landscaping projects in a broader territorial context, which we felt was lacking in the historical studies we consulted. This has made it possible to see that Ingrid Bourne specifically identified landscape elements that are still present throughout the area: slabs, parks, etc.

The second result concerns the specific methodology of this research, given that it is linked to a complex project process. Our methodological framework is based on an interpretation by landscape entities and patterns, organised in an evolving document with diverse corpora. We believe this is a fruitful approach for producing knowledge about urban history, without resorting to heritage recommendations or prescriptions. We believe it is more agile and pragmatic to discuss historical knowledge about specific landscape elements that are subject to future transformation. This allows us to collectively define, on a case-by-case basis, the heritage element that is useful to the project. In this way, a retro-prospective narrative is gradually constructed.

The third result stems indirectly from the previous two. We felt that this applied research was essential to our work on this the project. Indeed, acting within the perspective of ecological transition requires us to take targeted, economical actions, while maintaining or reusing a significant portion of what already exists. For this transformation to be qualitative and give meaning to the place, a detailed knowledge of its history is necessary. In contexts where this knowledge is incomplete or has little connection with the project, a significant amount of historical research is therefore necessary to be carried out by architects, urban planners and landscape architects. Could this be the beginning of a shift in the contribution of landscape expertise to the project process? Shouldn't historical analysis at the crossroads of the methodologies of historians and landscape architects be developed in response to current environmental and societal challenges? Shouldn't such a historical approach be better integrated into the organisation and remuneration of urban projects?

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INTERGENERATIONAL COLLABORATION IN INNER CITY DUBLIN: METHODS FOR ECOLOGICAL RESTORATION.

TOPIC: Guiding cities through what is alive: cities as ecosystems (example)

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Keywords: Community-driven Approaches, Socially Engaged Environmental Art, Reconnecting Communities with Nature, Immersive fieldwork, Art as a Tool for Climate Action

Abstract

In the age of climate crisis, the need to develop innovative, community-driven approaches to ecological restoration in urban environments is undeniable. This presentation explores how socially engaged environmental art can serve as a catalyst for reconnecting communities with nature while addressing biodiversity loss, climate resilience, and public well-being.

Drawing from over 20 years of experience as an artist and landscape architect, Von Maltzan will present methodologies that integrate art, ecology, and community engagement. Her practice fosters intergenerational collaboration, encouraging diverse stakeholders—children, residents, artists and professionals—to work together in shaping more biodiverse and meaningful public spaces. The presentation will focus on two current projects in inner city Dublin: "A Greening Strategy for the Tenters" and "St. Anne's Road Pocket Park" in Drumcondra.

In the "Tenters", Von Maltzan is currently collaborating with local schools, nature experts, and resident groups to develop a greening strategy for the area. Through immersive fieldwork, creative exploration, and hands-on design activities in the neighbourhood, children engage with urban ecology, learn from botanists and entomologists, and develop their own improvement proposals. This participatory process not only enhances environmental literacy but also gives young people agency in shaping their public spaces— settings where their voices are often ignored.

Adjacent to the railway station, St Anne's Road Pocket Park in Drumcondra was initiated by the local community and Von Maltzan in 2015. Today, an unfenced biodiverse 'green' environment on a narrow site and diverse habitat for flora and fauna, it was hitherto an unloved strip of mown grass by a busy road. The pocket park is not gated and open to the public at all times. The local residents have formed a community group that maintains the Park. Von Maltzan remains closely involved, organising socially engaged initiatives in and around the park in partnership with the community.

Public spaces need not merely form backdrops for urban life but can be active, evolving ecosystems that can foster deeper relationships between people and nature. By embedding artistic and ecological thinking into urban design, we can create more resilient, inclusive, and biodiverse cities—ones that are shaped not just for communities, but by them.

In her presentation, Von Maltzan will ask what are the best practices for integrating environmental art with urban greening efforts? How can ecological and social priorities be balanced, securing institutional support, and sustaining long-term community engagement? And how can these methodologies can be adapted and scaled for use in other urban and rural contexts?



Figure 1. Children from St. Catherine's School, Dublin 8 exploring the area with an Entomologist



Figure 2. School children exploring the area with an Entomologist



Figure 3. Drawing an insect inventory



Figure 4. Drawing an insect inventory



Figure 5. 8-year-old children from Scoil Treasa Naofa building Willow Installations in a public park



Figure 6. 8-year-old children from Scoil Treasa Naofa building Willow Installations in a public park



Figure 7. The children building models showing their improvement proposals for the neighborhood



Figure 8. A model showing a proposed texture rich imaginary play space



Figure 9. A model showing a proposal to improve the local public park



Figure 10. A model showing a proposed adventure space for the local neighbourhood

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Short papers

TOPIC 1
Guiding cities with society: Participatory approaches and governance strategies

The Likoto Project : Guiding European cities by their Infrascape

Topic: Guiding cities with society: Participatory approaches and governance strategies

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Keywords
Keyword 1: Infrastructures
Keyword 2: green grid
Keyword 3: Ecological planning
Keyword 4: Europe
Keyword 5: Landscape

Abstract
The Likoto project is delt since 2011 by a scientific team including landscape architects, geographers, ecologists, anthropologists as well as engineers, architects, reporters and photographers. It aims to create a dense green grid by using the aforestations, wastelands and other abandoned sites that can be observed along the great transport infrastructures network. Indeed, those unconsidered environments have often become important refuges for the regional flora and the urban biodiversity, as well as for social practices forbidden into the cities (like dwelling, camping, prostitution...) or not (walks, running, cycling...). They introduce large strips of woods and meadows into the cities and are often considered by their inhabitants as a complete part of their usual landscape. They are also an important ressource for wood extraction in order to produce energy but also wood for construction.
By mapping such unseen green grids and by increasing their ecological, urban and landscape potentialities, the Likoto project experiment a new way of governing the great ecological infrastructures required by the climate change. Instead of trying (without success most of the time) to create new green infrastructures by planning them, we propose to transform the effective native green grids that have spontaneously grown where nobody could expect them! Strangely, the great infrastructures, which have often destroy natural areas and important cultural landscape have also create the condition of a new kind of "infrascape" that we must be able to think and design as an important aspect of the ecological transformation.
From 2011 to 2024, this project has concerned the territory of Likoto (Eurometropolis Lille-Kortrijk-Tournai) between France and Belgium. This laboratory has help to confirm most of the team's intuitions. It has also permit to organize a set of building sites to experiment new ways of maintenance for those environments. It has shown that a multifunctional maintenance of those environments could bring benefits to the infrastructures authorities, although at this time they have to pay for it.

This approach of landscape governance could be enlarged at a much higher scale. A recent research travel through Europe has permit to present this approach in many Landscape architecture schools and to understand how each cultural area in Europe develop its own way of living with its infrascape. This complexity is also an occasion to improve the Likoto project. On this basis, we think that this great and very simple landscape project could inspire the idea of an European Spontaneous Green Grid, whose ways of governance are to be discussed.

Text

1. Introduction

1.1. Likoto is a scientific and a pluridsciplinar team which has grown since 2011 in order to create a linear forest through the area of the Lille-Kortijk-Tournai Eurometropolis.



Figure 1. The Likoto Team in 2023

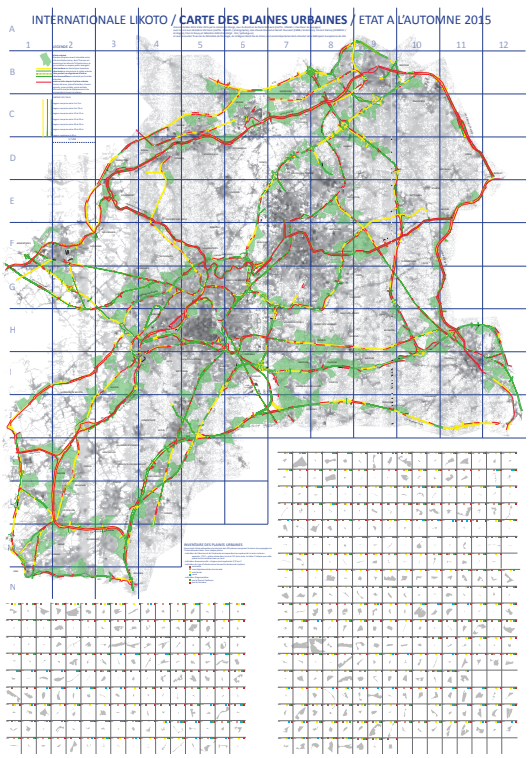


Figure 2. Map of the Likoto Spontaneous Green Network

1.2. This linear forest is thought as a complement, or maybe an alternative to the green networks that most of the urban areas try to create since the last decades in order to struggle against the biodiversity collapsing, and to impulse by the same way an efficient network of green areas and slow mobility links through the urban environment, which is highly cut by the great infrastructures.
The green networks' projects have trouble realizing because the green continuities that structure them depend of a large and expansive mastery of the ground property (1 / Delbaere 2010, 2013, Delbaere, Grandjean & Nageleisen, 2022).

1.3. Likoto proposes to overtake this problem by basing the green network not on an abstract planning but on the existing landscape. Now, what shows a native green network though the townscape? The answer appears thanks to satellite views: urban and mainly suburban areas are crossed by long woody strips and by linear lawns of grass and shrubs which have spontaneously grown, sometimes on the basis of initial plantations, along motorways, railways, high speed line and canals.



Figure 3. Google Earth view of one representative part of the Likoto Network

2. Aspects of the Infrascape

2.1. Indeed, the building of those infrastructures, mostly during the second part of the 20th century, has concerned huge areas, which have became public properties, but 80% of them

are abandoned fields without other utility than linking the artifact level to the natural one, in the form of slopes, embankments, verges, basins or acoustic mounds (2 / Delbaere 2018).

2.2. The Likoto Eurometropolis is an ideal place to observe this phenomenon because here the spread city has been built into an huge European node of 650 kilometers infrastructures, that is to say 1300 kilometers of verges and 2000 hectares of urban public ground already wooded for half of them.

2.3. Since 2011, Likoto realizes a cartographic survey of this « spontaneous green network » and evaluates its effective and potential qualities, which are of several kinds (3 / Delbaere et alii, 2015).

2.3.1. From an ecological point of view, those woods contribute to the carbon trapping, the dusts' fixation and the regulation of urban climate. But they also constitute important refuges for plants and animals biodiversity in high-artificialized areas. At this day, the Likoto's botanists and ecologists have identified more of the third of the regional natural flora on only 25 places of observation through the spontaneous green network (4 / Ferrand 2017, Lemoine, Deconchat 2012, IENE 2014, Muratet 2017).



Des habitats diversifiés, de la pelouse au bois

Figure 4. Aspects of the Likoto's ecological habitats

2.3.2. From a social point of view, the green network spreads numerous informal public spaces, used for social practices as various as walks, often with dogs, but also running, biking. It is an important place for illegal social practices that cannot take place in the city, like temporary housing, camps, rubbishes, street art, urbex, drugs or prostitution.

All those actions slowly transform those places, creating thin tracks and little buildings made with materials from the sites.



Figure 5. Aspects of some of the Social practices that can be observed in the Likoto Network

2.3.3. From the urban point of view, inhabitants identify those landscapes as part of their environment, protecting them from the noise and bringing a beautiful green frame for their dwelling. They also are crossed by foot to link the stadium, the school, the nearest park or other huge equipment that have been built far from the city because of their size (5/ Delbaere 2014, Lion 2015, Mahey 1999).

2.4. So then, and strangely, it appears that the great infrastructures, which are responsible of the urban fragmentation, of the social segregation and of the biodiversity collapse, have slowly became the potential support of an efficient green network, linking ecological, social and urban services. Those links create a complex environment, nor natural neither urban that Likoto calls the Embankment Ecosystem, that is to say the main place of urban sociobiodiversity.

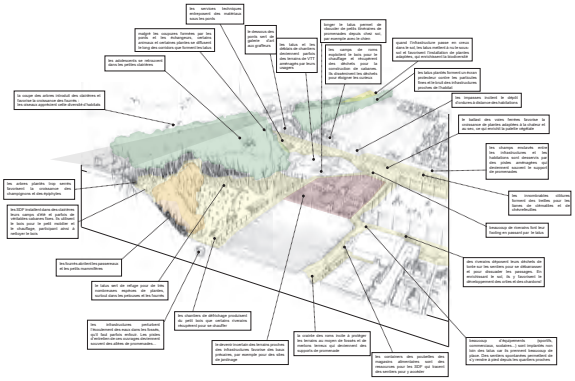


Figure 6. Axonometric view of the Embankment Ecosystem

2.5. The density of those social and biological interactions comes from the fact that the Likoto's very diffuse urbanization boosts a deep relation between urban areas and infrastructures, which are separated only by some hundred meters of fields, wastelands and big equipments. Likoto has identified 419 of those « urban plains » that should be considered as the seeds of a future Landscape city parks (6/ Delbaere 2019, 2023).

3. A projet through research : the linear forest

3.1. Likoto's work has included new goals since 5 years because of the intern dynamics of change into the spontaneous green network (7/ Delbaere & alii, 2024). The plantations and the spontaneous growing of trees are not very maintained by the infrastructures services. Most of the time, they just maintain the nearest strip beside the roads and railways, ant let the trees grow freely faraway. But time after time, those woods have become unstable. Because they have been planted to tightly, they have grown withered and threaten the infrastructure users' security. An important part of delays in train stations is due to falling branches on railways, and some motorways, especially in Belgium, are potentially concerned by those problems.



Figure 8. Usual aspect of the unmaintained aforestations

3.1.1. To solve them, the French Rail Society has radically decided to cut all the trees on a 15m strip beside the railways, and the Lille Metropolis District starts to do the same. But such solutions must face several problems.

3.1.2. First, by cutting trees without stubbing up them, they stimulate the trees to grow more quickly, forming dense an unstable thickets. The positive result of such actions can be felt only at short time, and quickly brings the necessity to command other of those expansive and complicated works, that highly disturb the traffic. Second, those cuttings degrade the biodiversity and increase the urban heat. Third, they causes the inhabitants greed, as they don't understand why the trees that protect them from noise and smell are cut, especially as they find them beautiful. And last, those cuttings destroy a precious biomass, sometimes used for energy production, but which often could serve for construction.

3.2. Because of those problems, Likoto has been missioned by the Ministry of Ecology to experiment new ways of maintaining those woods, able to link, even to enlarge, their security and the different services they bring.

3.3. In the Belgium side, a maintenance protocol has been voted and is used by the plantations regional district whose director is a member of Likoto.

3.4. Additionally, Likoto is actually managing around ten sites and leads 5 experimental building sites. It aims to bring selective cuttings and to keep the well growing trees. The subsequent enlightment of the ground brings the growing of young trees to make the wood durable, while it can receive more diverse species of shrubs and herbs.



Figure 9. Views of the wood extraction's building sites

3.5. At the same time, those works, which are realized with manual tools from the outside border and the neighboring districts, needs the opening of new tracks and entrances to the woods. These tracks and entrances reinforce the social use avec the sites, which sometimes become some new close public spaces.



Figure 10. Views of the Informal public spaces' building sites

3.5.1. The linking of those tracks with the others makes us dream about the creation of a long pedestrian and cycling sideway following the complete network of infrastructures, as an alternative to the car driving. Additionally, the creation of public paths concentrates the public use into precise parts of the woods, and preserves the rest as sanctuaries for flora, fauna and marginal social practices (8/ Delbaere, 2019).

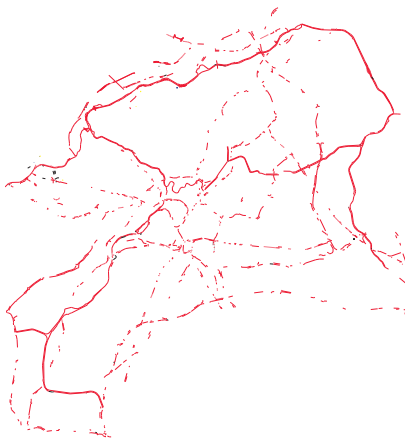


Figure 11. Map of the existing tracks in the Likoto Network

3.6. The wood extracted from our works is reemployed into the site itself for little buildings, or it is distributed to the neighborhood as heating wood. When we product large quantities of wood, it is burnt into collective boilers. Likoto tries to make the linear forest become a major tool for the increasing of renewable energies in the Northwestern European bioregion (9/ Delbaere, Lacoste, 2023, Delbaere 2023, MEL 2020).

3.7. The team has already demonstrated that it is possible to use the logs as construction wood. Thanks to the workshops of the Lille Landscape Architecture School, where 3 of the team members teach, we have experiment construction dispositive adapted to such thin, twisted and wet logs. We have recently achieved a 10 meters long footbridge which is to be placed at the entrance of one of our worksites.



Figure 12. Views of a footbridge construction

3.8. Time after time, the spontaneous green network's status is changing. Our work uses knowledge and savoir-faire from forestry, and the spontaneous green network is now described as a linear forest that we are to protect by making it better known by its inhabitants and users. Indeed, those woods are sometimes threatened by urbanization, and the Likoto's goal is to have them officially protected by the eurometropolitan planning (10/ Bianchi, Delbaere 2020). To increase the knowledge of this strange forest, we are drawing since several years a very precise atlas whose maps could help the inhabitants to find their way under the trees. Those figurative maps localize the existing tracks, the side itinerary to

follow when the tracks are cut, as well as the new segments that should be built. The atlas is at the time a precise description of the linear forest, and a Landscape project for it to get completed (11/ Cortazar & Dunlop, 1983, Ehrmann & Delbaere, 2015).

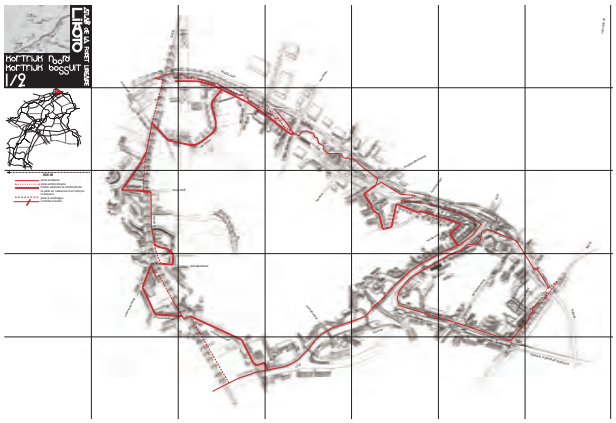


Figure 13. One map of the Likoto Atlas

4. How it works

4.1. Likoto Team strives for becoming a current consulting for the infrastructures services an the regional authorities.

4.2. Her works are funded by research contracts of the Ministry of Ecology, with the help of local districts that bring the properties and sometimes joint their own building sites to ours.

4.3. Those building sites are lead through teaching works, training teams of new Landscape architects in the Lille Landscape Architecture School and in the Forestry school of Bavay.

4.4. The team is composed by a dozen researchers coming from disciplines as different as Landscape architecture, urban planning, ecology, architecture, engineering, pedology, botanic, mycology, anthropology, geography, arts.



4.5. This huge pluridisciplinarity's energy is friendship. That's why the team meets twice a year for « scientific trails » during 3 days, along the great infrastructures (12/ Grousseau 2016, Delbaere & alii, 2018, Biehler & Steenhuyse, 2023). Those key moments make the research grow up, as trees do along the motorways.

Figure 14. View of a scientific randonnée along the Likoto track

5. Conclusion : toward an European Spontaneous Green Network

5.1. Such an approach of landscape governance could be enlarged at a much higher scale. Europe is particularly concerned by this topic because it is crossed from one part to another by an incredibly dense network of highways and of railways. And if we admit that the efficiency of the green infrastructures depends of their size, why not improving the Likoto project to such a scale? But from a different point of view, is it possible to reproduce the same project in the so different geographical, ecological and cultural European areas?

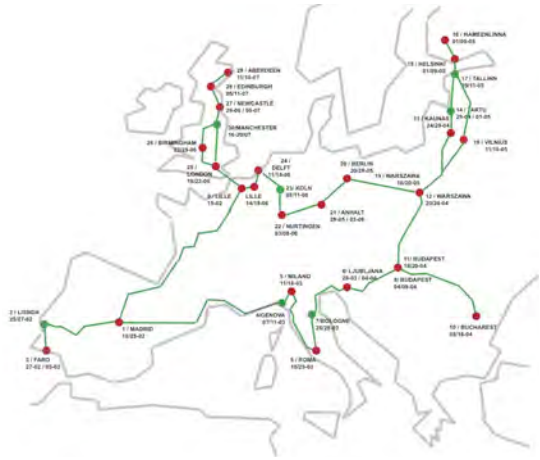


Figure 15. Schematic map of the World Highway Network

5.2. That is to experiment this hypothesis that I have realized a long time research travel through Europe during February and July 2025. I have crossed 17 European countries and 26 of their main cities by bus.

Figure 16. Travel map

5.3. I have maped more than 13000 kilometers of the European infrascape and in each city I have organized long walks through the slopes and the tracks in order to understand the



particularities of each local infrascape. Experimenting an efficient way of mapping such large landscapes seen from the road at 100 kilometers per hour has been one of the big challenges of this trip. A continuous sketch of the slopes, embankments and appearing landscape has been drawn and then after transformed in strange maps mixing planimetric map and sections.

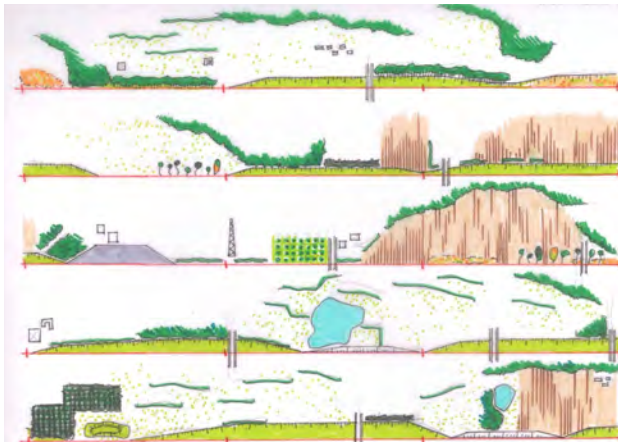


Figure 17. Example of map

5.4. The result shows the incredible diversity of those landscape situations, but also how people and local authorities have already started to transform those places in useful green infrastructures.

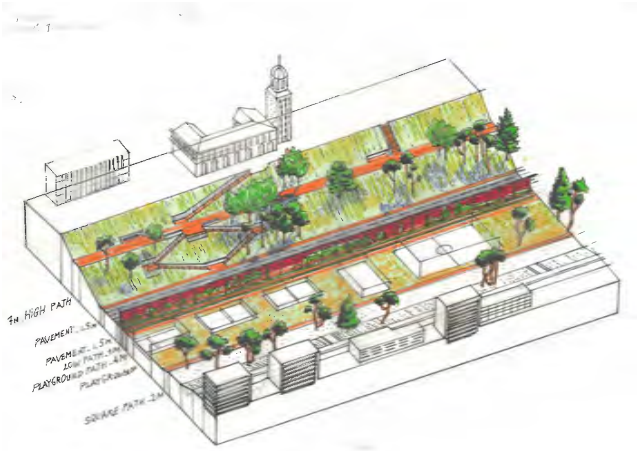




Figure 18. Some axonometrical views of different European infrascapes

5.5. This surprising survey will be presented during a European symposium that I have started to organize, and I unfortunately don't have the time here to describe so different situations.

5.6. But the fact that so many projects have already been started shows that it would be almost simple to make them more readable by gathering them in a collective high scale landscape project that should become one important aspect of the European Union action for the renewal of Landscape and an effective ecological transformation of our countries.

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NEW STREETS FOR VIENNA

TOPIC: Guiding cities with society: Participatory approaches and governance strategies

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Keywords: urban streets, urban heat effects, climate justice, climate adaption

Abstract

This contribution focusses on the transformation of dense inner city quarters towards climate justice. In Vienna, data show increasing urban heat effects in the context of climate change for many historic working class neighbourhoods. Some parts of the urban population are more vulnerable than others: neighbourhoods with little green infrastructure, small children, elderly and people with chronic illnesses, manual workers and persons with low socio-economic status suffer from urban heat.

This was the starting point of a research on urban climate justice in an interdisciplinary cooperation of the landscape planners of tilia with traffic planners from con.sens mobilitätsdesign funded by AK Vienna. A vision for climate resilient streets was worked out, based on analyses of the current situation in Vienna and strategies of the City of Vienna to minimize urban heat. In addition, innovative approaches of other European cities were collected. Five new street typologies were developed, with space for active mobility, play and rest, with trees and spacious shade, with concentrated underground technical infrastructure and minimized sealed surface. With "New Streets for Vienna", a systematic transformation towards climate justice is proposed and visualized on the example of two selected neighbourhoods.

Building on these outcomes, tilia has worked on several projects for the City of Vienna: A handbook for cooling measures in public space, developing concepts for public space in several inner city districts and planning projects of new Viennese streets.

To meet raising summer heat, Vienna has started to change its streets by reducing space for cars and by providing streets with greenery, places to rest and play. The urban development plan `Der Wien-Plan STEP 2035´ has a special focus on climate and aims to reduce sealed surfaces of streets. The future will show if a systematic change of streets will be realized.

1.1. Introduction

In Vienna with its continental climate and very densely built historical city quarters climate change and urban heat phenomena are clearly recognizable: The average temperature has risen by almost 2°C and in summer 2024 more than 40 heat days with more than 30°C have been reported. This effects livelihood in the Austrian capital. Some parts of the city and of the urban population are more vulnerable than others: neighbourhoods with little green infrastructure, small children, elderly and people with chronic illnesses, manual workers and persons with low socio-economic status suffer most from urban heat. Data of the City of Vienna document influences of climate change (1) and clearly show increasing urban heat effects in many historic working class neighbourhoods. This was the starting point of a research on urban climate justice (2) in an interdisciplinary cooperation of tilia and the traffic planners from con.sens mobilitätsdesign funded by AK Vienna, an organization representing the interests of Austrian employees. The aim was to develop a vision for climate resilient streets for historic city quarters. Streets are public property and the biggest land

reserve for climate adaption in dense inner city neighbourhoods, in some cases street surfaces reach 25% of the total area of a district.

The research worked with a mix of methods including an analysis of historic plans, photographs and planning literature on streets, street surveys (two selected neighbourhoods, best practice in Vienna), of climate and traffic documents (city, political parties) and expert interviews with decision makers in the planning administration. An internet search revealed international best practice. The chosen examples were analysed via documents and online expert interviews. The vision of new streets for Vienna is based on a triangulative combination of these findings. Finally, the authors reflect on the planning expertise of tilia and on recent climate adaption approaches of the city of Vienna.

After this general introduction, the findings of the research project are described:

1.2. New Streets for Vienna

The research started with an analysis of the history of the streets in two Viennese neighbourhoods which are strongly affected by heat phenomena, with many children and elderly people and a population with lower income. Compared to other European metropoles, the Viennese grid of streets going back to the 19th century consists of narrow streets, reaching from 15 to 23 m and a pronounced street hierarchy. Until the middle of the 20th century, the streets used to be multifunctional public spaces. At that time, a change of mobility started and national traffic laws in the 1960s privileged the requirements of car traffic. Space for the differing interests is scarce and until today it is difficult for the city to change the spatial use of its streets.

To get additional inputs for the local discussion towards a transformation of urban streets, innovative approaches of other European cities (London, Paris, Valencia and Vitoria-Gasteiz) were collected. The international experiences show that a clear strategy of the city to reduce car traffic and sealed surfaces and to raise the percentage of greenery is crucial for a transformation process towards climate resilient streets. For a successful transformation it is necessary to collaborate with the urban population. And in order to prevent tendencies of gentrification, changes should be undertaken in the whole city.

With "New Streets for Vienna", a systematic transformation towards climate justice is proposed, offering cool urban space, places to stay, rest and play and space for active mobility and reduced car traffic. Figure 1 shows a cross-section of a typical historic street, after the dark asphalt surface has been changed: Greenery provides shade in summer and allows precipitation to drain into the ground. Cooler surfaces, evaporation and an exchange of air contribute to a better microclimate. Concentrated underground technical infrastructure leaves space to plant trees. Sealed surfaces are necessary for mobility, but they are reduced to a minimum.

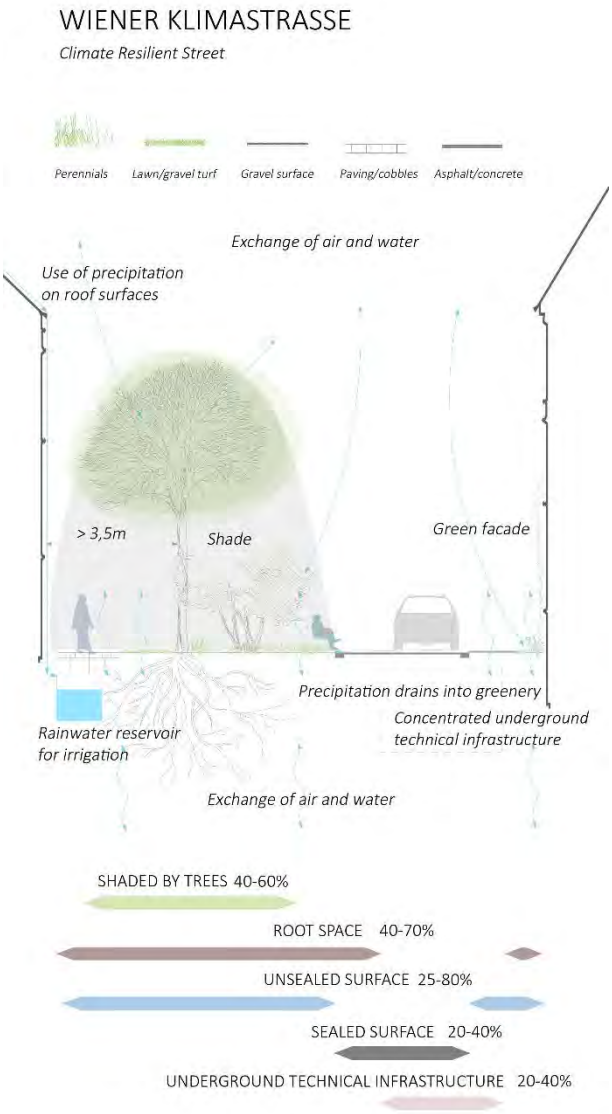


Figure 1. Vision of a Climate Resilient Street. (tilia)

Five new street typologies for streets with different functions in urban neighbourhoods have been developed, for shopping promenades, main streets for transit and transport, green and urban

neighbourhood streets and streets for local (motorized) traffic. The introduced street typology has been tested and visualized on the example of two selected Viennese neighbourhoods.

The biggest challenges for the transformation of streets in Vienna are the topics car parking and financial questions. Data on the exact number of cars and free lots in garages could help to take pressure out of the emotional debate on parking lots in public streets. And measures towards a reduction of car traffic help to lower the need for parking lots. Concerning the costs for new streets it is important to use synergies and to recognize that street infrastructure is renewed every 30 years. A transformation step by step is possible if climate adaption is in the focus of all street project within a city. In order to spend money efficiently, bigger projects should be realized in areas of urban heat islands in poorer neighbourhoods because there many people have little possibilities to compensate summer heat.

Finally, next steps towards climate resilient city streets were proposed:

- An attractive idea is crucial to make the positive effects of a transformation of the streets and the benefits of a climate resilient city visible for the Viennese people.
- A change of traffic organisation of the city with a focus on better public transport, active mobility and the reduction of parking lots in public space allows to develop the potential of streets for a cool microclimate in dense urban quarters.
- Projects in cooperation with the people living and working in the city quarters allow to develop locally based transformation processes of neighbourhoods.
- Cool spaces in all parts of the city should be realised together with the local people to support good livelihood in summer heat and a climate just Vienna.

The findings of the research have been published, discussed in public and at planning and traffic conferences. The representatives of AK Wien also had exchange meetings with decision makers of the city.

1.3. From Visions to Urban Space

The knowhow of the research project has proved to be a valuable basis. tilia continued to work towards new streets, and the studio for landscape planning was contracted by the City of Vienna with several climate adaption projects:

A handbook with examples for cooling measures in public space (3) was worked out together with the city administration. This `COOL-ing Fibel´ aims to raise awareness of decision makers for the importance of climate adaption and shows how they can contribute to better living conditions in hot Viennese summers.

A systematic approach towards a cooler urban environment was a developing plan for public space in three inner city districts (4), including a net of green and cool streets for active mobility and a basis infrastructure of cool neighbourhood spaces.

tilia also participates in the transformation process with planning projects of new Viennese streets in working class districts: Reinprechtsdorfer Straße (5) and Simmeringer Hauptstraße (6), (7). The streets are equipped with new trees providing shade and cool spaces, with spacious flowerbeds that contribute to a colourful street and to evaporation. Drinking fountains and water elements allow to get refreshed on hot summer days. Benches and play elements invite to stay longer outside. The bright pavements contribute to a better albedo-effect. It has proved to be one of the biggest challenges to reduce sealed surfaces. In the planning processes with the departments and politicians in charge of street infrastructure it has been very difficult to reach over 10% of unsealed street surface. The change of the physical structure of a street which does not give priority to the requirements of cars is hard professional work which requires inspiration, innovative solutions and many compromises.

During the last years, the City of Vienna has developed a set of strategies to meet climate change and to minimize urban heat, including new concepts for streets. Vienna's excellent public traffic and its bicycle infrastructure are extended. The city has started to reduce space for cars and to equip streets with greenery, places to rest and play. The recently passed urban development plan `Der Wien-Plan STEP 2035´ (8) has a special focus on climate aspects and includes a strategy for systematic climate adaption measures, starting in historic urban quarters where population groups live who are struck most by urban heat effects. It does not aim to change the whole grid of urban streets as we proposed in our research. But in a long term perspective, all streets should get more

than 15% unsealed, green surfaces. In addition, it introduces a new street typology, the "Vienna Garden Street" for hot and dense urban quarters.

1.4. Conclusions

For Vienna, data depict recognizable urban heat effects for many parts of the city and they are predicted to increase due to climate change. Street infrastructure can contribute to better living conditions, especially in dense inner city districts. On a strategic level, city development documents supporting climate resilience have been decided. Many recent street projects include infrastructure for active mobility, cooler surfaces, greenery, water elements and places to stay. The future will show if a systematic change of streets will be possible: Will hot poorer neighbourhoods get cool spaces first? Will active mobility get a close-meshed grid of cool, green connections? Will a more sustainable use of water resources be realized? And will the city contribute with new street typologies and less sealed surfaces to a better climate? In 2025, the financial situation of the city has become more difficult, the pace of change is already slowing down, but the direction towards climate adaption has been fixed.

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THE SHEFFIELD STREET TREE PARTNERSHIP: PARTICIPATORY URBAN FOREST GOVERNANCE IN A DIVIDED CITY

TOPIC: Guiding cities with society: Participatory approaches and governance strategies.

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Keywords: Urban Forestry, Street Trees, Participatory Governance, Climate Resilience, Civic Trust

Abstract

In its recent past Sheffield saw poor decision-making lead to poor street tree management which in turn led to civil unrest (Dempsey, 2023). Sheffield City Council received an increasingly acrimonious response from residents angry about how street trees were managed. In response, a new governance model was developed: the Sheffield Street Tree Partnership (SSTP). This partnership represents a transformative approach to urban forest governance - one that fosters civic trust, integrates diverse expertise, and prioritises climate resilience and community participation.

This paper explores how the SSTP provides a model for participatory governance that moves beyond traditional municipal decision-making structures. The SSTP brings together local government, private contractors, academics, and community representatives to co-develop strategies for the long-term management and expansion of Sheffield's urban forest. This governance model has facilitated consensus-building across its membership and is in the early stages of addressing long standing inequities in tree distribution across the city. This is particularly important in areas of lower socioeconomic status where tree cover and thus ecosystem service benefits are disproportionately lacking. This focus on tree equity goes beyond the tree management arrangements in place before SSTP, demonstrating an ability to respond flexibly to the city's needs as expressed by its wide membership and interests.

The paper will focus on a key output of the partnership, the development of a **Spatial Street Tree Palette**, a tool designed to guide strategic tree planting in Sheffield's streetscapes. Unlike conventional species lists, this palette will integrate ecological, climatic, and social considerations into decision-making. By focusing on spatially responsive planting strategies, the tool aims to:

1. **Enhance Climate Resilience** – By guiding the selection of species that will thrive in Sheffield's projected climate future, accounting for hotter summers, wetter winters, and increased pest pressures.
2. **Promote Social Equity** – By supporting initiatives that address disparities in tree distribution to ensure all communities benefit from urban greening.

3. **Maximise Natural Capital** – By aligning tree planting efforts with broader ecosystem restoration and urban biodiversity objectives.
4. **Foster Community Empowerment** – By providing a transparent, evidence-based framework that allows residents and community groups to engage in decision-making processes.

This paper situates the SSTP's approach within broader governance and participatory planning discourses. It examines how a co-created governance structure has enabled the city to move beyond conflict and toward a shared vision of urban resilience. Drawing upon participatory workshops and targeted stakeholder engagement, the paper demonstrates how participatory governance, that emphasises collaboration, knowledge exchange and co-production, can facilitate systemic change in urban tree management

The findings show that the Sheffield model holds lessons for other cities facing similar challenges. This includes how achieving 'success' or 'progress' is not only a function of appropriate planting strategies but also of effective governance frameworks that enable change.

This paper concludes by reflecting on the next steps for the SSTP, including the implementation of the Spatial Street Tree Palette. The Palette is a potentially replicable framework for cities globally, illustrating how participatory governance strategies can transform urban forest (street tree) management in the face of climate change.

1.1 Introduction

1.11 Sheffield's urban forestry story is one of civic division, institutional mistrust, and ultimately transformation. In the early 2010s, poor decision-making and opaque governance led to the felling of **c.5,700** mostly healthy street trees under a Private Finance Initiative (PFI) agreement between Sheffield City Council (SCC) and its contractor, Amey. This **25-year** citywide improvement programme runs from 2012–2037. The public backlash was intense, culminating in protests, arrests, and a significant breakdown in trust between residents and the local authority [1]. This paper explores how the Sheffield Street Tree Partnership (SSTP) emerged from that conflict as a new form of participatory governance, prioritising transparency, co-production, and consensus building to improve street tree management and support climate-resilient planting.



Figure 1. Protestors in Sheffield – Mail Online (14 December 2018) https://www.dailymail.co.uk/news/article-6494643/Sheffield-tree-protest-victory-300-saved-council-cuts.html [Last Viewed 30 June 2025]



Figure 2. Felled trees in Sheffield - BBC News (5 June 2018) https://www.bbc.co.uk/news/uk-england-south-yorkshire-44369606 [Last Viewed 30 June 2025]

1.2 Background

1.2.1 The PFI model used in Sheffield outsourced street tree management according to a contract not publicly available, without robust public engagement or scrutiny [2].

1.2.2 Healthy, mature trees were often removed not because they posed a risk (e.g. diseased), but because they conflicted with highway maintenance and were treated as infrastructure assets like lampposts or bollards.

1.2.3 In this model, instead of developing solutions to retain or work around them, mature trees were felled, followed by a young tree replacement programme. The public saw this as a threat to the city's identity and wildlife, undermining decades of environmental action [1]. Activists, campaigners, and residents protested the felling, sometimes physically preventing removals.

1.2.4 A later public inquiry confirmed that this unrest stemmed from a failure to engage meaningfully with stakeholders and to balance ecological, infrastructural, and social priorities [3].

1.2.5 Existing models of urban forest governance failed to resolve this conflict. Business as usual, led by SCC as client with Amey as the contractor, was perceived to be politicised, and technocratic, resulting in an escalation of the conflict. Sir Mark Lowcock's independent inquiry into the Sheffield Street Tree dispute (2023) described the Council's behaviour as "…a serious and sustained failure of strategic leadership". The consequence was that "people on all sides suffered anxiety, stress, injuries and wider physical and mental health problems.". Many of these effects remain evident today.

1.2.6 Mediation facilitated by the Right Reverend Peter Jonathan Wilcox, Bishop of Sheffield, highlighted the need for a governance framework capable of managing conflict and enabling systemic change.

1.3 The Sheffield Street Tree Partnership (SSTP) - Origins and Formation

1.3.1 Following years of dispute, a panel set up by SCC and chaired by the Sheffield and Rotherham Wildlife Trust (SRWT) brought together opposing actors to agree a pause in felling,

1.3.2 One of the three core aims that the Sheffield Tree Action Group (STAG) brought into negotiations was the creation of a citywide Street Tree Strategy. Their objective was to prevent a repeat of past failings by committing all parties to transparent, fair, and robust street tree management, and ensuring that any departure from such standards would require explicit justification. This objective became a shared goal that laid the groundwork for a broader vision.

1.3.3 The co-creation, public consultation, and publication of the Street Tree Strategy (2021) marked an important milestone in the dispute. It aligned the Council's operational requirements with a broader commitment to engage effectively and transparently. It also monitored outcomes and considered public views and research on street trees' role in climate resilience and equity.

1.3.4 This early partnership work, steered by independent actors, enabled campaigners and officials to voice opinions and debate without returning to dispute.

1.3.4 A willingness to engage in open dialogue, underpinned by the principles of 'fairness' and 'transparency', moderated by independent parties setting the agenda and tone of debate led to formal recognition of the SSTP in 2021. This was laid out in the Partnership's terms of reference [4].

1.3.5 Today the SSTPs core members include SCC, Amey, STAG, academics from the University of Sheffield and Sheffield Hallam University, The Woodland Trust, a representative from the Sheffield Street Tree Wardens, and an independent data analyst. The SSTP continues to be chaired by an independent chair, supported by a dedicated Partnership Manager.

1.3.6 The SSTP operates through consensus. While each partner remains embedded in their respective institutions, they commit to a shared, transparent decision-making process grounded in deliberation and mutual accountability. Decision-making draws on lived experience, technical knowledge and legal context. Unlike tokenistic consultation, this model fosters meaningful collaboration, debate and accountability. This meant change for the original stakeholders in the client-contractor model. Council officers had to relinquish control; Amey had to commit to

open decision making. Additionally, civic actors had to stop protesting and engage constructively. This "co-governance" model marks a departure from the hierarchical practices that had fuelled conflict.

1.3.7 Rules of engagement that emphasise mutual respect, shared responsibility, and mutual support have been formalised into a Partnership Charter, and meeting minutes are made public via the Partnership's website [5].

1.4 What Makes this Model Effective

1.4.1 The SSTP model contrasts with other cities where tree felling has occurred. In some cities, felling is often done on a rolling basis, perhaps in a piecemeal area-by-area manner with notifications pinned to trees. In this case, any resistance is dealt with locally. Often, it doesn't arise due to short lead times and lack of resident capacity to respond.

1.4.2 The SSTP model also contrasts in towns and cities where similar unrest has occurred. Street tree conflicts often follow a familiar pattern: technocratic management, civic resistance, media scrutiny, and reactive policy shifts.

1.4.3 Plymouth is an example of this pattern. In 2023, the local authority oversaw the felling of 110 trees in Armada Way, a major thoroughfare in the city, prompting extensive public backlash. After political turmoil similar to Sheffield, the Council Leader resigned, and an independent review commissioned. So far, the resulting action has been limited to changes to the council's governance arrangements with no real involvement of citizens in this beyond 'community engagement' which is loosely defined [7]. What sets Sheffield apart is its inclusive and systemic response.



Figure 3. Image showing felling along Armada Way in Plymouth

1.4.4 The SSTP seeks to deliver effective street tree management and strategic planting not as a set of isolated tasks or actors, but as an interconnected, dynamic system. The SSTP recognise that decisions about street trees affect, and are affected by, many other parts of the urban environment, governance structures, and communities. This systems thinking approach (after Arnold and Wade, 2015) [6] is evident in six key areas:

1. **Holistic View**: Whilst decision making relates to individual tree planting or tree removal decisions, the SSTP seeks to look beyond these considerations to understand broader impacts on climate resilience, biodiversity, health, transport, infrastructure, and social equity for the city as whole.

2. **Interconnected Stakeholders**: The SSTP considers how local authorities, residents, highways teams, ecologists, utility companies, and voluntary groups interact, and how their decisions overlap. This is reflected in the membership of SSTP and of involvement in new housing/ development projects.

3. **Feedback Loops**: The SSTP includes a dedicated data gathering and evaluation subcommittee to help monitor how strategy outcomes feed back into Partnership objectives, actions and governance.

4. **Leverage Points**: The SSTP seeks to identify where small changes (like improved community engagement in specific parts of the city or asset data that is shared with, and analysed by, a wider range of stakeholders) can lead to significant improvements in outcomes and trust.

5. **Long-Term Thinking**: The SSTP seeks to consider climate projections, urban development, and maintenance needs over decades not just budget cycles or the Streets Ahead PFI contract.

6. **Adaptive Governance**: The SSTP encourages flexibility in policy and approach, with mechanisms to learn from mistakes, adjust plans, and respond to change (e.g. storms, pests, public attitudes).

1.5 Comparative Governance Models Across the UK

1.5.1 Several cities are working to improve urban forest governance, but none have replicated the full participatory model seen in Sheffield. The following three examples provide a range of approaches:

1. The London Urban Forest Partnership (LUFP) brings together the Mayor of London, the Forestry Commission, the Greater London Authority (GLA), public agencies such as Action for Conservation, and potential funders to coordinate canopy targets and deliver woodland creation. While stakeholder collaboration is strong, empowerment is typically top-down, with project coordination and delivery driven centrally, with communities in a recipient role. In Sheffield, community, civic bodies and public agencies share decision-making, creating stronger civic governance and public 'buy-in'.

2. In Birmingham the Birmingham Tree People and Urban Forest Accelerator comprise a CIC in partnership with the Local Council, National Trust, Woodland Trust and communities to co-create engagement, undertake street tree surveys and ward level canopy planning. Whilst this model is similar to the SSTP with a shared governance structure, and with co-creation at its centre, the Birmingham Street People and Local Authority don't operate as a formal partnership with consensus-based governance. It should also be noted that the focus of this partnership relates to trees in parks and green spaces, avoiding the potential contentiousness of street trees.

3. In Bristol the Bristol Tree Forum is an advisory body integrated into the city's tree strategy, advocating for statutory community consultation before felling, and co-management of strategic decisions. In contrast to the advisory and often marginalised role played by civic actors in cities like Bristol [8], SSTP embeds co-governance principles at the heart of decision-making, creating a framework that is both structurally inclusive and operationally transparent.

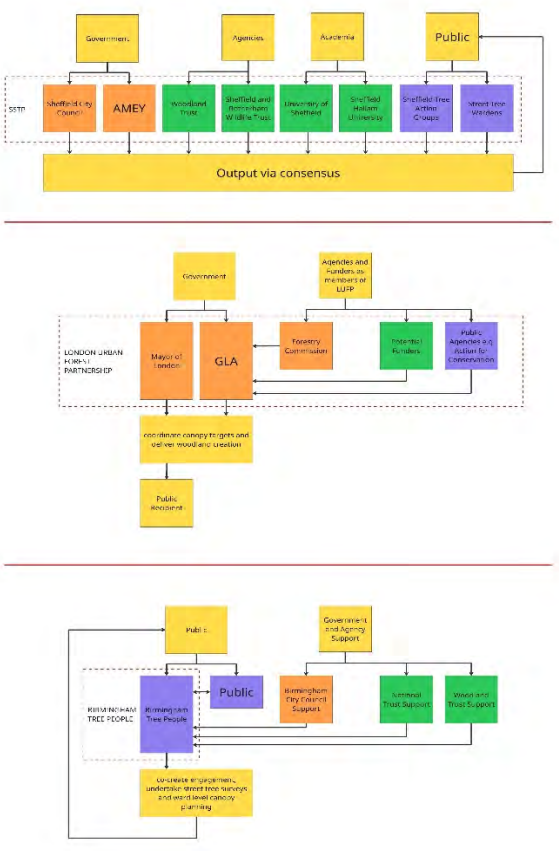


Figure 4. Structural relationships SSTP, LUFP and Birmingham Tree People.

1.6 Towards Climate Resilience and Social Equity – The Spatial Street Tree Palette

1.6.1 One of SSTP's most ambitious outputs is the Spatial Street Tree Palette (The Palette), currently in development. Unlike traditional species lists, the Palette integrates ecological data, climate modelling, and social equity considerations. Its aims include:

- **Climate Adaptation:** Selecting species resilient to future weather extremes (hotter summers, wetter winters).
- **Tree Equity:** Guiding planting in areas with low canopy cover and high deprivation.
- **Ecosystem Services:** Aligning planting with biodiversity corridors, habitat needs, areas of high air pollution or flooding.
- **Transparency:** Offering a shared, evidence-based framework for public use and scrutiny.

1.6.2 While the Palette is not yet a statutory obligation, its development within a co-governance framework ensures legitimacy and alignment with civic aspirations. What distinguishes this project is not just the technical output but the inclusive and deliberative process through which it is being developed.

1.6.3 The development of the Palette has been underpinned by a series of carefully designed workshops, conceived not as top-down dissemination events but as spaces of co-production and provocation. These workshops, free and open to all without preconditions, have drawn together an unusually broad mix of participants: residents, ecologists, local and regional authority staff, highways engineers, artists, academics, and civic organisations.

1.6.4 Each session was structured around themes such as "Scenarios, Space and Species" and "Constraints and Application", and featured provocations from expert speakers like Dr Henrik Sjöman (Swedish University of Agricultural Sciences), Dr Jill Edmondson (University of Sheffield), Dr Harry Watkins (St Andrews Botanical Garden), and Dr Luke Bennett (Sheffield Hallam University), whose perspectives sparked new thinking across disciplines.



Figure 5. First workshop event – Provocation by Dr Harry Watkins



Figure 6. Second workshop event – Discussion with Nathan Edwards SSTP Chair



Figure 7. Workshops used text prompts, plans and available data to guide and inform discussions

1.6.5 Breakout sessions encouraged participants to wrestle with real-world complexities (through questions), from spatial constraints (is there space for a tree?) to species resilience under climate change (which species will survive?), challenging assumptions about what to plant, where, and

by whom. This format treated innovation not as the preserve of technical experts but as a collective, iterative process. The workshops were also grounded in Sheffield's specific socio-ecological context, particularly the need to redress historic planting inequalities between the city's eastern and western areas.

1.6.6 The resulting Palette is envisaged as more than a static database or species selection guide. It is being developed as a toolkit for officers, developers, residents, and communities. Two functional approaches are being explored: one that guides planting decisions through user-inputted spatial data, and another that starts from strategic distribution goals (e.g. maintaining genetic diversity, adapting to 2050 climate scenarios etc.) and scales recommendations accordingly.

1.6.7 The goal is to move beyond ad hoc planting, guided by an individual tree officer's species preference, toward a scalable, replicable model that enables communities to play an informed role in tree selection and placement. This is vital in a city like Sheffield, where historical inequities in street tree cover have translated into uneven access to shade, neighbourhood identity, and urban biodiversity. "Valuing and integrating trees into the planning and design of our towns and cities is vital if we are to meet climate and livability challenges." [9].

1.6.8 Crucially, the Palette is not a finished product but a living framework, one that will evolve through further expert consultation, data refinement, and stakeholder feedback. Questions remain about species resilience, data mapping capabilities, and how best to integrate with national frameworks like Biodiversity Net Gain (BNG). The Palette's openness to ongoing challenge is what makes it robust.

1.6.9 The Palette exemplifies the SSTP's participatory, adaptive governance model. It is planned as a tool for climate planning, but also for civic learning, democratic accountability, and environmental justice.

1.7 The Next Steps for the SSTP

1.7.1 The focus is now on completing and piloting the Palette. This involves a number of stages which involve different stakeholders:

- Refinement of the Palette as a digital tool: This involves the completion of technical modelling to compare an approach to location / user-driven input with an approach that is strategy-led for species selection. The SSTP will develop funding opportunities to commission an accessible online version of the Palette with an interactive map and decision-tree logic. Users will be guided through differentiated interfaces from the outset. Residents will be asked one set of questions – e.g. relating to an individual plot or street, while e.g. council officers and developers will be asked a different set of questions relating to development site or neighbourhood, or wider.
- Pilot Implementation: The Palette will then be tested in selected neighbourhoods / contexts to test its integrity. We will apply this in areas where there is currently low tree canopy and high-deprivation to evaluate usability and impact on planting decisions.
- User Experience Evaluation: The piloting will allow us to collect structured feedback. We will target diverse user groups (e.g. council officers, community groups, developers) to improve accessibility / use.
- Mapping & Monitoring: SSTP will collaborate with national and local institutions (e.g. Forest Research, i-Tree, local GIS teams at the council and universities) to integrate spatial layers such as urban heat, air quality, and biodiversity corridors into the tool.

1.7.2 Once the tool has been piloted and implemented, we will focus on continuing and deepening of meaningful community engagement. This will involve the following stages:

- Community-Led Pilot Projects: We will partner with local groups and ward councillors to co-deliver planting projects using the Palette, reinforcing civic ownership and equity.
- Citizen Science & Monitoring: We will work with stakeholders (e.g. Sheffield and Rotherham Wildlife Trust, the two Universities and existing app providers) to establish opportunities for residents to contribute to data collection (e.g. tree health, canopy growth, biodiversity) through apps or seasonal surveys.
- Capacity Building: We will offer training sessions and resources to empower local residents, wardens, and schools to use the Palette effectively and contribute to tree stewardship.
- Communication: It is crucial that this approach becomes a part of how Sheffield operates as a city. There will be an ongoing publicity programme to keep citizens informed, ensuring transparency and maximising public participation in street tree planting and care.

1.7.3 The third stage is to align the Palette with policy through citywide and strategic integration. This involves:

- Alignment with BNG and Design Codes: This will ensure that Palette outputs align with planning policies like Biodiversity Net Gain, the National Model Design Code, and Net Zero goals.
- Embedding in Procurement & Planning: There is a need to integrate the Palette's principles into city-wide street tree planting contracts, developer contributions, and Section 106 agreements.
- Establishing Ward-Level Equity Targets: We will work with the Council to establish and monitor canopy cover equity targets by ward or neighbourhood, to guide future investment.

1.7.4 There is an embedding of research and evaluation throughout this process which has been made possible through the involvement of university partners. Specific steps include:

- Ongoing Academic Partnerships: There will be opportunities to commission follow-up research to track long-term outcomes on resilience, biodiversity, and civic trust.
- National/International Learning Exchange: We will share findings and lessons learned with other UK cities and networks (e.g. Trees for Cities, LUFP), and explore scope for scaling up the model.
- Plan for Climate 2050: We will use the Palette and associated strategies to develop a long-term, adaptive Urban Forest Strategy for Sheffield that responds to projected climate futures.

1.8 Conclusion

1.8.1 The SSTP illustrates how participatory governance, when well-structured and sufficiently resourced, can enable cities to move from conflict to cooperation. It shows that tree strategies are not simply about species choice or maintenance standards, they are about relationships, institutions, and values.

1.8.2 As TDAG [10] notes, successful governance frameworks must be co-created, embedded, and flexible. Sheffield's SSTP meets those criteria and may offer a replicable model for cities facing complex environmental and civic challenges.

1.8.3 The SSTP is not a panacea, but it is a promising alternative to business-as-usual urban forestry. Its work on the Spatial Street Tree Palette exemplifies how participatory governance can integrate ecological planning with civic trust and climate resilience.

1.8.4 This model holds valuable lessons for cities worldwide. Success lies in building institutions that are capable of learning and adapting. As cities face increasing environmental and social pressures, such

governance innovations may become essential.

1.8.5 Challenges remain. Gathering robust data on local species performance is time-consuming. Aligning the Palette with policies such as Biodiversity Net Gain (BNG) and national design codes requires ongoing negotiation. But the governance model itself, open, ambitious, iterative, is a significant innovation. Bringing together institutional, academic, and civic knowledge, the SSTP has created space for strategic thinking even amid uncertainty.

1.8.6 This paper has been an opportunity to set down what the SSTP is achieving and aims to achieve in the future. As other cities grapple with their own approaches to community unrest, we hope to carry out comparative research into how SSTP can provide an innovative example of strategic tree planting within different policy and cultural contexts. As cities play an increasingly vital role in addressing the climate crisis, now is the time for cities to consider a different and truly collaborative approach to planting and sustaining healthy and resilient street tree populations.

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Leading Landscape Design with the Participation of Forest Peripheral Communities: An Eco-Social Pathway for Building Sustainable Cities

Topic 1: Guiding cities
- - With society (art, design, consultation, uses)
Participatory approaches and governance strategies

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Keywords: community co-management; forest edge communities; Japanese healing forests; sustainable development; social-ecological systems

Abstracts: In the face of the structural contradiction between ecological protection and community development in the transition of global ecological governance, there is an urgent need for forest fringe communities to explore the adaptive co-management pathway with the synergy of multiple actors. Based on the theoretical framework of social-ecological system (SES), this study takes the Japan's "University of Tokyo Healing Forest" as an empirical study, and reveals the synergistic structure and practical logic of its community co-management mechanism, which is an important reference for exploring the management of forest-edge communities. The model is based on the three-phase coupling of 'knowledge-institution-action', constructing a multi-scale linked governance system, and realizing sustainable ecosystem gifts through the establishment of an endogenous recycling mechanism for forest resources and localized governance. The study shows that the "University of Tokyo Healing Forest" model realizes the effective transformation of social capital into ecological capital through the progressive mechanism of 'main role reconstruction - system flexibility design - function compound value-added', and its innovative value lies in the linkage of 'healing' function, which transforms the disadvantages of marginal communities into ecological service advantages. Its innovative value lies in using the 'healing' function as a link, transforming the disadvantages of marginal communities into ecological service advantages, providing a replicable model of 'development under protection' for the same type of marginal communities in forests, and providing localized solutions with both operability and humanistic care for the construction of sustainable cities.

Forests are known as the 'lungs of the earth', the core component of terrestrial ecosystems[1], and also the main form of existence in nature[2], covering many types of nature reserves, forest parks, forest farms, scenic spots, etc. The healthy development of forests is not only a matter of ecological protection, but also affects the sustainable development of the communities on their fringes[3]. China has established 'insisting on the harmonious coexistence of human beings and nature' as one of the basic strategies for development[4], proposing the construction of a modernization in which human beings and nature coexist harmoniously, and forests, as an important element in the construction of an ecological civilization, have been given attention by forestry, grassland, environmental protection, education and other relevant departments[5].Studies have shown that most low-development village residents rely heavily on forests for their livelihoods[6] and that the health of forests is critical to the development of marginalized communities[7]. However, community development can also have negative impacts on forests[8], such as the prevalence of 'forest pseudo-ecotourism'[9][10], the destruction of forest resources through irrational planning and construction[11], and the untapped potential for management by marginal communities[12][13].At present, the traditional forest management model is difficult to balance resource protection and community development needs, and exploring sustainable ecological governance paths has become a global issue.

Community Co-management refers to the joint participation of multiple subjects in the community, such as community residents, community organizations, government departments and enterprises, in the management and decision-making process of community affairs. Forest fringe communities refer to communities located in the forest periphery, bordering the forest or adjacent to the forest area, with the dual attributes of ecological vulnerability and socio-economic development needs. Social-ecological system (SES) theory refers to the coupled system formed by human social subsystems and natural ecological subsystems through complex interactions, emphasizing the dynamic feedback and interdependence between human activities and the ecological environment.Coordinated development of forests and communities is the key to achieving the goal of building and managing marginal forest communities[14], and it is necessary and urgent to correctly understand the relationship between forests and marginal communities and to carry out in-depth research[15].In view of the above, sustainable management of forests is increasingly receiving high attention from the international community and Governments[16]： In 1970, the Government of Nepal implemented community forestry (CF) management practices to address the conflict between forests and the development of marginalized communities[17];North American scholars, on the other hand, have argued for the recognition of the rights of local people, and they believe that combining traditional knowledge and culture with modern scientific forestry can bring new opportunities for forest management[18];Native-Outsider Interactions Bring New Perspectives to Forest Management, Japanese Researchers Say[19];Indonesian scholars transformed traditional forest communities into new types of communities through digital technology, using digital platforms for communication, resource management and business activities to create conditions for sustainable forest development[20].Successful national experiences in forest management and community co-management[21] are important to learn from and inform the endogenous development of communities on the edge of forests[22][23].

Since 1925, the Fuji Healing Forest Research Institute of the University of Tokyo has been committed to the research theme of the relationship between forests and human beings[24], and has implemented the 'Healing Forest' project, which is centred on the recycling of forest resources within the region with the function of 'healing' as a link, and has provided countries with new perspectives on the relationship between forests and human beings and practical suggestions and cases on how to better use and protect forest resources. The 'Healing Forests' project, with its multi-party approach to building a community-based co-management mechanism on the edge of forests, has not only provided countries with new perspectives on the relationship between forests and human beings, but also offered practical suggestions and cases on how to better use and protect forest resources.Based on the social-ecological system (SES) theory, this paper systematically analyses the synergistic logic and practical value of the University of Tokyo-type healing forest community co-management mechanism, with the aim of providing a localized solution to the problem of co-management of forest fringe communities that combines humanistic care and operational feasibility.

1. Background and origins of Healing Forests

The University of Tokyo Healing Forest is located on the shore of Lake Yamanaka at the foot of Mount Fuji in Yamanakako Village, Minamitsuru-ku, Yamanashi Prefecture, Japan, and is the site of the Fuji Healing Forest Research Institute of the University of Tokyo, which occupies an area of approximately 40 hectares and is a university practice forest mainly consisting of larch trees. In 2011, it was changed from Fuji Exercise Forest to Fuji Healing Forest Research Institute (Table 1), which is dedicated to the research and practice of 'creating healing forests based on the recycling of forests in the region'. Fuji Healing Forest Research Institute (FHRI) is located in a temperate and subtropical climate zone, with extensive forest cover and complex topography. The forests at different altitudes are of different types and have a multi-layered structure, including trees, shrubs, herbs and ground cover. This structure provides diverse

habitats for wildlife and enhances the biodiversity and ecological functions of forests.

The rise of 'University of Tokyo Healing Forest' is rooted in a profound socio-economic transformation: firstly, a shift in the value of social demand. Along with the acceleration of urbanization, people's perception of forests has shifted from 'resource supply' to 'psychological healing'. The traditional practical thinking centred on timber production has gradually dissolved, and the leisure, health and cultural functions of forests have become new demands, reflecting the re-evaluation of the non-economic value of nature in the post-industrial era. Secondly, space deprivation and ecological alienation. Urban expansion has led to a sharp decrease in green space, and the popularity of wage labour has severed the daily connection between humans and nature, giving rise to 'nature deficit disorder'. Residents seek compensatory contact through gardening and forest bathing, and the forest has been reconfigured as a 'spiritual refuge' to relieve urban pressure. Thirdly, the local economic structure has been remodeled. In the area represented by Lake Village, the transformation of the traditional agricultural and forestry economy into the tourism service industry has degraded the forest from a production site to a symbolic landscape. This 'economic rupture' has prompted the society to reflect on the logic of single development, and to explore the potential of the forest's composite services, so as to activate the development of marginal communities with healing functions. Fourth, the demand for innovation in forestry model. Traditional forestry relies on the timber economy and ignores ecological and social benefits. By integrating mental health and community cohesion, the 'Forest of Healing' programme builds a sustainable path of 'low intervention and high value-added', marking a shift from 'resource plunder' to 'systemic symbiosis'. This marks a paradigm shift from 'resource plunder' to 'systemic symbiosis'.

The above transformations together constitute the practical soil of 'healing forests', which is essentially an adaptive exploration of social, economic and ecological goals from opposition to synergy, and whose ecological characteristics and economic backgrounds are different from those of China's protected forest fringe communities, and which can be a reference and guide for exploring the co-management model of its forest fringe communities.

Table 1 Brief timetable of Fuji Healing Forest Research Institute

Period of Time	Theme
1925	Received applications for donations of private land from 146 people to establish the Fuji Exercise Forest.
1926	Forestry office and six nursery fields were completed, and residents gave up some of their rights to forestry income. The Institute was granted a lease on prefecture land in Yamanashi Prefecture.
1927-1935	Forestry group planting larch.
1929	Establishment of larch growth measurement points in forestry groups.
1935-1950	Establishment of alpine plant sample gardens and herb gardens.
1954-1955	Establishment of the Yamanashi Prefecture Forestry Experiment Station Cold Zone Sapling Breeding and Afforestation Experiment Project and commencement of the Cold Climate Tree Propagation Experiment.
1955	Commencement of forest health and recreation research.
1979	Lake in the Hills Village Town Hall Sale.
1982	The Forestry Agency of Japan proposed forest healing in 1982[25].
2011	Implemented the 4th Educational Research Programme and changed the name to Fuji Healing Forest Research Institute.
2020	Publication of 'The University of Tokyo: How to Create a Forest of Healing' (Tsukiji Shuppan)

2.University of Tokyo Healing Forest in the context of social-ecological systems theory

Based on the Social-Ecological System (SES) theory, the "University of Tokyo Healing Forest" is an integrated case of social, ecological, and economic systems, centred on the promotion of physical and mental health, community development, and the sustainable use of resources through the interaction between people and the forest. The target state is an ecosystem that connects people with the forest, which is not only a natural resource but also an important place for people to gain physical and mental health. By preparing the forest, providing a safe and comfortable environment and diversifying activities, the system aims to promote harmonious coexistence between humans and nature.

2.1 Socio-systemic function

Healing function: 'Healing forests' are forest environments that provide comfort, enjoyment of life,

and enjoyment of work to people who come into contact with their space or use their resources in a variety of situations, thus playing a ‘healing’ role. The Fuji Healing Forest Research Institute has expanded the definition of ‘healing’ to include physical, mental, and sensory satisfaction, which is not limited to recovering from an undesirable state, but rather to achieving both physical and mental satisfaction through contact with the forest or use of its resources.For example, through the healing power of the natural environment (such as fresh air, natural sound and light) to alleviate psychological pressure, and at the same time with the help of professional psychological guidance to promote self-exploration and emotional release, forming a dual healing path of ‘natural healing + psychological intervention’, in order to achieve the innovative integration of forest walks and psychological counselling; through the deep integration of outdoor physical training with the natural healing properties of the forest By deeply integrating outdoor physical training with the natural healing properties of the forest environment, it can relieve psychological pressure and regulate emotional balance while improving physical functions, thus creating a forest gym that achieves the synergistic healing effects of ‘exercise and shaping’ and ‘ecological healing’ for both body and mind.

Community Building Function: Through diversified activities and resource recycling practices, connecting residents, students and other groups, reconstructing the ‘residents-nature-society’ relationship network with the forest as a link, and at the same time relying on the collaborative mechanism between the government and academic institutes to stimulate the residents' ecological identity and sense of collaboration, and ultimately forming a sustainable community symbiosis system, achieving Strengthening cohesion and improving quality of life.For example, the ‘Firewood Heater Project’ - Lake Yamanaka Village has taken the recycling of discarded wood as its core, and combined it with residents‘ training, collaborative installation, and a shared use mechanism to transform resource regeneration into a community interaction bond, which not only improves the quality of life but also strengthens residents’ ecological collaboration. The firewood auction in Ina City, Nagano Prefecture, for example, builds a ‘villager-citizen’ resource recycling collaborative network through the auctioning of harvested timber, the participation of city residents in forest preparation, and the home delivery of firewood, thus realising the benefits of waste resource recycling through the construction of a trusting relationship. The aim of regenerating waste resources and ecological conservation is achieved through the building of a trusting relationship, and community cohesion is activated at the same time.

Educational Function: Students can transform theoretical knowledge into practical skills in activities such as natural environment design and field cooking, and deepen their understanding of ‘symbiosis between human beings and nature’ through forest healing experience. In addition, the presentation of project results stimulates innovative thinking and a sense of social responsibility, forming a complete educational loop from the acquisition of knowledge to the construction of eco-ethics, and fostering practitioners of sustainable development with both scientific literacy and ecological sensibilities. For example, the Natural Environment Design Studio of the University of Tokyo, through the educational practice of ‘Healing Forest’, guides architecture and landscape architecture students to reconstruct their ecological awareness through the project of ‘Branches in the Forest’. The project uses fallen branches from the forest to design children's playground facilities, integrating ecological knowledge, design skills training and public education, thus demonstrating the multi-dimensional value of experiential nature education in fostering sustainable design thinking and a sense of social responsibility.

Economic function: activate the on-site economic income by relying on forest education and firewood auction and other innovative business forms, and at the same time reduce the cost of ecological depletion by recycling discarded wood; through the participation of residents in forest preparation and consumption, build a network of urban-rural resource exchange, and ultimately form a symbiosis of economic gain, ecological protection and community cohesion.

2.2 Ecosystem services

Material services: wood is processed into building materials and biomass clean energy after scientific logging; discarded branches are converted into low-carbon fuels through smokeless carbonisation technology; a regional closed-loop system is constructed to convert forest resources into teaching aids and recreational facilities, reducing transport energy consumption and enhancing added value. The ‘production-consumption-regeneration’ model not only meets basic material needs, but also creates compound value through non-consumptive services such as education and interaction, highlighting the core role of forests as a sustainable resource base.

Regulatory services: the chemical level releases negative ions to purify the air and optimise the atmospheric environment; the physical level regulates the microclimate and improves human comfort; the hydrological level maintains soil and water conservation and purification and ensures the sustainability of water resources; the soil level enhances the stability of the soil by sequestering carbon and preventing

erosion through scientific management; and the biological level maintains the diversity of species and promotes the dynamic balance of the ecological network. The synergistic effect of forest practices and sustainable landscape planning will form a multi-scale ecological regulatory network, enhance system resilience and improve ecological service efficiency.

Cultural services: Relying on nature education and psychological healing activities, strengthen the emotional connection between human beings and nature as well as ecological well-being; activate the social relationship network and cultural capital accumulation through community collaboration in forest preparation and traditional cultural practices; enhance the spiritual value of the environment through the design of landscape aesthetics, such as healing trails, to form a composite service system that combines education, healing and cultural identity, and promote the internalisation of ecological awareness and social cohesion. Enhancement of ecological awareness and social cohesion.

Supporting services: Maintaining the structural health and biodiversity of the forest through sustainable management practices to ensure the long-term stability of the ecosystem and its ability to provide services; strengthening the interaction between people and the forest through community-based co-management mechanisms to activate the effectiveness of social capital in supporting ecological preservation; and forming a positive feedback between ecological well-being and the regional economy by relying on healing and education and other derivative services. Positive feedback is formed through healing education and other derivative services, which transforms the ecological stability of forests into the kinetic energy of sustainable social development.

3.Community co-management mechanism for University of Tokyo Healing Forest

3.1 Knowledge integration: cognitive synergy and role transformation

A multidisciplinary collaborative network that promotes the integration of knowledge from forestry, ecology, psychology, and sociology, with the University of Tokyo's Healing Forest Institute as the core coordinator. Psychologists explore the positive effects of forest activities on mental health, ecology teams examine habitat quality, foresters develop vegetation management strategies, pedagogues design nature-awareness curricula, and sociologists track the evolution of community relations, coupling the use of resources with cultural healing functions. The Institute serves as a hub to promote the transformation of residents' roles from passive “takers” of forest resources to active “co-builders” of ecosystems through participatory management mechanisms. ‘Ecological co-builders’. Residents begin by participating in diverse activities such as forest bathing and psychological counselling, and gradually become more involved in forest management (e.g. restoring historical woodlands and maintaining healing trails); through the design of educational courses and the maintenance of facilities and other ongoing practices, the residents' identity is transformed from resource takers to ecological decision makers, thus facilitating the transformation of their roles from resource takers to ecological decision makers. Through the design of educational programmes and the maintenance of facilities and other ongoing practices, we will solidify the transformation of their identity from ‘resource takers’ to ‘ecological decision makers’, promote the formation of endogenous dynamics in the community, and realise the paradigm shift from passive dependence to active governance, thereby reshaping the relationship network of ‘human-forest symbiosis’.

3.2 Institutional design: flexible governance and balance of power and responsibility

The multi-subject collaborative framework constructed by the Healing Forest Institute is structured on the basis of ‘government coordination, academic empowerment, social synergy and professional support’, integrating local governments, civil society organisations, universities and experts, enterprises and other subjects to form a multi-level governance network. Local governments, as policy promoters, formulate forest environment tax policies, take the lead in forest management and public facility construction, strengthen residents‘ main responsibility in forest management, and provide policy guidance and resource guarantee for participatory community management; universities (e.g., the University of Tokyo), relying on the dual paths of research and education, combine forest science courses with field practice, and promote the inheritance of knowledge and iteration of technology; and civil society organisations focus on residents’ mobilisation and on-site practice, and promote knowledge transfer and technology iteration; and local government and local government organisations focus on residents' participation. Civil society organisations focus on residents' mobilisation and localised practices, organise forest co-construction activities to stimulate endogenous community dynamics and strengthen social capital accumulation; cross-disciplinary experts (ecology, psychology, education) provide professional technical support to ensure the scientific validity of the project.The four types of subjects are linked through the mechanism of ‘shared responsibility and shared resources’: the government builds an institutional platform, universities export

intellectual resources, civil society organisations activate participatory networks, and experts provide technical support, forming a four-dimensional synergistic closed-loop system of 'policy-knowledge-action-technology'. The system will ultimately achieve the multiple goals of ecological protection, community cohesion and sustainable development.

3.3 Action practice: three-dimensional pathways and functional symbiosis

Spatial dimension: through the design of diversified activities, covering the needs of students, volunteers, residents and other groups, stimulating broad participation; using experiential practice as a carrier, enabling residents to intuitively perceive ecological values and internalise the concept of 'healing'; simultaneously lowering the threshold of participation through safety, security and comfort, enhancing the sustainability of the activities; and finally, through emotional connection and value transfer, promoting the transformation of residents from 'passive participants' to 'active guardians'. In the end, the emotional connection and value transfer will promote the transformation of residents from 'passive participants' to 'active guardians', forming an endogenous symbiotic cycle of ecological protection and community development.

Value Dimension: Using the recycling of forest resources as a carrier, transforming mountaineering into 'homework therapy' to create a physical and mental healing scenario; designing participatory eco-courses to promote the internalisation of sustainable behavioural logic among residents and children; integrating local traditions (such as healing place culture and festivals) to make the forest a living cultural space to perpetuate eco-identity. The integration of local traditions (e.g., retreat culture and festivals) will make the forest a living cultural space and perpetuate ecological identity. In addition, by relying on the collaboration of multiple actors to coordinate ecological protection, community cohesion and cultural heritage, a sustainable paradigm with healing function as the core and multi-party co-governance as the support will be formed, which will provide an innovative path for ecological governance and humanistic development in modern society.

Social dimension: Promote residents' recognition of ecological values through the "cognitive-emotional" dual-track mechanism: in the cognitive dimension, relying on field education, mountaineering and other practices, the principles of forest resource circulation are transformed into perceptible ecological knowledge, and through participatory learning such as the design of healing trails, the residents deepen their systematic understanding of the functions of the forest as a carbon sink and soil and water conservation; in the emotional dimension, using immersive scenarios such as forest bathing to trigger a sense of pleasure and belonging to build a "people-forest" emotional bond. In the emotional dimension, immersive scenarios such as forest bathing and picking wild vegetables are used to trigger a sense of pleasure and belonging, and to build a 'people-forest' emotional bond. Further, through the joint preparation of the forest, a responsibility-sharing mechanism will be established to promote the transformation of residents from 'knowledge receivers' to 'ecological decision makers', and to strengthen the sense of social responsibility in the process of collaboration. The interaction between cognitive rationality and emotional experience encourages residents to internalise ecological protection as a value norm, actively participate in firewood auctions and other resource management, and form an endogenous impetus for community governance. This closed-loop path of 'educational empowerment-emotional resonance-practical reinforcement' reconfigures human-forest interaction and provides a replicable social intervention model for ecological community building.

Fig. 1 Community Co-Governance Mechanism of the University of Tokyo-Style Healing Forest

4.Mechanism Innovation and Practical Insights

4.1 Innovativeness

The University of Tokyo-style healing forest takes the function of 'healing' as a link, and transforms the disadvantages of marginalised communities into ecological governance advantages through multi-dimensional paths: firstly, using forest preparation, wilderness education and other activities as a carrier, encouraging residents to participate in forest management, and enhancing community cohesion and a sense of belonging through collaboration; secondly, creating a safe and comfortable healing environment through scenarios such as forest bathing and psychological counselling Secondly, through forest bathing, psychological counselling and other scenarios, the project creates a safe and comfortable healing environment, relieving residents' physical and mental stress and improving their quality of life; at the same time, the project innovates in the mode of resource utilisation by converting logged timber into firewood, benches and other daily necessities, and develops mountain labour positions to create non-traditional

economic value and activate the endogenous dynamics of the community. The project focuses on the integration of technology empowerment and education, combining advanced management techniques to reduce ecological risks, and practical training to raise residents' environmental awareness and promote sustainable development transformation. At a deeper level, by connecting forest owners, resource demanders and local institutions, the project builds a multi-subject collaborative network of 'residents-government-universities-experts', forming a social structure of autonomous governance, and shifting marginalised communities from passive dependence to active planning, thus realising the revitalisation of the region. This governance model, with ecological healing as its core and multi-party collaboration as its support, not only reshapes the relationship between people and forests, but also adds value to the cycle of 'social capital and natural capital', and provides an innovative path for marginal forest communities to 'develop under protection'.

4.2 Practical Implications

By transforming community disadvantages into ecological service advantages, the University of Tokyo-style model establishes an innovative path of 'development through conservation', achieving a win-win situation for both ecological conservation and economic development. The model not only provides a replicable governance path, but also offers a localised solution that is both operational and humanistic for the transformation of ecological governance in the process of urbanisation. In addition, through the community dividend mechanism, traditional forestry culture inheritance and forest healing activities, it activates the participation of residents and promotes community economic development and residents' well-being, thus achieving synergistic growth in economic, ecological and social benefits. Finally, a collaborative governance framework of 'government coordination-academic empowerment-social synergy-professional support' has been constructed to avoid single-principle domination; forest healing has been incorporated into the public health policy, and a linkage between ecological compensation and community dividends has been established; and an in situ resource recycling system has been promoted to strengthen the endogenous regenerative capacity of the ecosystem. The model provides a systematic response from theory to practice for ecological governance in the process of global urbanisation.

5. Conclusion

This paper provides a sustainable solution for the development of marginal forest communities in China from the perspective of ecological governance by revealing the synergistic structure and practical logic of the community co-management mechanism of 'University of Tokyo-style healing forest'. The model is based on a three-stage coupling of 'knowledge integration, institutional innovation, and action synergy': at the knowledge level, a theoretical framework is formed based on interdisciplinary research results; at the institutional level, a flexible system of power and responsibility distribution is designed to promote multi-dimensional collaboration among the government, community, and experts; and at the action level, ecological restoration, health services, and cultural empowerment are realised through the use of zoning and resource recycling management strategies. At the action level, the ecological restoration, health service and cultural empowerment are added value through zoning utilisation and resource recycling management strategies. Its success lies in the linkage effect of 'subject empowerment, functional complexity and social resilience': activating endogenous motivation through residents' participation in decision-making, avoiding governance rigidity through institutional flexibility, and enhancing system sustainability through multi-dimensional value integration. This model has successfully solved the structural contradiction between ecological protection and community development, and provides an important reference for the management of marginal forest communities in China. It not only maximises the healing potential of forest resources, but also promotes community participation and sustainable forest management.

To sum up, the University of Tokyo-style healing forest provides a useful reference for community co-management on the edge of the forest. In the future, we should continue to deepen the integration of ecological protection and community development, and promote the implementation of innovative projects such as the healing forest, so as to contribute to the construction of a modernisation in which human beings coexist harmoniously with nature.

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DIFFERENCES IN PERCEPTIONS OF URBAN MEADOWS IN POST-SOVIET CITIES

TOPIC: Guiding cities with society: Participatory approaches and governance strategies

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Abstract
As cities worldwide face the dual crises of biodiversity loss and climate change, urban meadows are gaining attention as a sustainable alternative to traditional lawns. This paper explores how these semi-natural habitats are received in post-Soviet urban contexts, using Latvia as a focal point. Historically, public green spaces in Latvia were shaped by Soviet-era planning paradigms that prioritized order, tidiness, and intensive maintenance. This legacy has left a cultural imprint where unmanaged or "wild" landscapes often symbolize neglect rather than ecological richness. After independence, many public spaces suffered from underfunding, further reinforcing perceptions that naturalistic vegetation equates to decay.

Recent efforts in Latvia to introduce urban meadows, such as those in Riga, Cēsis, and Jelgava, have encountered these cultural barriers. Jelgava's 2024 pilot project, for example, aimed to transform portions of public parks and roadside verges into biodiverse meadows seeded with native plants. While younger residents and environmental NGOs largely welcomed the project, surveys revealed that many older residents perceived it as unkempt or purposeless. These perceptions were often linked to a lack of clear information and communication about ecological goals.

The study adopted a mixed-methods approach, combining case study analysis, literature review, surveys, and interviews with municipal staff and residents. Findings indicate that acceptance of urban meadows improves when municipalities invest in explanatory signage, community engagement activities, and partnerships with local institutions. In Jelgava, for instance, acceptance rose significantly when schools participated in monitoring and when clear visual materials explained the benefits of meadows for pollinators and climate adaptation.

Key barriers identified include aesthetic misalignment with public expectations, cultural conditioning favoring manicured lawns, and insufficient public communication. Conversely, factors that support acceptance include targeted information campaigns, participatory planting events, and interdisciplinary cooperation among planners, ecologists, and educators.

The paper argues that successful implementation of urban meadows in post-Soviet cities requires reimagining the role of landscape professionals as both designers and communicators. Municipalities must align ecological objectives with culturally resonant narratives that help residents see meadows as symbols

of renewal rather than abandonment. This approach demands sustained investment in public engagement, adaptive management, and cross-sectoral collaboration.

Ultimately, urban meadows have the potential to transform urban green infrastructure in ecologically and socially meaningful ways if they are supported by inclusive strategies that bridge the gap between scientific knowledge and community values.

Introduction

As global cities face growing ecological challenges, urban green infrastructure has become central to strategies that address biodiversity loss, climate adaptation, and quality of life. Urban meadows, a form of semi-natural habitat introduced into urban areas, represent a promising alternative to traditional lawns, supporting pollinators, reducing maintenance costs, and enhancing ecological connectivity [2,3]. However, their implementation, particularly in post-Soviet cities like those in Latvia, encounters specific societal and perceptual barriers [7].

This paper focuses on understanding the societal reception of urban meadows in post-Soviet contexts, with a special emphasis on Latvia. Building on recent urban greening projects and local case studies, it investigates the public's perception, explores the barriers and drivers of acceptance, and suggests strategies for more effective integration of urban meadows into city landscapes.

Historical and Cultural Context: Green Spaces in Post-Soviet Cities

The Soviet approach to green infrastructure was rooted in centralized urban planning, where green belts and parks were often highly structured and maintained [7]. While public green space provision was relatively generous in quantitative terms, the diversity and ecological value of these spaces were limited. Grass lawns and ornamental plantings were the norm, with little room for spontaneous or biodiverse vegetation [3].
Following the collapse of the Soviet Union, many public spaces in cities like Riga, Jelgava, and Daugavpils fell into neglect due to budget constraints and urban restructuring. Over time, unmaintained lawns and vacant lots came to be seen as symbols of decay, reinforcing a public aesthetic that associates tidiness with functionality and disorder with failure. These historical experiences continue to shape the public's perception of "wild" or "naturalistic" landscapes, including urban meadows [4,7].

Urban Meadows in Latvia: Recent Initiatives and Public Reactions

In recent years, Latvian cities have initiated pilot projects to introduce urban meadows. Riga's municipal programme, inspired by Scandinavian and Western European models, began in 2020 and focused on converting sections of parks and roadside verges into wildflower meadows. Cēsīs and Jelgava have followed, with Jelgava launching its first experimental meadows in 2024. These efforts are often supported by EU programmes such as LIFE and ELFLA, emphasizing biodiversity and sustainable land management [5].
Despite these efforts, public reactions remain mixed. According to surveys conducted by Jelgava municipality in 2024, many residents expressed confusion about the purpose of the meadows, with some perceiving them as neglected or aesthetically displeasing. The research found that while younger residents and environmental activists generally welcomed the initiative, older residents and those with Soviet-era backgrounds expressed skepticism [4,6].

Landscape Perception and Public Engagement

Perception of landscapes is not merely aesthetic but is informed by cultural, historical, and personal experiences. Research by Veinberga and Zigmunde (2019) highlights how Latvian and international experts rate the aesthetic and ecological value of green spaces differently. While ecological attributes such as biodiversity and native species are prioritized by foreign experts, local professionals tend to emphasize tidiness, safety, and order [4].
Public engagement in landscape planning is vital to address this perceptual gap. The Aarhus Convention (1998) underscores the importance of access to information and public participation in environmental decision-making [1]. Similarly, the "New European Bauhaus" initiative promotes sustainability through inclusive and beautiful public spaces, emphasizing co-creation with communities.

Methodology

The study employs a mixed-methods approach - case study analysis: focused on Jelgava's 2024 urban meadow pilot, and surveys and interviews - conducted with municipal specialists, local residents, and environmental NGOs. Literature Review: Covering academic studies on landscape aesthetics, urban ecology, and post-Soviet public space transformation [3,4,5,6,7].

Results and Discussion

Residents often interpret unmanicured spaces as signs of neglect. Cultural Conditioning: Soviet-era values emphasize order, control, and cleanliness in public space design [4,7]. Lack of Information: Municipalities often fail to clearly communicate the ecological rationale behind urban meadows. Targeted Communication: Informational signage, community events, and visual storytelling improve public understanding. Participatory Activities: Meadow planting days, citizen science initiatives, and educational workshops foster ownership. Institutional Support: Collaboration with schools, NGOs, and local businesses enhances community buy-in [5,6].

Jelgava Case Study: Lessons Learned

The Jelgava pilot project serves as an instructive example. Located in a public park and alongside pedestrian routes, the meadow included native species and was established through manual seeding. Surveys indicated that acceptance improved significantly when explanatory signage was added and when local schools were engaged in maintenance and monitoring.

Interviews with municipal staff revealed that the project required intensive coordination across departments (environmental, public relations, and education), highlighting the need for interdisciplinary planning. Local NGOs were instrumental in translating ecological goals into accessible messages for the public [5,6].

Toward Inclusive Urban Nature

Urban meadows can serve as a bridge between ecological sustainability and social inclusion, but only if framed appropriately. This requires rethinking the role of the landscape architect as both designer and communicator, capable of facilitating dialogue between ecological science and public perception.

Municipalities must invest in communication strategies that emphasize both ecological function and cultural narrative. Furthermore, planning processes must allocate sufficient time and resources for engagement, monitoring, and adaptive management. As demonstrated in Jelgava, success hinges on a community-centered approach.

Conclusions

Urban meadows hold immense potential to transform urban green space in ecologically meaningful and socially engaging ways. However, in post-Soviet cities like those in Latvia, their success depends on confronting deeply rooted perceptions shaped by history and aesthetics. The findings from Jelgava highlight the need for public dialogue, institutional collaboration, and a renewed role for landscape professionals.

By aligning ecological goals with culturally resonant narratives and participatory practices, urban meadows can evolve from contested interventions into beloved features of urban life. This transformation requires not only new design strategies but also a reimagining of how cities communicate, collaborate, and care for their green spaces.

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RECONSTRUCTION OF LOCAL SUBJECTIVITY IN RURAL TOURISM: SUSTAINABLE DEVELOPMENT AND COMMUNITY EMBEDDING OF NUANQUAN ANCIENT TOWN

TOPIC: Guiding cities with society: Participatory approaches and governance strategies

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Keywords: Rural revitalization, Historic town, Cultural Heritage Conservation, Sustainable development, Community embedding

Abstract

China's rural tourism industry is experiencing rapid growth under the national rural revitalization strategy. However, many historic towns are witnessing the large-scale outmigration of indigenous residents, which threatens local cultural continuity and challenges the long-term sustainability of these heritage sites. Focusing on Nuanquan Ancient Town in Hebei, with a 700-year history and rich cultural traditions. Although many indigenous residents remain, tourism-led resident relocation, insufficient community participation, and cultural marginalization have reduced the town's sustainability. This study investigates the underlying reasons why indigenous people struggle to integrate into new economic and social networks, and explores governance strategies to ensure their participation and long-term residency. The core issue examined is how to create conditions that encourage indigenous people to stay and contribute to tourism-driven local development.

This study adopts a semi-structured interview method , conducting 30 in-depth interviews from November 2024 to January 2025 with key stakeholders, including 10 indigenous residents, 5 investment developers, 8 tourists, 3 government administrative departments and 4 cultural protection experts . The interviews focus on four key areas: (1) the evolving role of indigenous people in tourism development (2) the impact of tourism on local social networks and community identity (3) the effectiveness of existing local governance structures in supporting the socio-economic inclusion. (4) policy and practical intervention to reintegrate indigenous people into local economic and social networks.

The results indicate that the outmigration of indigenous people is not driven solely by economic factor, but by the gradual deconstruction of local social network during tourism development. First, economic benefits are concentrated in the hands of external investment and local governments, with indigenous people excluded from key segments of the tourism industrial chain, limitng their financial incentives to remain. Second, governance structures have become increasingly technocratic, the decision-making mechanism of tourism development tends to be standardized, and the lack of respect and tolerance for local culture and indigenous lifestyles leads to limited living space for indigenous people. The community governance system is inadequate, and the response to the views of indigenous people and the needs of local communities is not timely and adequate. Third, tourism has restructured local social capital, replacing traditional reciprocal network with market-oriented relationships. As a result, indigenous people face weakened social support systems, increasing the likelihood of outmigration. This study shifts the discourse on rural tourism sustainability from a purely economic perspective to one that emphasizes the interaction between local social capital and economic-social embedment. Sustainable development in historic towns requires participatory governance mechanisms that enable indigenous people to gain meaningful economic roles in the tourism sector and rebuild local social capital networks. By fostering community-driven decision-making, inclusive policy frameworks, and locally embedded tourism models, the study offers new perspectives and

pathways for global historic towns facing similar challenges of sustainability and indigenous socio-economic integration.

Text

1 Introduction

The rural revitalization strategy implemented by China positions rural tourism as a key engine for economic transformation. However, this development process has also exposed a profound contradiction between the historical town modernization driven by tourism and the protection of cultural authenticity. According to the "2023 National Rural Tourism Development Statistical Bulletin" released by the Ministry of Culture and Tourism, in 2023, rural tourism in China received 2.157 billion visitors, generating considerable economic benefits. However, this superficial prosperity also masks the survival crisis faced by historical towns like Nuanquan Town, as the influx of tourists coincides with a sharp decline in the number of local residents. Despite attracting over 20 million visitors each year, the number of original residents in Nuanquan Town has now dropped to less than 1,000, a 69% decrease from 2010 to 2020. The departure of the original residents, like unraveling a thread, gradually strips the cultural soul of the town. How to retain the original residents while developing rural tourism becomes an urgent issue to be addressed.

The loss of the original residents' subjectivity in Nuanquan Town also reflects the challenges faced by China's rural tourism model in the development of the new era. Although current research emphasizes participatory governance and community embedded development as key to sustainable development, China's historical towns still face a contradiction: during the development process, government-led infrastructure upgrades and commercialization measures have brought short-term economic benefits, but they have also caused damage to the interests of the original residents, undermined social cohesion, and weakened cultural vitality. This study, through in-depth research on Nuanquan Town, explores the reasons for the loss of the original residents and the absence of local subjectivity, revealing how governance deficiencies, economic exclusion, and the erosion of social capital jointly lead to the marginalization of local community networks. By introducing participatory governance mechanisms, enabling the original residents to obtain a substantive economic position in the industrial chain, and rebuilding the local social capital network, this study propose feasible strategies for coordinating tourism development with cultural management, and provide lessons for global historical towns.

2 Literature Review

2.1 Research on the Sustainable Development of Rural Tourism

Rural tourism is a key path for rural revitalization, and its sustainable development has attracted much attention in recent years. Scholars believe that it can promote rural economy, protect cultural heritage, and enhance community vitality. Ruiz-Real, J. L. (2020) mentioned that rural tourism is beneficial for addressing rural issues, but it requires environmental friendliness. Nuanquan Ancient Town has been marginalized due to residents not integrating into the tourism industry chain, highlighting the issue of economic benefit distribution. From a cultural perspective, heritage protection is also given equal attention in tourism development. Sheng et al. (2022) advocated for the revitalization and utilization of heritage to enhance community cohesion and avoid "static protection". The migration of residents from Nuanquan Ancient Town can confirm this. Widawski, K. (2023) proposed the concept of "sustainable sharing", and Nuanquan Ancient Town needs to balance excessive commercialization and closed protection. The community participation mechanism is the core. Della Spina, L. (2025) stated that inclusive governance is conducive to heritage and economic growth. Lu et al. (2023) believe that specialty industries should be combined with local culture. Li et al. (2024) warned that excessive tourism dependence will weaken the community's ability to resist risks. The research shows that a three-dimensional mechanism of cultural identity, etc. is needed to achieve long-term and positive development.

2.2 Theoretical Development of Community Embeddedness and Local Subjectivity

The community embeddedness theory originated from sociology and emphasizes overall interdependence. Granovetter proposed that economic behaviors are embedded in social networks. The traditional reciprocal network in Nuanquan Ancient Town was replaced, reflecting the influence of social capital. The theory was further refined into three dimensions. Knapik et al. pointed out that cultural heritage can strengthen community embeddedness. The local subjectivity theory focuses on the active role of community

members. Fahmy et al. (2025) pointed out that residents being excluded from the decision-making system led to the disintegration of cultural identity. The governance dilemma of Nuanquan Ancient Town is a manifestation of weakened subjectivity. The academic community has deconstructed it into three levels, corresponding to the sustainable development mechanism. The integration of these two theories forms an "embedded subject" analytical framework. The models of Della Spina and Widawski can provide ideas for Nuanquan Ancient Town.

2.3 Research Progress on the Protection of Cultural Heritage of Historical Ancient Towns

The protection of cultural heritage in historical ancient towns has shifted from static preservation to dynamic inheritance. In the early stage, the focus was on restoration techniques. Later, it was found that it was difficult to maintain cultural vitality. Sheng et al. (2022) emphasized that the activation and utilization should be combined with community life. Current research focuses on balancing social functions and economic value. Widawski, K. (2023) concept of "sustainable sharing" has been recognized. Nuanquan Ancient Town is facing the problem of simplification of cultural resources. Digital technology helps in protection, but it is necessary to avoid the loss of authenticity. Lu, Y. (2023) emphasized that the protection strategy should be tailored to local conditions. The community participation mechanism is the key. Fahmy, A. (2025) pointed out that residents being excluded from decision-making led to the disintegration of cultural identity. Li et al. (2024) warned that excessive tourism dependence weakens the community's ability to resist risks. A "cultural identity, livelihood guarantee, and decision-making participation" system needs to be constructed.

Although existing studies have recognized the importance of rural tourism in promoting economic growth and cultural preservation, research on the protection of ancient towns in rural tourism is still very limited. In particular, most studies fail to fully consider the subjectivity of the indigenous people and their community embedding in tourism development, resulting in policy recommendations that are often too general and lack specificity and operability. Moreover, there are significant deficiencies in existing research regarding how to balance the relationship between protection and development, especially in ensuring the authenticity of local culture and the sustainable development of the community. This study addresses the urgent problems of ancient towns and, based on theory, explores various challenges in the tourism development of Nuanquan Ancient Town from four perspectives: indigenous people, tourism development, social and economic integration, and policies. We employed a semi-structured interview method to collect first-hand data from different stakeholder groups and provided more specific and practice-oriented suggestions for policy-making. By emphasizing the subjectivity of the indigenous people and their community embedding, we not only revealed the problems existing in the current tourism development model but also proposed specific improvement measures, such as reconstructing the economic embedding mechanism, establishing an adaptive governance system, and rebuilding the social capital network, to achieve the sustainable development and cultural preservation of ancient towns. These research findings and recommendations can provide valuable references and lessons for other historical ancient towns facing similar challenges, and help promote the development of rural tourism research towards a more in-depth and practice-oriented direction. In the following sections, we will analyze the role of indigenous people in tourism development, gender subjectivity differences, community participation, and the commercial transformation of cultural structures, and explore the support of the existing local governance structure for the social and economic integration of indigenous people, as well as the assistance of policy and practical intervention measures in helping indigenous people reintegrate into the economic and social network.

3. Research Subjects and Methods

3.1 Research Subjects

3.1.1 History and Cultural Heritage of Nuanquan Ancient Town

Nuanquan Ancient Town has a history of over 700 years and is a historical and cultural tourist town in Hebei Province（Location: As shown in Figure 1）. This ancient town integrates four remarkable cultural features: ancient villages, castles, ancient mansions, and ancient tea houses and theaters（Cultural heritage is shown in Figure 2.）. The layout of the village, streets, and residences is complete, and it is a typical representative of traditional residential architecture in the northern region.



Figure 1. The location of Nuanquan Ancient Town.

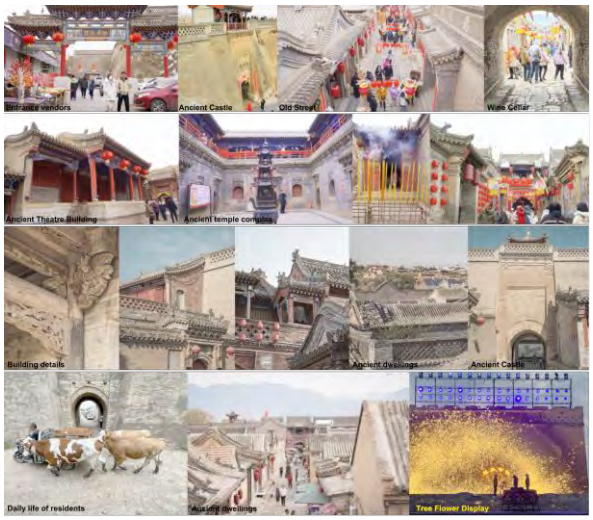


Figure 2. The Cultural Heritage of Nuanquan Ancient Town.

3.1.2 Overview of Tourism Development

The Nuanquan Ancient Town is in a period of accelerated integration of culture and tourism. Its tourism infrastructure, reception capacity and brand awareness are all on the rise. It is expected to attract over 700,000 tourists in 2024. In 2023, the total tourism revenue of Yu County reached 5.057 billion yuan. A product system featuring ancient architecture sightseeing, folk custom experience and characteristic food streets has been formed. However, the "government + enterprise" cooperation model, although bringing in capital and technology, has marginalized the original residents. Most of them can only operate low-profit stalls and are unable to share the main benefits. A more structural contradiction lies in the spatial differentiation of "one town and three forts": the Xigubu, due to its early development and complete facilities, residents can still be integrated into the tourism chain through homestays and cultural and creative industries; while the Zhongxiaobu and the Beiguanbu, due to insufficient investment, most of the historical residences within the fort walls are either vacant or collapsed. The new policy on rural homesteads, combined with the pull of education and employment in the county town, has made "migration, vacancy and decline" the norm. The high cost of traditional construction techniques and the shortage of skilled craftsmen have accelerated the withdrawal of old houses from daily life, leading to a decline in cultural identity. In addition, the tourist flow is highly concentrated at the end of summer and during the Spring Festival "returning home rush", while the rest of the time is a long off-season. Official promotion is still limited to traditional channels and lacks brand storytelling, etc. The absence of diverse products such as night economy, study tours and in-depth experiences of intangible cultural heritage, and the low annual occupancy rate of homestays further weaken the willingness of original residents to continue operating, creating a double bottleneck for community integration and industrial sustainability.

3.2 Semi-structured Interview Method

3.2.1 Selection of Interviewees

This study adopts a semi-structured interview method to collect data from various stakeholders in the tourism development of Nuanquan Ancient Town. The interviewees include 10 local residents, 5 investment developers, 8 tourists, 3 government departments, and 4 cultural protection experts, covering different interest groups. Before the interview, we explained the purpose of the interview to the respondents, obtained the consent of all respondents in advance, and recorded the entire interview process. The distribution of interviewees is shown in Table 1.

Identity	Occupation	Age	Date
The original residents	Farmer	40-49	2024/11/1
	Small Vendors	40-49	2024/11/1
	Craftsmen	50-59	2024/11/1
	House Lessors	40-49	2024/11/1
	Cultural Activity Organizers	30-39	2024/11/2
	Young Migrant Workers	20-29	2024/11/2
	Elderly Residents	70-79	2024/11/2
	Housewives	40-49	2024/11/3
	Retired Teachers	60-69	2024/11/3
	Freelancers	30-39	2024/11/3
Investment and Development Contractors	Corporate Investor	40-49	2024/11/5
	Small and Medium Enterprise Owners	50-59	2024/11/5

	Cultural Real Estate Developers	50-59	2024/11/5
	Tourism Operators	30-39	2024/11/6
	Outside Investor	40-49	2024/11/6
Government Department	Local tourism commissioner	30-39	2024/12/1
	Cultural Heritage Protection Specialist	40-49	2024/12/2
	Urban Planning Project Specialist	30-39	2024/12/2
Tourists	Domestic Tourist	20-29	2024/12/1
	Domestic Tourist	30-39	2024/12/1
	Domestic Tourist	40-49	2024/12/2
	Domestic Tourist	50-59	2024/12/2
	Domestic Tourist	60-69	2024/12/2
	Domestic Tourist	70-79	2024/12/3
	Domestic Tourist	30-39	2024/12/3
	Domestic Tourist	40-49	2024/12/3

Table 1. The distribution of the respondents.

3.2.2 Interview Outline Design

This interview focused on the following key questions: (1) How were the roles of indigenous people shaped and weakened in the development of tourism? (2) How did the development of tourism affect the local social networks and community identities? (3) Did the existing local governance structure support the social and economic integration of indigenous people? (4) How did policies and practical intervention measures help indigenous people reintegrate into the local economic and social networks? The interview used more accessible language.

3.2.3 Time, Location and Recording Method of the Interview

From November 2024 to January 2025, a total of 30 interviews were organized. Each interview lasted for 45 to 60 minutes. The interview locations were selected based on the characteristics of the interviewees. Resident interviews were conducted at community activity centers or in their homes; developer interviews were conducted in offices; and tourist interviews were conducted at tourist centers or at the exit of scenic spots. The interviews were recorded using audio equipment and notes were taken by the interviewers.

4. Results and Discussion

Based on the research and interview results, discussions were held on key issues, and an analysis was conducted on the economic integration status of the original residents of Nuanquan Ancient Town and the development of the community (as shown in Figure 3)

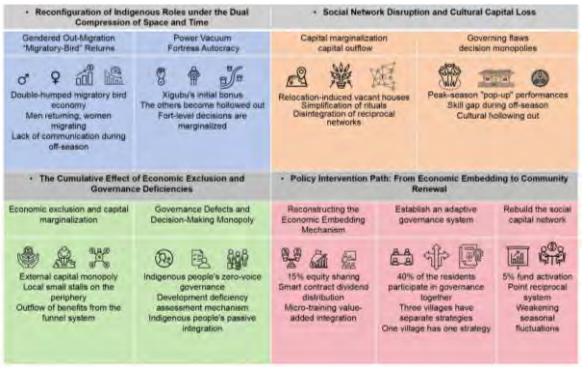


Figure 3. Analysis of the Economic Integration of the Original Residents in Nuanquan Ancient Town and Community Development.

4.1 Reconfiguration of Indigenous Roles under the Dual Compression of Space and Time

4.1.1 Gender-based Differences in the Subject and "Migratory Bird-like" Return to Hometown

Under the stimulus of the double peak of passenger flow at the end of summer and during the Spring Festival, the Warm Spring Ancient Town presents a typical "migratory bird economy": young men usually go out to work and only return during the peak season to do short-term jobs; women, due to marriage, childbirth and educational needs, move to the county town, forming a gender-based migration pattern of "men out and women away". A male resident said, "There are only low-skill tourism jobs here, mainly farming, and the income is too low. Young people have no choice but to go elsewhere." A female resident added, "Our children go to school in the county town. For their convenience, we all moved there. The old house is completely empty now." The short-term economic opportunities during the peak season cannot offset the long-term employment vacuum during the off-season. The original residents find it difficult to establish sustainable local livelihoods, further weakening their voice in the tourism value chain.

4.1.2 Lack of Power and "Bu-level" Decision Monopoly

Xigubu gained an initial advantage due to its early investment. The local residents could still integrate into the tourism economy through guesthouses and cultural and creative stores. However, the Zhongxiaobu and Beiguanbu, which lacked long-term investment, saw most of their historical buildings become vacant and collapse, and the residents were systematically excluded from planning and benefits. The interviewed residents generally reported: "We had no opportunity to

participate in the decision-making. How should the Iron flower display performance be changed, and how should the tickets be distributed? No one ever asked us." The imperfect governance structure and the dominance of external capital have placed the original residents at the periphery in both the town-level and fortress-level decision-making processes, leading to the prosperity of Xigubu while the Zhongxiaobu and Beigubu deteriorated further.

4.2 Social Network Disruption and Cultural Capital Loss

4.2.1 Systemic Weakening of Community Participation

The policy of relocating rural homesteads and the promotion of education and employment have led to the loss of the daily functions of old homesteads, and community rituals have also shrunk. Residents lament: "In the past, the entire village would participate in festivals, but now it's just tourists taking photos." The traditional reciprocal network has been replaced by market-oriented relationships, and community cohesion has sharply declined, simultaneously weakening the ability to resist seasonal risks brought by tourism.

4.2.2 Commercialization of Cultural Structures and "Hollowing Out"

During peak seasons, culture is reduced to sellable "pop-up performances"; during off-seasons, traditional handicrafts suffer from lack of profitability and fall into disuse. An old craftsman lamented: "There are no successors for the old skills. My craft may soon be lost." When culture transforms from a practical aspect of life into a symbolic landscape, its community identity function is undermined, accelerating the "cultural and spatial" dual hollowing out.

4.3 The Cumulative Effect of Economic Exclusion and Governance Deficiencies

4.3.1 Marginalization of Capital and Outflow of Profits

A resident sighed, "We can only set up small stalls and earn a meager income. Those large hotels and performance venues have been controlled by external investors. We can hardly get any benefits." The tourism industry chain of Nuanquan Ancient Town is dominated by external capital. In particular, large investment institutions such as CITIC Industrial Fund played a leading role in the development of Xigubu, forming a typical "tourism development model driven by external capital", causing local residents to be in a marginalized position. They mainly operate low-profit stalls and sell homogeneous products, while the high-profit hotels and performance venues are controlled by external investors. This led to the outflow of tourism revenue from the local economy, exacerbating economic and social structural inequality.

4.3.2 Governance Defects and Decision Monopoly

A resident complained: "It feels like we have no say at all." The governance structure of Nuanquan Ancient Town is not well-established, lacking adequate consideration and protection for the interests of the local residents. This governance model lacks social impact assessment, restricting the social and economic integration of the local residents and leaving them in a passive position during the tourism development process.

5 Strategies and Suggestions

5.1 Reconstructing the Economic Embedding Mechanism

At the legal and policy level, the tourism development projects of the ancient towns will be incorporated into the current regulations. Drawing on the community shared-ownership model in Canada and the "village-enterprise common prosperity fund" system in Dongyang, Zhejiang Province, enterprises are required to transfer 15% of their equity to the village collective, with quarterly dividends. In addition, the county-level human resources and social security, culture and tourism, and rural revitalization departments jointly formulate "micro-training" plans, with the course duration controlled within 3 to 7 days. The content covers high-value-added aspects such as heritage interpretation, digital cultural tourism product design, and short-video operation. After the training is completed, an employment agreement is signed with the project operator, forming a closed-loop structure of training, employment, and dividends, effectively alleviating the employment vacuum during the off-season of tourism.

5.2 Establishing an Adaptive Governance System

Drawing on the experiences of international governance and the "micro-grid" system in Zhejiang Province, the "Nuanquan Ancient Town Development Committee" was established. The committee is composed of local residents, the town government, enterprises, and social experts in a ratio of 4:2:2:2. It is divided into three areas: Xigubu, Zhongxiaobu, and Beiguanbu. The accommodation, dining, and stalls in Xigubu are first available for local villagers to apply for, and the remaining spaces are then open to the public. In Zhongxiaobu, the village collective leases the old houses, and the claimants must build an intangible cultural heritage workshop and train apprentices. In Beiguanbu, those who restore the old houses using traditional techniques can enjoy 5 to 10 years of low rent and are not allowed to make structural changes. Each

area has a "micro deliberation hall", and the "bench meeting" takes place on-site every month for on-site decision-making.

5.3 Rebuild the social capital network

Drawing on the "Hometown Tax" system in Japan and the "Community Micro-Fund" model in Chengdu, 5% of the ticket fees, parking fees, and shop rents will be allocated to the "Nuanquan Heritage Revitalization Fund", which will be specifically used for the restoration of traditional dwellings and the revival of endangered festival rituals. A "Community Point System" will also be implemented: Residents can earn points for participating in cleaning, guiding tours, and festivals, and these points can be exchanged for dividends. The list and accounts will be publicly displayed quarterly. The use of both the fund and the points system will rebuild mutual benefits among neighbors, cushion the impact of off-peak seasons, and enhance the resilience of the community.

Through the integrated mechanism of spatial differentiation governance, seasonal risk mitigation and the reconstruction of the original residents' subjectivity, the Nuanquan Ancient Town is expected to break the vicious cycle of "boom in peak season, hollowing out in off-season, and long-term decline", and move towards truly sustainable community embedded development.

6 The limitations of the research and future prospects

This study has thoroughly explored the issue of local subjectivity reconfiguration in the Nuanquan Ancient Town under the background of rural tourism. However, there are still some limitations. Firstly, the research conclusions are mainly based on the case analysis of the Nuanquan Ancient Town, and their universality may be limited. Although the case of Nuanquan Ancient Town reveals some common problems in rural tourism, other ancient towns in different regions may exhibit different characteristics and needs due to differences in culture, economy, and social background. Future research can conduct multi-case comparative analysis to further verify and improve the conclusions of this study.

Secondly, the time range of this study is relatively short, mainly covering the period from 2024 to early 2025. To better understand the long-term impact and sustainability of rural tourism, future research can adopt longitudinal research methods to track the tourism development process of Nuanquan Ancient Town and other similar ancient towns, observe the long-term effects of policies and intervention measures. For instance, regularly collect data on residents' satisfaction, the structure of tourism revenue, the frequency of cultural inheritance, residents' participation levels, community cohesion, and the long-term effectiveness of policy interventions.

In addition, this study mainly focuses on the social and economic integration of the indigenous people and the cultural inheritance in rural tourism. However, there is relatively less in-depth analysis of other important stakeholders in tourism development (such as tourists, developers, and the government). Future research can further explore the interaction relationships among these stakeholders and their impact on the sustainable development of the ancient town.

Future research can also supplement quantitative analysis methods, such as questionnaire surveys, to more comprehensively assess the impact of tourism development on the economy, society, and culture of the ancient town. By integrating multiple research methods, it can provide more scientific and comprehensive decision support for the sustainable development of rural tourism.

In conclusion, by emphasizing the subjectivity of the indigenous people and their community embedding, this study not only reveals the problems in the existing tourism development model but also proposes specific improvement measures. It can provide valuable theoretical and practical references for the development of Nuanquan Ancient Town and other historical ancient towns facing similar challenges, and provide new ideas and methods for achieving the sustainable development of rural tourism and cultural protection.

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PROMOTING LANDSCAPE QUALITY FOR THE WELL-BEING OF POPULATIONS. FROM KNOWLEDGE TO IMPLEMENTATION OF THE "WELL-BEING AND LANDSCAPES IN BRITTANY" SURVEY

TOPIC: Ecological and social issues addressed using public consultation tools

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Abstract

In line with regulations, European and national commitments and local landscape issues, local authorities are responsible for setting landscape quality objectives in their urban planning documents, in line with the aspirations of inhabitants. Yet these "everyday" landscapes are valued differently by everyone. Preserving quality landscapes for the individual and social well-being of all requires considering these differences in perception and developing solutions that reconcile the various issues with a view to social and territorial equity.

The aim of France's first regional survey of everyday landscapes and their impact on the inhabitants is to help local decision-makers understand how people feel, and act accordingly. Entitled "well-being and Breton landscapes", the survey was carried out by the *Observatoire de l'environnement en Bretagne* with its partners. It answers two questions: What are the characteristics that make landscapes considered qualitative today? What are the challenges for improving the quality of tomorrow's landscapes?

During the autumn-winter period 2022-2023, almost 2,300 Bretons answered some 50 questions about their feelings and wishes regarding landscapes within 1km of home, those within 1km of work and those visited during leisure time. In view of the large number of participants, for the first time the social dimension of landscape - "an area, as perceived by people" - is objectivized by robust data on a regional scale.

The survey results provide a wealth of information on everyday landscapes. For example, the results concerning landscapes linked to the home provide us with information on socio-spatial inequalities. The assessment of well-being shows major differences according to age and housing type. Often wrongly judged as a non-operational concept because it is "too" subjective, the landscape is nonetheless a gateway to defining shared values: 75% of the inhabitants feel that the priority action is to maintain the bocage. The bocage is the symbol of a conquest of the desired rural landscape: it refers to the regional identity through its peasant history and its multifunctionality in the service of the environment. As for the urban environment, it is seen as a laboratory for a variety of actions to be implemented in response to environmental issues.

The results of the survey also show where the affective relationship is weakest, and that's in workplace landscapes considered above all as functional and evoking a variety of nuisances. These are landscapes that need to be investigated to improve well-being. To get to work, 78% of people observe landscapes on a daily basis. Almost half have daily tactics for improving their trajectory in terms of landscape quality.

The discussion outlines the current and potential effects of this survey in Brittany at different scales. The results could be incorporated into various regional programs. Locally, local authorities are using the data at their own scale as part of their planning documents. Because the first result of the survey is the high level of public interest in landscape issues, the results of the survey have been transcribed into plays for distribution to local inhabitants.

1. Introduction



Figure 1. This study is based on everyday landscapes. © *G. Bonnel, photographic landscape observatory of the DDTM and the Ille-et-Vilaine department.*

During the autumn-winter period of 2022-2023, almost 2,300 inhabitants, elected representatives and landscape professionals in Brittany took part in the regional "well-being and Breton landscapes" survey [Reference 1: OEB, 2024]. This considerable contribution highlights the first result: Bretons are involved in the collective construction of landscape knowledge by responding to the survey.

Analyzing perceptions enables us to characterize and qualify our landscapes as closely as possible, based on the experiences of each and every one of us. This approach is fully in line with the notion of landscape as defined in the Council of Europe's Landscape Convention (2000): "an area, as perceived by people". Landscape is an essential component of human beings' surroundings. For the Council of Europe, it expresses "the desire to confront, head-on and in a comprehensive way, the theme of the quality of the surroundings where people live; this is recognised as a precondition for individual and social well-being (understood in the physical, physiological, psychological and intellectual sense)" [Reference 2: Council of Europe, 2008]. The results of the survey are intended to show the factors of well-being that are derived from the characteristics of everyday landscapes.

Because the issue of everyday landscape is a recent one in public policy, the construction of landscape data is also recent. The network of players involved in landscape knowledge in Brittany is very active (State services, Brittany Region, ESO laboratory at Rennes 2 University, Ille-et-Vilaine and Côtes-d'Armor Departments, Armorique and Gulf of Morbihan Regional Nature Parks, Brest-Brittany Urban Planning Agency and Brittany Biodiversity Agency). His aim is to develop a science that is created with citizens and experts, a participatory science that can influence public decision-making, particularly in land-use planning.

That's why the *Observatoire de l'environnement en Bretagne*, a public interest group created in 2007, has launched the first-ever regional survey in France, asking the inhabitants directly what they think of their everyday landscapes: Do you feel comfortable in your living environment less than 1 km away? What landscapes do you enjoy within 1 km of your home? How do you perceive the landscape during your commute?
The survey results put into words the landscapes we encounter every day. The originality of the survey lies in the fact that it will be repeated in 10 years' time to measure changes in perceptions of Breton landscapes. The results are intended to help decision-makers understand how citizens feel, and how to improve their well-being, through actions such as the development of public areas, modes of transport and places for socializing. The aim is also to facilitate democratic debate on the construction of our territories by giving citizens access to landscape knowledge.

The first part of this article shows that this survey stems from an active working group in Brittany dedicated to the creation of landscape indicators. Wishing to build robust social indicators, the working group designed the survey to obtain qualitative and quantitative data representing Brittany's landscapes and populations. The second part highlights the results of the survey, based on the following triptych: living landscapes, working landscapes and leisure landscapes. The landscapes traversed are also questioned and linked to the everyday landscapes. The discussion shows how these results have an operational impact on territories.

2. Method and materiels

2.1. The co-construction of landscape indicators

With its main mission to provide reliable environmental data, the *Observatoire de l'environnement en Bretagne* (OEB) has developed the "landscape" topic from 2018. One of the challenges is to build landscape indicators to complement the panel of regional environmental indicators on water, climate, biodiversity, etc. An indicator is defined as "a parameter or a value calculated on the basis of parameters giving indications on / or describing the state of a phenomenon, the environment or a geographical area" [Reference 3: OCDE, 1993].

A working group made up of some fifteen Breton institutions is working on this issue, with the aim of measuring changes in the landscape, with a view to maintaining or even improving landscape health. By 2021, eleven landscape indicators will have been constructed: monitoring of regional landscape dynamics based on landscape atlases and photographic landscape observatories, number of populations concerned by a landscape plan, etc.
Following this initial exploratory work, the working group decided to create new social data based on a survey of local inhabitants. The ambition of the regional "well-being and Breton landscapes" survey is to define what makes for quality in everyday landscapes by answering two questions:
- What are the characteristics that cause landscapes to be considered qualitative today?
- What are the challenges for improving the quality of tomorrow's landscapes?

The aim is also to examine the links that local inhabitants (if they exist) forge with landscapes, in order to provide food for thought on territorial knowledge and planning tools (landscape atlases, landscape diagnosis in planning documents, ecological coherence schemes, etc.).

2.2. Data representative of Brittany's landscapes and populations

Launched from December 2022 to March 2023, the survey consists of an online questionnaire on the oeb website and semi-directive field interviews conducted by nine students from two master's degrees in geography at the university of rennes 2.

The survey questions are structured according to a multiscale approach to living landscapes: living landscapes within a kilometer of home, working landscapes within a kilometer of work, and leisure landscapes within a kilometer of home. Setting a perimeter allows respondents to concretely define landscape boundaries mentally.

The three scales are also clearly identified by the daily practices of each inhabitant. Questions shed light on the perception of landscapes crossed during commuting and leisure activities. This approach has the advantage of identifying the conditions necessary to define quality landscapes according to the social functions inherent in landscapes, and according to the individual or collective choices desired or undergone. The triptych also makes it possible to translate the results into action.

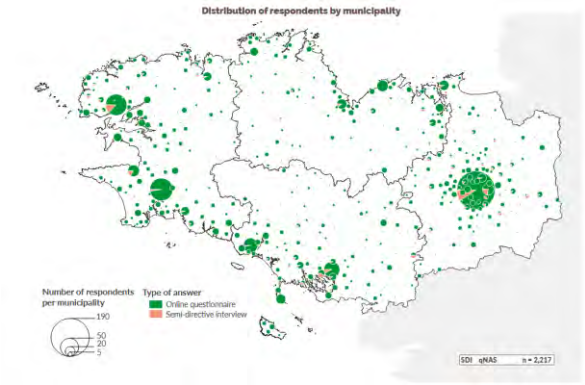


Figure 2. Out of 1,207 municipalities, 632 municipalities are covered by the sample.
© *Observatoire de l'environnement en Bretagne*.

Nearly 2,300 people took part in the survey, including 120 in the field interviews, representing 1,000 pages of transcriptions. The entire sample is representative of the variety of Breton landscapes, in terms of municipality density as defined by the *Observatoire des territoires*, coastal and non-coastal municipalities and landscape families [Reference 4: Le Dû-Blayo *and al.*, 2013].

To guarantee the survey's representativeness, questionnaire data is adjusted for socio-spatial characteristics (age, gender, socio-professional categories, demographic weight by department). Similarly, the 120 people who took part in the semi-structured interviews were selected according to these criteria. This sample is therefore representative of the Breton population, both socially and geographically.

3. Results in the form of priority actions to enhance landscape quality

3.1. Quiet and nature, the landscape qualities of the places where you live

A majority of 86% of Bretons feel comfortable living within one kilometer of their home. The notion of well-being is associated with a calmness and increased contact with nature close to home. The way of living is a determining factor in the appreciation of this well-being (living in a house and living in sparsely and very sparsely populated municipalities).

As for the 14% of respondents who feel "neither well nor not very well" or "not very well" in their place of living, several socio-geographical variables explain these results:
- living in a densely populated municipality.
- living in a block of flats and, more generally, in a city center or neighborhood.
- living in an area considered "quite noisy" or "very noisy".



Figure 3. Brittany's coastal landscape.
© D. Lédan, photographic landscape observatory of Gulf of Morbihan Regional Nature Park.

In terms of daily practices, inhabitants in densely populated and intermediate areas are more inclined to socialize, whereas in rural areas, they prefer contact with nature. The less densely populated the municipality, the stronger the links with nature.

There are also major differences at both ends of the age spectrum. Young people feel the least comfortable in their living environment and have the least contact with nature, as they combine the above-mentioned socio-geographical variables. Those aged 65 and over feel better than other age groups and have the most contact with nature.

Contact with nature and calmness are guarantors of the quality of the living environment, and communal density is ultimately a major variable in the appreciation of well-being. These results raise the question of social and territorial equity in terms of access to quality landscapes for all. With the goal of "Zero Net Artificialization of Soil" by 2050, the quality of urban landscapes for the well-being of inhabitants is a major issue. Urban planning in favor of health, developed by the *École des Hautes Études en Santé Publique* in Rennes (France) and others, offers a range of approaches to support urban development projects that respond to this challenge: densifying the city while encouraging as much contact as possible with nature (from one's window and downstairs) and reducing as much as possible all types of pollution, including noise pollution [Reference 5: EHESP, 2020].

3.2. Maintain the bocage and limit urban sprawl close to home

Often wrongly judged as a non-operational concept because it is "too" subjective, landscape is nevertheless a gateway to defining shared values: 75% of inhabitants believe that the priority action is to maintain the bocage. This is the most popular action, regardless of municipality density. Nevertheless, it is widely favored in rural municipalities (90%).

With 64% of the region devoted to agriculture, and a well-known agri-food industry (1st region in France for meat production and processing), the bocage is here the symbol of a conquest of the desired rural landscapes: it refers to the regional identity through its peasant history, and to its multifunctionality in the service of the environment (water, air and soil quality, etc.) and agriculture (refuge for crop auxiliaries, windbreaks for animals).

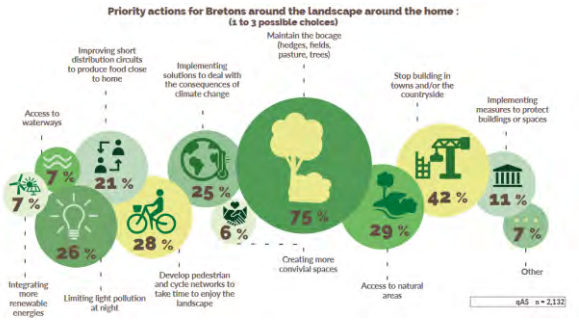


Figure 4. 75% of Bretons consider that maintaining the bocage is the priority for improving the landscapes where they live.
© Observatoire de l'environnement en Bretagne.

4 out of 10 people want to "stop building in towns and/or the countryside". Brittany is the 2nd region in France with the highest rate of artificialisation, and Bretons are aware of the impact of this phenomenon on the landscape. The underlying aim is to limit the fragmentation of environments in favor of biodiversity.

The urban environment, for its part, is seen as a laboratory for a variety of actions to be implemented in response to environmental issues. Indeed, inhabitants living in densely populated areas propose more varied responses than the question of the bocage: "having access to nature areas", "limiting light pollution at night", "implementing solutions to the consequences of climate change".

Ultimately, strengthening ecological corridor policies contributes to both plant and animal biodiversity and the well-being of inhabitants.

3.3. Greening the workplace landscape

Workplace landscapes are an integral part of inhabitants' daily lives, and a dozen or so questions were asked about their appreciation. These landscapes are the most depreciated in everyday life. Indeed, for 39% of inhabitants, landscapes within 1 km of the workplace are pleasant, with a quality environment, and 44% answer that "many things need to be imagined making the environment appreciable".

The workplace is a functional space where the surrounding landscape is not necessarily a specific criterion of individual or social well-being. 72% of working people living in very low-density areas describe their workplace as pleasant. For the other three density typologies, 37% of working people rate their workplace as pleasant. Respondents who work in the city may show a form of indifference to the landscape that surrounds them at work. It is also in the workplace that respondents mention the greatest number of nuisances, be they noise, visual or olfactory: "Proximity to the expressway and busy road which cause a lot of noise and pollution (odors, exhaust, pig transport truck)".

Qualification of the workplace's external environment would require further study, to pinpoint the factors behind its depreciation (perception of the work itself, reception conditions, analysis of the landscape and practices in the field, etc.). However, the survey shows that these landscapes are unsatisfactory for many, with many actions to be taken to improve their quality.



Figure 5. Example of a working landscape. © *G. Bonnel, photographic landscape observatory of the DDTM and the Ille-et-Vilaine department.*

These priority actions are mainly focused on greening workplaces: "More green spaces in the heart of the industrial zone". Favoring public transport, soft mobility and de-urbanization are also actions favored by a good number of respondents.

While Bretons have an affective relationship with the landscapes in which they live, the landscapes in which they work play little part in social thinking. With 8 out of 10 inhabitants working indoors, the outdoor landscape is of secondary importance.

3.4. Maintain and enhance the quality of natural landscapes

For leisure, 7 out of 10 Bretons visit natural areas. Leisure areas are chosen because they meet quality criteria: the search for beauty, the search for symbiosis with natural elements (waterways, trees, wind, waves, rocks, etc.) and the search for social isolation. In fact, 87% of inhabitants consider landscape quality to be a motivation for visiting a leisure destination.

Underlying all this, Bretons want nature to be less anthropized. It's the "others" who contribute to landscape degradation. Tourists, but also other users, are often singled out for their practices that do not respect the environment or the way people live together: non-respect for natural areas, lighting fires, soil degradation, dog droppings, pollution from waste, hunting, etc. 12% would therefore like to see a better distribution of social practices in leisure landscapes, with, for example, a better division of time devoted to walking and that for hunting, measures to limit over-frequentation of areas, and so on.

The actions expected in favor of leisure landscapes are ultimately geared towards respecting and protecting nature by reconciling natural dynamics and social practices: encouraging soft mobility and reducing the role of the car, de-urbanizing, maintaining paths, limiting all forms of pollution.

3.5. Accentuating space-time as you cross the landscape



Figure 6. Example of landscape crossed. © *G. Bonnel, photographic landscape observatory of the Finistère DDTM.*

Symptomatic of petroleum landscapes, the landscapes crossed are part of everyone's daily routine: on the way to work on the way to a place of leisure, and so on. This imposed time in the rhythm of life is ultimately diverted/increased, as this space-time contributes to people's well-being. Our survey shows that regardless of the number of kilometers traveled to get to work, landscape observation is a common practice for many Bretons (78%). Landscapes are described as different depending on the location (44%), pleasant (39%) and changing with the seasons (38%). It's mainly the 16–25-year-olds who have a more mixed perception, describing them as monotonous and stressful.

Individual tactics are put in place to improve daily life. Nearly 1 in 2 people sometimes take the time to change their route to get to work through a more pleasant landscape. And the older people get, the more likely they are to modify their home-work route.

While Bretons have little connection with the environment outside their workplace, they do have a more developed relationship with the landscapes they pass through on a daily basis. This is all the more true when it comes to leisure travel.

In their free time, when travelling to their place of leisure, the residents particularly enjoy passing through landscapes. Landscapes are observed by 91% of inhabitants. They are appreciated for being pleasant, changing and soothing. 77% of Bretons sometimes change their itinerary to take advantage of a more pleasant landscape. Here, landscape quality plays a key role in inhabitants' perceptions. From roads, greenways or streets, travel is an opportunity for inhabitants to take time to discover or rediscover landscapes. Taking care of roadsides is of real importance in improving the quality of everyday landscapes. This goes hand in hand with Bretons' desire to prioritize active modes of transport (cycling, walking) by consolidating, securing and planting soft paths. In this way, landscape quality contributes to the health of residents via their daily physical mobility.

4. Discussion

Densifying the city by integrating quality biodiversity wherever possible, promoting the benefits of nature to young people, reinforcing the bocage network, "naturalizing" spaces where everything is mineral, greening and increasing the number of soft paths are all actions to be taken that echo the values shared by inhabitants. They also echo solutions for adapting to climate change. The results of the survey can be used to make a success of the ecological transition through landscape, from the regional to the local level.

For example, the results could be integrated into the various regional programs to meet the needs of inhabitants. Expectations in terms of soft mobility and ecological corridors via the bocage can be integrated into the regional plan for regional planning, development sustainability and equality of territories (SRADDET).

In the same vein, the question of well-being through landscape quality could be a prerequisite in the orientations of the Regional Environmental Health Plan (PRSE) and echo the new landscape/health recommendation in the context of the implementation of the Council of Europe Landscape Convention. By renewing the survey, these social indicators would also make it possible to evaluate these public policies through the prism of inhabitants' experiences.

Once the results have been circulated to local authorities in 2024, etc., work is underway to help local authorities make the results their own. For example, the *Pays d'Auray*, as part of the revision of

its territorial plan, is using data from its own territory to begin a landscape diagnosis. In the same vein, the *Parc Naturel Régional du Golfe du Morbihan* is carrying out the same work for the revision of its charter. This operationalization is possible when the sample size is sufficient. Where this is not the case, the OEB can help local authorities to apply the survey method on a local scale, to deepen the study of local landscape representations and compare them with the regional frame of reference.

OEB and its partners are working with a professional theater company to develop a cultural program for the 2025-2026 season. Based on the results of the survey, inhabitants will be invited to create and perform a play entitled *Se souvenir des loups*. The aim of the various public presentations is to continue disseminating the results, but more broadly to promote the landscape approach to develop new ideas about the world's habitability and our relationship with the living.

5. Conclusion

This demonstration shows how people's experiences can be considered in public policy. Being cross-cutting, the notion of landscape offers a framework for cross-sector collaboration between policies (urban planning, transport, housing, tourism, climate, etc.) and practices relating to landscape and health. The new Health and Landscape Recommendation in the context of the implementation of the Council of Europe Landscape Convention opens the way to new areas of exploration. It reinforces the European project of social cohesion, defined by the Council of Europe as "the capacity of society to ensure the well-being of all its members". Assessing landscape quality and its links with human health is an opportunity to collectively define well-being and ensure this project. Through the "Well-being and Breton landscapes" survey, the first milestones have been set in Brittany.

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Landscape Architecture Criticism : a way to make the projects going on...

Topic: Guiding cities with society: Participatory approaches and governance strategies

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Abstract
One of the most singular aspects of the Landscape Architecture Project is that it needs a long time to be achieved. Not only because it is made of living materials, and especially plants that need time to grow, but also because the way people and societies appropriate public spaces is a long time action. But strangely, most of the Landscape Architecture offices show their project as they are some months. after their building, and very rarely many years after. At the same time, the Landscape Architecture Institutions ask since several decades for a reform of the designers' contracts in order to integrate a long time mission after the building site, but they aren't successful.
The question that we would like to ask here is : how could Landscape Architecture create such new missions although they cannot be integrated in the professional contracts? And the answer we'll propose and illustrate is that this new instance could (and should) be the critical one. Indeed, critic is a way of considering projects not from their designers'point of view, but from the users' one, in the ordinary time of their every day life. Because it shows and analyse projects as they become several years or decades after their building, the Landscape Architecture critic could become a way of make them going on by exploiting their social and biological dynamics, revealed by analysis.
This communication will be based on the works led since 2018 by a French team of LA critics, all teachers and researchers in the different French LA schools. This "Critic and Landscape project Network" has experimented some aspects of what could be a coherent and useful LA critic. Indeed, criticizing Landscape project can't be like criticizing a movie or a painting : public spaces involve specific problems that must be faced and studied. We will show some aspects of this work and hope that it will bring a lot of questions answered suggestions from our colleagues.

1. Introduction

1.1. One of the most obvious specificities of the landscape project approach, we think everyone would agree, is its relationship with time.

1.1.1. Whereas an architectural project produces a three-dimensional object that is immediately operational and expected to be marginally transformed beyond that point, a landscape project implants a space in the territory whose functionality is sometimes only partial, whose forms and ambiences are not yet complete, and sometimes cannot even be glimpsed, and whose constituents are called upon to transform themselves, sometimes radically.

1.1.2. This particular temporality is usually attributed to the fact that the landscape project mobilizes living materials - plants, of course, but also the soil and the water that runs through it, all of which need time to grow and develop.

1.1.3. Less frequently, we associate the landscape projects relationship with time with the fact that, in addition, it produces spaces destined for uses whose planning is always uncertain and whose evolution unpredictable.

The spaces we design may initially be intended for sporting or recreational functions, and then be reallocated to unforeseen uses such as the installation of a market or a fair, or the addition of various facilities. The changing populations who use them, and the sociological mutation of the neighborhoods in which we work, also explain why the practices that take place there often change substantially, and modify the space in return.

1.1.4. By mobilizing living materials and shaping a constantly evolving social life, landscape projects produce spaces whose quality can only be fully appreciated several years after the work has been completed.

1.2. It is therefore quite paradoxical that the media organs of our profession, such as specialized magazines, agency websites and exhibitions, often show our creations only a few months, or even weeks, after completion of the work.

The grass may be green, the young trees may still have all the vigor that their slow preparation in the nursery has given them, the floors and street furniture may be impeccable, but at this stage, the work is more architectural than landscaping.

We believe that maintaining such ambiguity, and giving the impression to clients that time is, in fact, an insignificant dimension of the quality of a landscape designers' work, fosters confusion with the work of architects or project managers, and its hardly surprising that the latter so easily seize on a form of activity for which, in reality, they are not trained.

When our magazines, publications, exhibitions and websites show and discuss our projects as they are 10, 20 or 30 years after delivery, landscaping will finally assert itself as the holder of its own know-how and aspirations, which few will be able to dispute.

2. The impossible introduction of a long time maintenance in the usual Landscape projects

2.1. But how will we introduce into the design process the consideration of its long time « alteration »?

2.1.1. The professionnel councils and syndicates, especially the Federation Française du Paysage, claim since many decades to integrate into the designers' missions a specific element dedicated to the project long time support. One part of the fee should pay for this mission, and the more it will be important, the more the quality of the support will increase.

2.1.2. Unfortunately, this demand meets with a complete refusal for different reasons. Modifying the rules of the designers' contracts means that the specific way Landscape architect are working is recognized, what doesn't occur at this time, at least in France. The Landscape architects missions are still the same than the Architects'ones, despite for them the long time support is not so necessary. The lack of political

and institutional attentiveness for the Landscape architecture professions explains the failure of all their tries to obtain such reforms.

2.1.3. And maybe there is also some kinds of intern oppositions to this reform into the profession. Indeed, such long time missions induce an important lengthening of the contracts, that could disturb the management of the private offices, even when they are Landscape architecture offices. By addition, would the work enterprises in charge of the initial building site be also in charge of this kind of deep and long time maintenance? If this support induce a set of humble corrective works many years after the initial building site, will this kind of work be profitable for those enterprises? And also, who will decide that such or such transformation of the initial design has to be realized? Can we imagine that any demand, coming from any neighborhood association, or any nature protection foundation, should be accepted?

2.2. For all those reasons, we think that if it is so difficult to add long time maintenance missions into the Landscape architects'contracts, it is simply because it is impossible in the actual frame of their mission, that doesn't recognize the project alteration as a full part of the design process. And so, it is more simple and efficient to imagine a specific proceeding dedicated to the life of « the project after the project ».

3. The critical approach to make the project going on

3.1. That is that proceeding that we call the critic approach. Indeed, criticism involves understanding a work of art - a film, a building as well as a public space or a park- not only from its designer point of view, but also from that of its commissioners, that of its users and of the social, political, economical and cultural context in which they are involved. What critic studies is not the project for itself, but through its choices and meaning and its effects on the society and the people living in.

3.2. Since 7 years, a teacher's and researchers' network has been created in France in order to study the methodological conditions of such a critical approach, applied to the Landscape architecture projects.

3.2.1. Gathering teachers from the 5 French Landscape architecture schools and from some Architecture schools giving importance to the Landscape teaching, this network has studied during its seminars and its site works diverse questions like the role of the fieldworks in the critical evaluation, why and how interviewing the project actors, or the importance of the project archives analysis.

3.2.2. In November 2023, it has presented its conclusions to a large audience of practionners, students and teachers gathered during the « Etats Généraux de la Critique de projet de paysage » in Blois Landscape School.

3.2.3. Those researches show that it is really possible to build pertinent methodologies in order to understand how the landscape project goes on after its building. The challenge is here to understand the evolution or alteration of the project not like its disfiguration - as it is the case most of the time-, but like the following steps of a continuous process of transformation of the public space : a process in which the designer's work has been a very strategic and decisive moment, but nevertheless, just a moment among a lot of other, before and after his intervention.

3.2.4. This idea postulates an understanding of the project like a long time process informed not only by the designers, but also by the abiotic, biological and social forces. In reality, it simply extends the consensual idea that a good Landscape project must be designed in reference to the existing place, that means the place as it hase already been designed before the Landscape architect work. If our projects are the continuation of the ancient ones through the analysis of the existing site, why

wouldn't we admit that our projects will go on through the ones that will occur after us?

4. Critic is a full part of the design process

4.1. The result of this is that because it deals with such a dynamic understanding of what is a project, the critical approach can not be separated from the design activity. Indeed, even if the critical approach comes after the building site, it describe the way the project is already changing and how this way is the following of the designer's intentions. In that way, it aims to anticipate possible new changes.

4.2. One of the most important teachings of the Etats Généraux de la Critique de Projets d'espaces publics is that, for most important part of the audience, it seems quite logical that the critical approach should be integrated in the design process, as a good way to make the project going on after its building. It could prescribe complementary works in order to support the changes of the built place without forgetting the initial purposes of its designers - that is the big problem with the usual public spaces maintenance.

4.3. Moreover, the Landscape projects critic Network has just begun a new research program with a French planning authority in order to expriment how such post-building projects could be imagined and realized.

4.4. If it is proved that this kind of approach is possible, we should then imagine how to fully integrate the critical approach in the usual design process, in the schools and institutions where the Landscape architects are formed, and also into the regional services in charge of the public space maintenance. It is a complete part of the 21st century's Landscape architects activity that is to be built, especially as this way of leading the design activity is in perfect relation with the challenges of the global climate and democratic crisis that we have to face.

4.4.1. Because it focuses on already built places more than on new places and infrastructures, the critical approach participate to the ecological challenge.

4.4.2. And because it mainly deals with the way people and civil society takes on their own environment, the critical approach helps them to feel and become responsible of the world as their home.

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LANDSCAPING_ON_THE_EDGES_OF_BRAZIL: Proposition for an urban project along the Oiapoque quay

TOPIC: Guiding cities with society: Participatory approaches and governance strategies

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Keywords: Oiapoque waterfront, city of Oiapoque, ecological landscaping, borders, Amapá.

Abstract

At COP30, the world's attention is focused on Brazil, which is suffering high deforestation rates and faces contradictions regarding its environmental management. The question that arises is how cities react to poor urban management that leads to climate change and, consequently, to the poor quality of life of their populations? To answer this question, we contextualize the situation of Oiapoque, a city located in the extreme north of Brazil bordering French Guiana, one of the French overseas territories. In northern Brazil, the wetlands, also known as ressacas, are in a constant process of degradation, raising concerns for governments. The Oiapoque River, which is 360 km long, forms a natural and geopolitical border with the French Guiana, in the state of Amapá. This is an exploratory study that investigates the relationship between the population and different elements of the landscape, such as urban trees, the river, the Binational Bridge (the only one connecting a South American country to the European Union), mining and the prospect of future oil exploration in the municipality (expectations of receiving millions of reais in royalties). The themes of illegal mining, oil, prostitution, indigenous peoples, the environment, and immigration seem mandatory in a space of confinement, exploration and occupation of borders. This work allows us to observe different types of borders and landscapes, where a dialectic between nature and culture, natural, urban and human landscapes is present. The research focuses on some key elements: the river x the bridge x the forest x the urban trees, highlighting their symbolic aspect and defining the residents' emotional relationships with these elements. The Oiapoque River and his coast are present in the population's imagination, just as the vibrant vegetation of the Amazon rainforest is also part of this. In the urban context of the city, however, trees do not seem to have such a defined role. What is the most strongly felt affective landscape for the population of the city of Oiapoque? The river, the bridge, the forest? This research sought to understand the relationship between "affective landscape" in Amazonian cities and propose a project for the city's waterfront with a new use for this city, providing spaces for contemplation, tourism, leisure, and preserving the natural landscape, proposing a green and tourist corridor as a tool to enhance the urban context.
The objective of this work is to analyze the current problems and propose a landscape project that is viable, contemporary, and at the same time meets the demands of tourists and residents. To obtain the proposed results, a design strategy is divided into four stages: field visit, diagnosis, conceptual plan, and design. The relevance of the research lies in the inclusion of landscape in a space of confinement, exploration, and occupation of frontiers, a Brazilian "wilderness." The project points to a problem surrounding the contamination between reality and the stereotypical views constructed about this little-known Brazil, contributing to the process of historical, cultural, economic and tourist development of Oiapoque.

1. Introduction

Oiapoque is a Brazilian city located approximately 600 kilometers from the capital of the state of Amapá, Macapá. This municipality that symbolically marks one of the country's entry points. Bordered by the Oiapoque River, which separates it from French Guiana, it covers a vast area of over 23,000 km², making it the second-largest municipality in the state. According to IBGE data, its population was estimated at 27,482 inhabitants in 2022 (≈1,19 hab/km²)[1], mostly concentrated in urban areas (around 61%), although rural space still plays a significant role.

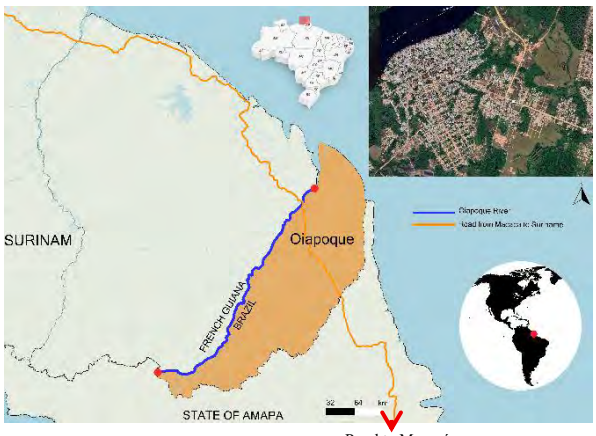


Figure 1. Location of the city of Oiapoque. Source: authors.

Her characteristics is diverse and distinct from Macapá, whether cultural, economic, architectural, or linked to the urban landscape. But something new is coming to radically change the lives of the population, the fauna, the flora, the urban landscape: the recent marine oil exploration. The city's economy until nowadays lived only from mineral exploration such as gold, prostitution, fishing, and tourism by foreigners coming from the territory of French Guiana.

Although the exploration of oil in the greater Oiapoque Coast is good news for the economic and social plan, it has also been the subject of living environmental concerns, notably regarding the death of marine and terrestrial species. But we are not going to stand still waiting for the worst part of the exploration to happen, we must act.

The objective of the research was to collaborate directly with local population through a landscape design proposal for the city's urban waterfront. But to do so, it is necessary to understand these unique social, cultural, and economic dynamics, which are essential for the regional development of the municipality. In this context, the research should contribute to improving the urban planning thanks to an innovative ecological landscape design, using the indigenous flora itself, exalting the value of the cultural and natural landscape of the city.

Firstly, a brief trip through history context was made, until arriving the current situation. In the second part, the waterfront open space system was analyzed. The study area has survived a kind of governmental inertia over the years, forgetting a multicultural heritage that must be immortalized. Through maps and photographic diagnosis, analyses were made for helping the design process. In the third and final part, we will show simple ways in which this project could be used in other studies as a model for innovative cities.

2. CONTEXTUALIZATION

In Oiapoque and its surroundings, black and indigenous communities share a common history of resistance and a deep connection to their ancestral lands. This historical and geographical coexistence highlights the ties between these marginalized groups. Their shared struggles for recognition, cultural preservation (figure 2), and land titling reflect a common pursuit of social justice and the protection of their traditional ways of life. Quilombolas (descendants of escaped enslaved people) and indigenous peoples, who have inhabited the region for centuries, have both developed ways of life, social organizations, and cultures rooted in defending their territories against external pressures.



Figure 2. Photo montage with a white woman, two indigenous people, a black woman of African origin and behind a more recent Brazilian, the result of this mixture. Source: authors.

During the colonial period, this city became a site of disputes among European powers for control

[1] Source : IBGE, 2022. https://cidades.ibge.gov.br/brasil/ap/oiapoque/panorama

over the region between the Oiapoque River and Amazon River. The original inhabitants were the Waiãpi, Galibi, and Palikur Indigenous peoples. In 1907, a military detachment was established to reinforce Brazil's sovereignty in the border region with French Guiana.

The territory of Oiapoque (figure 3) is composed of three districts: Oiapoque (**1**) at its heart (the municipal seat), the village Clevelândia do Norte (**2**), and Vila Velha/Caciporé (**3**), nestled near the Cabo Orange National Park.

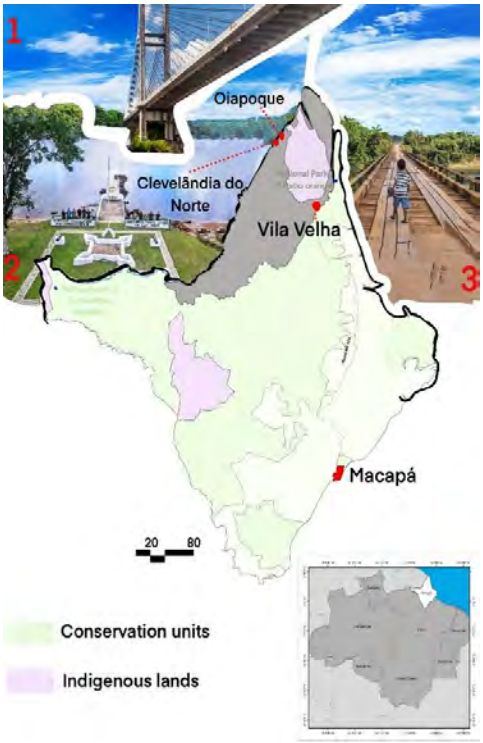


Figure 3. Distribution of the Territory of Oiapoque with their respective perceptible landscapes. Source: authors.

The archaeological findings by Peter Paul Hilbert [1] at Vila Velha Caciporé, which attest to the long-standing occupation by black communities (figure 4), align with the official recognition of these groups as original inhabitants of the territory — like indigenous communities who also hold constitutionally protected land rights under Brazilian law.



Figure 4. ancestral urns found by Peter Paul Hilbert (1957)

2. City Features

The State of Amapá has 70% of its natural area protected (figure 5), as stated by Tostes [2], who also highlight that the state preserves 90% of its forested area. And the municipality of Oiapoque is today an important commercial center in this border region. The city serves as an initial route for travelers traveling between French Guiana and Dutch Guiana, Suriname, Brazil and the rest of South America, receiving a constant flow of people daily, mostly Brazilians and French.



Figure 5. Map of the legal amazon 2024. Source: IBGE, 2022. https://cidades.ibge.gov.br/brasil/ap/oiapoque/panorama

Tourists cross the Oiapoque River in catraias (small boats with outboard motors). The largest concentration of these types of tourists occurs on weekends and more specifically during the pay periods of French government employees (see figure 6).



Figure 6. People from French Guiana arriving in the city by boat. Source: authors.

However, despite its strategic importance, Oiapoque lacks adequate infrastructure to accommodate this movement (figure 7). There is a lack of accessible benches, shaded areas for resting, and the few public bathrooms are almost always overcrowded.



Figure 7. The city's waterfront. Source: authors.

Being essentially a transit point, the city faces structural difficulties related to mobility. Travel options are limited: many streets are unpaved, public transportation is practically non-existent, and the population has become accustomed to using taxis and motorcycle taxis. Even with the presence of an international bridge (built with the promise of facilitating integration between countries), many still prefer the traditional crossing in small boats, due to the bureaucracy involved in officially using the bridge (figure 8).



Figure 8. The bridge, the river, and the forest. Source; authors.

The Oiapoque waterfront is occupied daily by many street vendors, who wait for their customers between boats and informal businesses. Indigenous and black people play a significant role in this scenario, selling their handicrafts as a means of sustenance and cultural appreciation (figure 9).



Figure 9: a routine scene on the riverbank. Source: authors.

However, the urban space reveals an alarming precariousness: basic sanitation is extremely scarce. There is a lack of sewage treatment, urban drainage is deficient, and the collection and treatment of solid waste is insufficient. Waste from daily consumption is visible in the streets, gutters, canals and even in rivers, reflecting the neglect of public policies on environmental infrastructure (figure 10).



Figure 10: typical house and lack of infrastructure in the gold miners' neighborhood. Source: authors.

At the same time, the city also experiences the constant presence of illicit activities, such as drug trafficking, illegal trade in wild animals and prostitution. These practices, often considered natural, are the result of the lack of social and economic alternatives and the fragility of the State on the border.

Over time, Oiapoque has fallen into a state of social and political inertia. Problems are repeated, habits are consolidated, and the urban landscape changes little. The explanation for this stagnation is known, corruption, which is deeply rooted in Brazil, has a direct impact on the daily lives. With each new administration, hope for improvement is renewed,

but in practice, little or nothing is done to transform the reality of the disadvantaged.

4. A Changing Landscape

At COP30, the world's attention is focused on Brazil, which is suffering high deforestation rates and faces contradictions regarding its environmental management. The question that arises is how cities react to poor urban management that leads to climate change and, consequently, to the poor quality of life of their populations?

With the arrival of oil exploration (figure 11) in Oiapoque costal plain, the city's economy will be boosted. The economy will not be based solely on the arrival and welcome of French foreigners. Other foreigners are already settling in, and Chinese people have started buying land in the surrounding area at low prices.



Figura 11: local da prospecção de petróleo na costa do Oiapoque.
Source : https://g1.globo.com/ap/amapa/noticia
Native Americans, who make up more than 70% of the population, live off subsistence farming, and will have to participate more actively in local governance to try to slow down this future occupation.

The city is expected to experience a construction boom and in 50 years it will be able to compete with the state capital. The technology involved in the oil industry could trigger intellectual partnerships with French Guiana, with the exchange of researchers and the construction of universities.

We can imagine the future existence of shopping malls with their big brands, the construction of a large airport and the expansion of the hotel network. Then the residents who live in this inertia will be able to actively participate in these changes. However, the alteration of this changing landscape should also be studied.

In 2009, Oiapoque waterfront was isolated by city hall for the revitalization of its port area. This project included the square with the historical landmark "Aqui começa o Brasil" (Here begins Brazil). More than 15 years have already passed, and the project has not been implemented (figure 12).

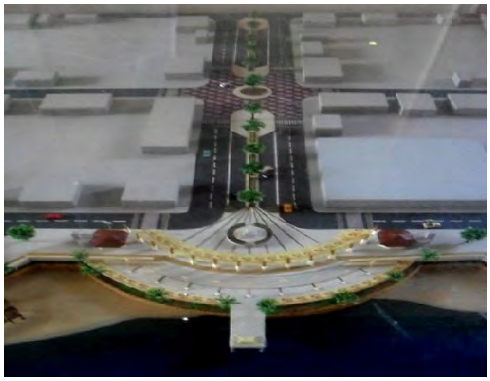


Figure 12. 2009 project not implemented. Source: Silva [4].
According to Silva [4], the current structure on the Oiapoque waterfront does not match the project presented in the model (Figure 4). The kiosks, for example, should be larger and better structured and the project's paving was not implemented (Figure 13).

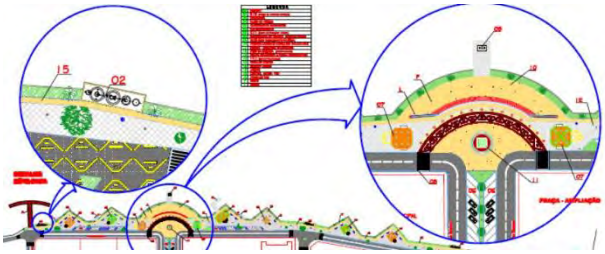


Figure 13. 2009 project not implemented. Source: Silva [4].

5. Methodology and Project

The method used in this work was qualitative, using on-site observation. As there is still no official information about urban agriculture in the city, it was necessary to look for references in Collective Gardens abroad, which served as urban renewal for the neighborhoods where they were inserted, according to Medeiros [5]. Subsequently, the delimitation of the landscape project to be allocated on the banks of the Oiapoque River, the main entry point to the city, was carried out.

The field visit included a journey through the forest, passing through several indigenous villages, and can

take up to 24 hours during the rainy season, due to the mudflats. A boat trip along the entire urban coastline of the municipality was also included. During the diagnostic phase, an inventory was carried out, with various thematic maps (Figure 14).



Figure 14. Thematic map showing the city's road system. Source: authors.

The landscape project followed the following design stages: firstly, the Mass Plan (where the initial ideas were expressed through patches), Path Design (with the definition of the main and secondary flows that will generate the paths), Vegetation Design (generation of shapes and definition of the tree, shrub, and herbaceous strata).

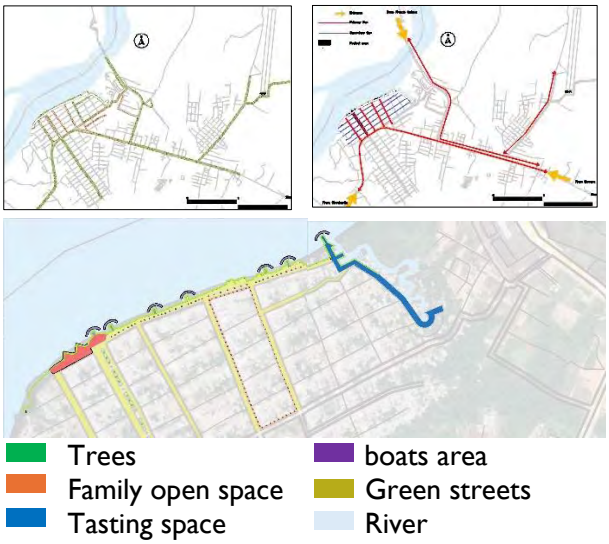


Figure 15. methodological steps and project. Source: authors.



Figure 16. methodological steps and project. Source: authors.

The Mass Plan deals with original thoughts, in the initial stage of project development. It was defined that the center of the project would be a mandala garden, which would function as a focal point and direct the gaze. The side entrances are occupied by spirals of herbs. Other social centers are allocated at the ends according to the age group of the users: kids' space (children), cultural space (adults) and spaces for the elderly.

In the Pathway Plan, the main flow passes through the focal point of the project and the kids' space. The other secondary and tertiary flows connect with the other common areas. The flows will generate the path network.

During the development stage of the Vegetation Plan, the form was created and the spaces "evolved". The main entrance is through the square. Spirals of grass welcome visitors. The tree layer provides shade on the sidewalks. Palm trees define the children's play area. The shrub and herb layer help to delimit secondary paths and other common areas. The flowerbeds will contain native edible herb species. The mandala garden is the center and focal point of the project.

3. Conclusions

Oiapoque continues to be a meeting and transit point, full of life, diversity, and stories. But it is also a portrait of a structure that resists change, trapped between unfulfilled promises and a daily life that, despite the struggle of those who live there, remains marked by abandonment.

The Oiapoque River and its banks are certainly present in the population's imagination, and the thriving tree vegetation of the Amazon rainforest is also part of this scenario. In the urban context of the city, however, open spaces do not seem to have such a defined role.

Taking into consideration all the urban problems presented throughout the work, such as precarious infrastructure, lack of trees and lack of public open spaces, we conclude that the city of Oiapoque urgently needs to reform its urban waterfront, the main leisure space for the population.

The proposed landscaping project will enhance local culture, providing pleasant spaces, stimulating tourism, and enhancing fauna and flora through a green corridor. The proposal is undoubtedly important for the city of Oiapoque, as it is understood that the city does not have a technical team in the city hall capable of designing new areas or the resources to hire architectural projects.

The methodology used provided support for achieving the proposed objectives of carrying out a landscape project that will be presented to public bodies in the future. It is hoped that the presentation of this proposal to the city hall will at least open the debate for urban reforms that consider public space in a dignified and appropriate manner, with all the necessary infrastructure to meet the interests of the community.

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NARRATIVE-DRIVEN PARTICIPATORY GOVERNANCE: RECONSTRUCTING MICROCLIMATIC JUSTICE IN SHANGHAI'S COMMUNITY GREEN SPACES

TOPIC: Guiding cities with society: Participatory approaches and governance strategies

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Keywords: Narrative governance, thermal commons, participatory materialization, microclimate justice, situated knowledge

Abstract

As cities around the world face the twin crises of a democratic deficit in urban planning and rising thermal inequality, this study explores how narrative-driven participatory governance can transform micro-landscapes into arenas for social climate justice. Through an in-depth analysis of the 0.6 hectare Habitat Garden on Xinhua Road in Shanghai, regenerated through community co-design, this research show how grassroots thermal storytelling can reshape technocratic climate governance while delivering measurable ecological benefits.

At the heart of this transformation is the institutionalisation of narrative infrastructure, where residents' lived experiences become the basis for spatial decision-making. Oral histories from older participants revealed underlying thermal inequalities: firstly, afternoon temperatures in south-west facing alleys were 2.8°C higher than in shaded courtyards, and secondly, Universal Thermal Climate Index (UTCI) values at exposed bus stops consistently exceeded 38°C. Through a participatory mapping workshop, these narratives were systematically translated into design interventions that directly influenced post-intervention vegetation layouts . These stories were materialised into shade corridors and thermal rest benches that reduced the localised UTCI to 31.5°C, validating from practice how community-driven placemaking can implement Fainstein's (2010) Just City framework at the microclimate scale.

Through the narrative mediation described above, the governance structure of the urban community itself underwent a democratic realignment. Municipal technicians and residents negotiated through rotating climate forums governed by a tripartite code of ethics: prioritising the spatial needs of the thermally vulnerable, adapting to technological feasibility constraints, and ensuring compliance with regulatory requirements. Community-trained 'narrative facilitators' play a key role in bridging the knowledge gap, for example by translating meteorological data into local thermal knowledge. This hybrid approach improves design acceptability and reduces implementation delays through pre-emptive conflict resolution mechanisms compared to traditional processes.

Post-intervention results suggest an unexpected synergy between narrative depth and ecological representation. Not only did this approach protect the local ecology during the heatwave, but it also prioritised the allocation of shade for the elderly and childcare workers during daily rituals, countering Hardin's (1968) tragic narrative by embodying climate care practices and reflecting the

site's evolution towards a hot commons.

The theoretical contribution advances two key paradigms: 1) narrative epistemology positions hot storytelling as a form of situated knowledge production that transforms residents from policy recipients to diagnosticians; and 2) participatory materialisation redefines co-design as an iterative process in which community narratives actually reconfigure community microclimates. In practice, this research develops replicable protocols for cities seeking to democratise climate adaptation, from narrative justice assessments that ensure equity in the translation of stories into space, to hybrid governance models that balance technical rigour with grassroots ecological wisdom. While rooted in the socio-political context of Shanghai, the findings of this study can provide replicable strategies for cities around the world in the tension between participatory legitimacy and climate urgency, demonstrating that socially-driven micro-climate governance can flourish beyond Western democratic norms.

1. Introduction

1.1. Background

Urban areas across the globe are confronted with two significant challenges: inequitable governance and an expanding heat gap. As Schink (2023) argue, traditional top-down planning approaches have a tendency to marginalise the voices of communities, with this marginalisation being most acute for vulnerable groups, such as the elderly, children, and low-income residents. Concurrently, climate change has compounded the urban heat island (UHI) effect, whereby urban temperatures are markedly higher than in surrounding rural areas due to reduced green cover, high-density buildings, and anthropogenic heat emissions (Akbari et al., 2009). In Shanghai, the rapid process of urbanisation has resulted in a substantial decrease in green spaces, thereby leading to an exacerbation of heat-related health risks. In certain historical districts where air circulation and shading are limited, south-west-facing lilongs are particularly susceptible to protracted periods of elevated temperatures. This poses a significant threat to the physical and mental well-being of residents. A comparable scenario is observed in cities such as Jakarta and Mumbai, where the dearth of cooling devices and inadequate green infrastructure in informal settlements serves to amplify existing health inequalities.

Many cities have attempted to address these issues through technocrat-led climate governance, such as the use of reflective pavements or engineered shading. Nevertheless, these approaches frequently overlook the intricate realities confronted by vulnerable groups. Research has indicated that vulnerable demographics are subject to elevated heat-related mortality rates, attributable to disparities in access to green spaces and cooling resources (Palinkas et al., 2022). This phenomenon can be attributed to systemic failings within a top-down governance model. A salient example of this failure is the lack of consideration for the intertwining of heat exposure with daily activities, particularly in areas such as older residents' activity spaces and children's play areas. The utilisation of technocratic solutions, which accord city-wide temperature metrics precedence over the vulnerability of specific neighbourhoods, serves to perpetuate thermal inequalities. This underscores the necessity to shift the focus from urban climate resilience to human narratives when addressing these issues.

In contrast, narrative-driven participatory governance can centre on the lived experiences of the most affected populations, allowing residents' needs at high temperatures to directly influence design decisions. This can result in interventions that are both ecologically efficient and socially equitable, addressing the spatial mismatch between heat risk and adaptation resources, and transforming vulnerable populations from passive beneficiaries to active drivers of climate resilience. In addition, this can offer other similar cities with new ideas and programmes to address climate issues.

1.2. Objectives

This study aims to achieve three objectives:

1) To study narrative-driven participatory governance mechanisms to systematically integrate grassroots experiences of heat protection into the urban design process, with a focus on translating community stories into actionable design strategies for heat protection.

2) To assess the socio-ecological outcomes of community co-design of green spaces through quantitative research, confirming the results of community microclimate improvement.

3) To develop scalable democratisation protocols for climate adaptation, prioritising culturally grounded practices over technical complexity to ensure that solutions match local needs and capacities.

By achieving these goals, this study aims to advance equitable, context-sensitive approaches to urban climate governance.

1.3. Significance

This study proposes a novel approach to urban climate governance that combines narrative-driven engagement with microclimate justice. Theoretically, this study contributes to the advancement of urban planning theory by demonstrating the efficacy of narrative epistemology in institutionalising lived experience in spatial decision-making and counteracting the phenomenon of 'climate segregation' (Schink, 2023) in technocratic systems.

In practice, this study provides a hybrid governance toolkit focussed on cultural narratives. The toolkit translates residents' experiences of high temperatures into actionable designs, ensures that solutions are tailored to the local socio-cultural context, and empowers communities to maintain green infrastructure and withstand extreme heat through participatory management. In addition, this research demonstrates the efficiency of inclusive models to operate in different political contexts without resorting to complex technologies. It combines the legitimacy of participation with the urgency of climate change, promotes justice-led urbanisation and development, prioritises vulnerable groups, and establishes a replicable pathway for equitable microclimate governance.

2. Materials and Methods

2.1. Research Object

This study focuses on the 0.6-hectare Habitat Garden on Xinhua Road, a brownfield regeneration project in Shanghai that was transformed through community participatory governance. Located within the historic district of Changning, the study area is characterised by traditional lanes (lilongs) and low-rise buildings, reflecting the tension between urban conservation and environmental challenges. The area has limited green coverage, and the dense, low-rise buildings restrict air circulation. This leads to significant heat retention and exacerbates the urban heat island (UHI) effect.

Information gathered from field visits revealed significant thermal inequalities in the area prior to the intervention, particularly in southwest-facing lilongs (traditional alleyway neighbourhoods), where prolonged thermal exposure exceeded UTCI thresholds for vulnerable populations. Elderly residents and children reported severe discomfort, with 85% avoiding midday outdoor activities due to a lack of shading and cooling resources.

Despite these challenges, the community's robust history of grassroots environmental stewardship, evidenced by prior initiatives such as rainwater harvesting systems and neighbourhood composting programmes, provided a foundation for participatory governance experimentation. This unique socio-ecological context positions Xinhua Road as an exemplary case for examining how collaborative urban design can mitigate thermal inequality while preserving cultural identity.

2.2. Research Methods

To ensure that the study is comprehensive and rigorous, this research combines literature

analysis with field research to explore how narrative-driven participatory governance can contribute to microclimate thermal justice in Shanghai's communities.

2.2.1. Literature analysis

The emergence of the narrative-driven and participatory governance approaches signalled a shift in urban planning and community development, moving away from the traditional technocratic model towards a more inclusive, human-centred approach. Participatory governance emerged as a critique of hierarchical governance, aiming to address the limitations of market-driven neoliberalism and state-centred authoritarianism. At the beginning of the 21^(st) century, scholars such as Ansell and Gash (2008) developed a collaborative governance framework that emphasised the importance of multi-stakeholder dialogue and trust-building in balancing efficiency and equity. Meanwhile, meta-governance theory redefined the role of the state as a strategic coordinator, advocating a hybrid model that combines bureaucratic, market and civil society logics in order to avoid fragmented decision-making.

Concurrently, a narrative-driven approach emerged in response to the post-structuralist critique of grand narratives, emphasising localised knowledge and emotional connections in spatial politics. As Wang and Bian (2022) have observed,, this approach involves the 'codification and rearticulation of lived experience' to transform decision-making processes and give marginalised voices a central role in climate justice initiatives, particularly in community green space planning.

As society develops, participatory governance is gradually shifting from superficial consultation to institutionalised empowerment. in 2007, Shanghai passed a greening ordinance that legally empowers the public to monitor urban greening projects. the ordinance is expected to be implemented in the next few years. However, challenges remain in achieving true procedural fairness and addressing power imbalances. Transient elite-led participation can make it difficult for ordinary members of the public to engage in community affairs in a sustained and in-depth manner, thus undermining the fairness and effectiveness of the entire participatory process. Meanwhile, narrative-driven research has evolved from simple storytelling to systematic knowledge generation, focussing on three key areas: the political economy of narrative inclusiveness, the role of cultural symbols in building collective identities, and the ethical considerations of digital tools in capturing community stories.

The extant literature demonstrates that participatory governance has the capacity to improve policy responsiveness and reduce climate inequalities. Nevertheless, participatory governance is also vulnerable to bureaucratic delays and superficial inclusiveness, and faces scalability challenges and the potential for technocratic complicity. Recent research is exploring the potential of digitisation in facilitating the integration of community knowledge into formal governance structures, with a view to reducing the limitations of this approach. In summary, the combination of narrative-driven and participatory frameworks fundamentally reconceptualises the relationship between the state, society and the market. In order to effectively navigate the complexities of urban governance in a globalised world, practitioners must examine institutional boundaries and cultural contexts.

2.2.2. Field Investigation

This study employed a multidimensional field investigation approach to systematically evaluate the spatial design and user experience of the Xinhua Road Community Habitat Garden, integrating subjective feedback and objective environmental data to enhance analytical depth.

In terms of spatial design, this study investigated the geometry, functional zoning, and landscape details of the associated community garden through the use of satellite maps and field measurements. The garden is divided into five interconnected thematic zones (Figure 1): Cedar Courtyard (social gathering centre), Squirrel Valley (biodiversity corridor), Shade Garden (dense canopy shade area), Shrub Hedge Garden (ecological buffer zone), and Sun Terrace (floral display area). The combination of

these zones creates a microclimatically balanced and ecologically harmonious community space, while optimising the outdoor thermal environment for residents and preserving the connectivity of local flora and fauna habitats.



Figure 1. Garden plan and zoning photos

This study also conducted research and statistics on the vegetation in the garden (Table 1), measuring plant canopy cover and other relevant data, with the aim of gaining a more in-depth understanding of the composition and growth of the vegetation in the garden.

Table 1. List of garden plants statistical

No.	Scientific Name	Specifications			Qty
		H (m)	W (m)	Φ (cm)	
1	*Cinnamomum camphora*	5-6	3-4	15-20	15
2	*Ginkgo biloba*	6-7	4-5	20-25	8
3	*Platanus × acerifolia*	7-8	5-6	25-30	6
4	*Magnolia grandiflora*	4-5	3-4	12-15	10
5	*Cedrus deodara*	10-12	5-6	30-40	5
6	*Nandina domestica*	1.2 - 1.5	0.8 - 1.0		20
7	*Pittosporum tobira*	1.5 - 2.0	1.0 - 1.2		12
8	*Rhododendron simsii*	0.6 - 0.8	0.5 - 0.6		28
9	*Pyracantha fortuneana*	1.0 - 1.2	0.6 - 0.8		10
10	*Ophiopogon japonicus*	0.2 - 0.3			150 m²
11	*Hosta plantaginea*	0.4 - 0.5			100 m²
12	*Hedera helix*				140 m²
13	*Parthenocissus tricuspidata*				100 m²
14	*Campsis grandiflora*				60 m²
15	*Trachelospermum jasminoides*				80 m²

In terms of user experience, this study adopted a mixed-methods approach to investigate user experiences, integrating quantitative surveys and qualitative interviews to ensure methodological rigor and depth. A structured questionnaire was distributed during peak summer usage periods (9:00–11:00 AM and 4:00–6:00 PM), targeting 100 resident users of the Xinhua Road Community Habitat Garden. Non-resident visitors were excluded through screening questions verifying local residency. To enhance representativeness, participants were stratified by age (<30, 30–60, >60 years) and usage frequency (daily, weekly, occasional), yielding 92 valid responses (92% completion rate). The questionnaire encompassed four core dimensions: demographic profiling, spatial behavior patterns (e.g., activity types, duration of stay), subjective thermal comfort ratings (5-point Likert scale: 1=extremely uncomfortable to 5=extremely comfortable), and design satisfaction evaluations (e.g., seating ergonomics, vegetation aesthetics).

To supplement quantitative data, this study conducted semi-structured interviews with 20 purposefully selected residents. Participants included 10 elderly individuals (aged ≥65), 5 caregivers (accompanying children aged 3–10),

and 5 high-frequency users (visiting ≥3 times weekly). Interviews focused on three themes: (1) behavioral adaptations to the renovated space (e.g., changes in daily routines during heatwaves), (2) perceived efficacy of design interventions (e.g., accessibility of shaded pathways), (3) improvement priorities (e.g., hydration infrastructure, enhanced canopy coverage). Each 15–20 minute session was audio-recorded with informed consent, transcribed verbatim, and anonymized prior to thematic analysis using NVivo. By cross-referencing survey metrics with qualitative narratives, this dual-method design enabled a nuanced understanding of how spatial interventions mediate thermal comfort and social engagement, while maintaining practical feasibility for single-researcher implementation.

Furthermore, comparative temperature measurements were conducted to quantitatively examine improvements in the thermal environment. In this study, representative areas within the garden (shaded gazebo, hard landscaped plaza) and adjacent non-green community spaces (car park, pedestrian street) were selected as control points. A portable weather meter was used to measure air temperature (°C), relative humidity (%) and wind speed (m/s) three times a day during the questionnaire survey period (9:00 a.m., 1:00 p.m. and 5:00 p.m.), with a continuous recording each time for 15 minutes. The Universal Thermal Climate Index (UTCI) was calculated using RayMan software in order to assess the level of thermal comfort. The effectiveness of the designed interventions was validated through correlation of measurements with subjective thermal comfort scores from questionnaires.

3. Results

This study systematically examines the transformative potential of narrative-driven participatory governance through a dual lens of theoretical inquiry and empirical analysis, centering on the Xinhua Road Community Habitat Garden in Shanghai. By integrating literature review with field investigation, the research elucidates how embedding grassroots narratives into urban design can simultaneously address thermal inequities and foster socio-ecological resilience.

Analysis of 92 validated resident questionnaires revealed that 78% of respondents rated thermal comfort in shaded zones as "comfortable" or "very comfortable"(Figure 2) . These quantitative findings were fleshed out using semi-structured interviews (n=20): elderly participants emphasized the cultural resonance of shaded courtyards, which mirrored the aesthetic principles of traditional lilong architecture.

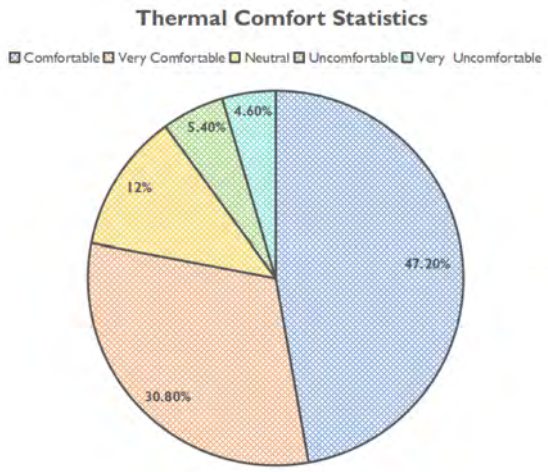


Figure 2. Pie chart of questionnaire results

Further thematic analysis using NVivo (Figure 3) identified three dominant narrative-driven design principles: (1) prioritization of vegetation in historically identified "heat traps" (e.g., southwest-facing alleys), (2) strategic placement of shade corridors aligned with solar trajectories, (3) customization of rest benches to accommodate elderly mobility patterns. These interventions are directly based on the thermal comfort narratives of the population and have a significantly higher design acceptance rate compared to traditional top-down programmes, while validate Fainstein's (2010) framework of the 'just city', demonstrating how marginalised voices can reshape urban spaces into inclusive thermal commons.

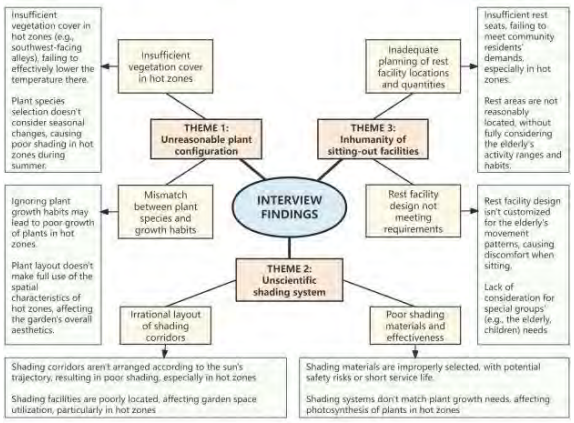


Figure 3. Thematic analysis results

As demonstrated by the findings of the quantitative study of the thermal environment, the localised thermal environment of the garden underwent a substantial enhancement following the intervention (Figure 4). After the intervention, the Universal Thermal Climate Index (UTCI), measured by portable thermohygrographs recorded three times a day (9:00 a.m., 1:00 p.m., and 5:00 p.m.), showed that temperatures in the shaded areas were up to 6.7°C cooler in the late afternoon peak hour, compared to other areas of the city. Key interventions derived from community narratives, including the establishment of shade corridors and the strategic planting of Cinnamomum camphora clusters, resulted in a reduction of surface temperatures by 3.5°C compared to pre-renovation levels. Adjacent non-greened areas, such as asphalt parking lots, consistently recorded UTCI values exceeding 38°C, corroborating the garden's efficacy in mitigating hyperlocal heat island effects.

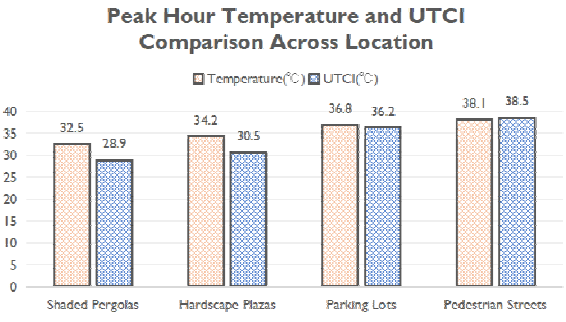


Figure 4. Peak hour temperature and UTCI comparison across location

4. Discussion

The Xinhua Road Community Habitat Garden project suggests that narrative-driven participatory governance can effectively transform urban microclimates into socially and ecologically restorative spaces, and that integrating residents' lived experiences into design and governance can mitigate thermal inequalities and facilitate the democratic reconfiguration of urban planning.

The significance of this research lies in its dual contribution to theory and practice. In principle, it challenges the prevailing technocratic norms by establishing community narratives as a pivotal component of spatial planning, thereby addressing a significant gap in the existing equitable resilience frameworks. In practice, the research provides a scalable model that prioritises cultural narratives over technological solutions, offering cities worldwide a blueprint to democratise climate adaptation. By demonstrating the potential for collaboration between communities and nature in the pursuit of equitable and sustainable urban development, this work offers novel concepts and pragmatic instruments for just urban development in diverse political contexts.

Nevertheless, the study's scope and methodology do exhibit certain limitations. The reliance on 92 questionnaires and 20 interviews, while adequate for achieving the desired qualitative depth, may underrepresent transient or low-income populations. The geographical focus on a single Shanghai neighbourhood may preclude the study from capturing the full spectrum of climatic and cultural variations that exist within the region. Moreover, the utilisation of portable sensors, while exhibiting pragmatism, engenders measurement variability when contrasted with the metrics obtained from fixed meteorological stations.

Future research could expand to include comparative case studies, such as Mumbai's informal bastis or Berlin's Klimastraße, in order to test the model's scalability. The integration of IoT networks for real-time microclimate monitoring, or the exploration of augmented reality tools for multilingual engagement, has the

potential to further enhance methodological rigor.

5. Conclusion

Narrative-driven participatory governance is not merely a theoretical ideal; rather, it is a practicable pathway to microclimatic justice. By centring residents' thermal experiences—from the codification of heat narratives into shade corridors to the democratisation of maintenance through blockchain protocols—the Xinhua Road Habitat Garden exemplifies how cities can harmonise ecological efficacy with social equity.

This research explores the translation of cultural narratives into a replicable climate resilience design toolkit, prioritising accessibility over technical complexity. This is empirically validated through synergies between subjective well-being and objective microclimate indicators, thereby challenging the dominance of technocratic governance and striking a balanced approach to governance between institutional rigour and grassroots activism. The toolkit is applicable to other, similarly Shanghai-based cities in a variety of political environments.

In summary, urban climate resilience is redefined as a collective action that brings together those most vulnerable to climate extremes to co-create heat-equitable outdoor spaces. Despite its limitations, it also offers a new perspective on the future planning and transformation of urban community spaces, balancing the legitimacy of participation with the urgency of climate so that communities can be both beneficiaries and architects of their climate futures.

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REVITALIZING URBAN VILLAGE PUBLIC SPACES: FOSTERING COMMUNITY ENGAGEMENT AND ENVIRONMENTAL AWARENESS THROUGH PARTICIPATORY MICRO-INTERVENTIONS

TOPIC: Guiding cities with society: participatory approaches and governance strategies

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Keywords: Urban Villages, Public Space Revitalization, Participatory Micro-Interventions, Community Engagement, Environmental Awareness

Abstract

Urban villages, unique spatial forms amid rapid urbanization, often suffer from inadequate infrastructure and a lack of recreational and communal spaces, negatively impacting residents' daily experiences. This issue is particularly acute in high-density cities like Shenzhen, where safe and inclusive public spaces for families are scarce, and environmental concerns are often overlooked. Consequently, improving public space quality in urban villages and fostering residents' environmental awareness have become critical research areas in resource-constrained settings.

This study explores the potential of small-scale, cost-effective spatial interventions to enhance public space quality and community environmental awareness. Six participatory micro-intervention activities focused on children's installations were conducted in Shekou Weizai Urban Village, Shenzhen, employing an Action Research approach that integrates on-site observations, public opinion surveys, and interviews. The site, characterized by limited social infrastructure, provided a setting for temporary installations and interactive initiatives. Resident feedback was collected to assess the impact on public space utilization, social engagement, and environmental awareness.

Findings indicate that these interventions significantly increased public space usage and social interactions, fostering a stronger sense of community. Observations and interviews revealed that the installations not only engaged children but also facilitated interactions among family members and neighbors, strengthening social cohesion. Additionally, residents demonstrated greater concern for public space quality and expressed aspirations for long-term improvements. The study highlights how flexible, shared spaces can be established through agile, temporary interventions in resource-limited urban villages.

This research underscores the viability of community-participatory micro-updates for public space enhancement in urban villages, offering insights for policymakers, designers, and community groups seeking cost-effective urban revitalization strategies. It emphasizes the role of landscape designers as both spatial strategists and community facilitators, advocating for adaptable, modular, and eco-friendly design solutions. By integrating ecological considerations, residents' preferences, and socio-cultural contexts, landscape designers can create more inclusive and resilient public spaces. Moreover, fostering community participation in the design and maintenance process can instill a stronger sense of ownership, ensuring the long-term sustainability of these spaces.

1. Introduction

1.1. Research Background

Urban villages (ChengZhongCun) are informal settlements that arise from China's rapid urbanization, housing marginalized populations in dense, poorly planned environments with inadequate public infrastructure (Liu et al., 2014). Shekou Weizai, a high-density urban village in Shenzhen, exemplifies these challenges. The lack of safe, inclusive recreational spaces disproportionately impacts children, restricting play opportunities and social development.

Conventional urban renewal often fails in such contexts due to high costs and limited community participation. In contrast, participatory micro-interventions—small-scale, low-cost, and co-designed upgrades—offer an adaptive alternative (Douglas, 2021). These interventions employ tactical urbanism strategies, such as modular installations and temporary activations, to test spatial improvements while fostering local engagement. This study examines their potential in Weizai, focusing on how micro-interventions can enhance public space, strengthen community involvement, and promote environmental awareness without displacement.

1.2. Research Gaps

The prevailing focus in previous studies on the revitalization of urban villages has been on extensive physical changes. Despite addressing tangible shortcomings, these efforts often neglect the socio-spatial interactions and community-led initiatives that underpin social activities in informal settlements.

Insufficient Exploration of Low-Cost, Incremental Interventions Current research predominantly focuses on high-cost, permanent redevelopment initiatives, overlooking the value of temporary, low-budget micro-interventions for experimenting with spatial solutions and promoting community involvement (Douglas, 2021).

1.3. Research Objectives

This study aims to contribute to the discourse on revitalizing urban villages by investigating the synergistic effects of participatory micro-interventions on improving public space quality, fostering social cohesion, and fostering environmental awareness in densely populated informal settlements.

The specific objectives of the research are:
Assessing the Social Cohesion Impact of Micro-Interventions Utilize qualitative approaches such as spatial ethnography and semi-structured interviews to analyze the role of temporary installations in promoting intergenerational engagements (e.g., children's activities, adult interactions) and communal place establishment. Evaluate Changes in Environmental Consciousness and Actions Conduct surveys to investigate the impact of being exposed to design features on individuals' attitudes towards sustainability and their inclination to uphold communal areas.

This study challenges the dominant "hardware-first" approach to urban renewal by advocating for a people-centric, iterative model that is in harmony with the socio-cultural and spatial dynamics of urban villages.

1.4. Theoretical Framework

Fusion of Participatory Action Research and Tactical Urbanism

This study integrates Participatory Action Research (PAR) and Tactical Urbanism (TU) to explore community-driven, iterative urban village revitalization. PAR, empowers residents as co-researchers through cyclical praxis (planning, acting, observing, reflecting) and collaborative learning. TU (Lydon & Garcia, 2015) enables rapid, low-cost prototyping—deploying child-friendly installations quickly while assessing scalability with modular materials.

The hybrid framework bridges immediate spatial interventions (TU) with long-term social empowerment (PAR), positioning landscape architects as "socio-spatial mediators" who navigate institutional barriers and amplify grassroots innovation. This approach advances methodologies for informal settlement upgrading through participatory, evidence-based design.

2. Site Background and Info

2.1. Study Area

Shekou Weizai Urban Village

Situated in the Nanshan District of Shenzhen, Shekou Weizai is an urban village known for its high population density, informal housing structures, narrow passageways, and limited public facilities. Notable physical and social attributes comprise:

Population Density:
The Weizai Community Data for 2023 indicates a population density of 25,226 persons per square kilometer, with 73% comprising migrant workers and low-income households, totaling 11,856 residents within an area of .47 square kilometers.

Public Space Deficit:
The sole park available to the community, Weizai West Park, highlights a severe deficiency in recreational and social amenities.

Housing Conditions:
The village comprises 1,299 self-constructed residences and 3,539 rental units, with lighting and ventilation being relatively inadequate.

Social Fragmentation:
Frequent changes in residential occupancy and a transient demographic profile are factors that undermine community cohesion, resulting in reduced neighborly engagement and limited involvement in public matters.

The village's limited space and absence of shared amenities present a compelling opportunity to investigate tactical urbanism strategies, specifically focusing on revitalizing unused areas (such as alleys and empty lots) to promote social engagement and enhance the environment.

2.2. Participatory Intervention Design

Co-creation is both the aim and requirement of this project. To proceed, designers must initially develop a framework and foundational design, as community administrators' approval is necessary. Subsequently, through negotiations with all stakeholders, design specifics are integrated into workshop activities, with collective feedback shaping the final design. Drawing from field research, our workshops aim to not only include design choices but also enhance children's understanding of traditional culture. Six micro-interventions centered on children were collaboratively designed with local stakeholders, guided by three core principles:

Modularity:
This furniture set showcases a modular design utilizing birch wood perforated panels of dimensions 500×700 and 700×700. By employing optical shafts and shaft clamps, the furniture can easily convert into tables, chairs, stools, and display boards, catering to diverse activity requirements. The incorporation of reconfigurable elements enables flexible repurposing across different locations.

Cost Containment:
Given the constrained project funding, an outcome-focused strategy is imperative, requiring strict control over workshop and equipment expenditures.

User orientated:
A user-centric methodology was employed, involving initial site observations and surveys to systematically assess user requirements and pinpoint areas necessitating enhancement.

Finally, we designed a set of furniture: "LaiJiaZuoZuo"(literal translation from Chinese: Come home and have a seat). This set of furniture comprises modular, adaptable, and mobile pieces designed to repurpose alleys and underutilized areas into engaging play or relaxation spaces. Design iterations were refined through workshops in which residents voted on locations and children provided names for them.

2.3. Data Collection

This research employed a qualitative-dominant, multi-stakeholder approach through semi-structured interviews involving six key actor groups, comprising a total of 11+ participants. These groups encompassed designers, NGO representatives, community managers, children, parents, and volunteers. The interviews explored participatory design processes, spatial interventions, and community engagement outcomes, with questions tailored to the specific roles of each group. Each interview session, lasting between 30 and 60 minutes, was recorded, transcribed, and supplemented with field notes from on-site observations. This methodological framework facilitated a diverse range of perspectives while emphasizing the effects of co-design within the case study. Ethical clearance and informed consent, including parental consent for minors, were duly obtained.

2.4. Analysis Methods

Data analysis followed a thematic analysis approach as outlined by Braun and Clarke (2006). Interview transcripts underwent inductive coding, revealing different themes based on various feedback. These themes were subsequently classified under the categories of social cohesion, environmental behavior, and design adaptability. Analytical rigor was maintained through peer debriefing, and the credibility of the identified themes was reinforced with pertinent quotations.

3. Results

The study uncovers three key findings, each addressing crucial aspects of micro-interventions in participatory landscape design:

3.1. Design Efficacy

Spatial Flexibility and Temporal Stability

The modular design framework enables a strategy of "temporary permanence," enabling adaptive repurposing in reaction to seasonal occurrences, daily variations, and changing community requirements. Field studies demonstrate significant utilization levels, as community managers frequently interact with modular furniture in their day-to-day operations.

Safety considerations focused on children: Emphasizing rounded edges and low-height features in design reduces injury risks, even though it may involve trade-offs such as wood durability. A designer underscored the importance of prioritizing safety and adaptability over material longevity.

Conflicting Perspectives on Spatial Adaptation Governance: A noticeable conflict has arisen between community managers' inclination towards permanent installations and designers' promotion of flexible systems. This discord highlights overarching power dynamics within spatial governance. A significant obstacle involves reconceptualizing adaptability not as a managerial challenge but as a tool to promote resident stewardship in the collaborative creation of public spaces.

3.2. Community Empowerment

Participatory Design as Social Infrastructure

Accumulation of social capital was observed through intergenerational workshops, leading to a decrease in communal alienation, especially among children. Facilitators observed notable behavioral changes, with initially reserved participants, such as introverted children, becoming active contributors. A parent reported that their typically reserved child enthusiastically participated in group activities, like assembling modular furniture, showcasing increased social engagement.

Promoting Environmental Stewardship: Implementing the "make-use" cycle in various settings such as markets and festivals has shifted residents from passive consumers to engaged co-managers. Authorities have noted increased attentiveness towards self-made furniture over traditional infrastructure, indicating that participatory approaches enhance individuals' connection to their surroundings.

Emergent Cultural Design Practices: Hands-on workshops preserved traditional craft knowledge while fostering child-led innovation, such as the creation of miniature chairs. Participants exhibited technical proficiency alongside socio-cultural awareness, as evidenced by their discussions on traditional hosting etiquette related to their creations.

Short-term interventions, while Interventions: While impactful, may not lead to lasting environmental education outcomes. According to a respondent from an NGO, children's understanding of ecological systems is still developing, and maintaining their engagement necessitates sustained long-term programming.

3.3. Sustainability Challenges

Grant Dependency as a Barrier

Financial Instability: Dependence on volatile government funding poses a threat to project sustainability, highlighting the need to investigate alternative financial frameworks such as public-private partnerships. Emphasizing the importance of intersectoral cooperation, a community administrator underscored, "Collaboration across sectors is essential for expanding micro-interventions." Echoing this sentiment, an NGO representative remarked, "Even outstanding initiatives struggle in the absence of varied sources of income."

4. Discussion

4.1. Social Impact

Micro-Interventions as Catalysts for "Third Places"

The empirical results of the study offer strong support for Oldenburg's (1999) foundational theory of third places. Our micro-intervention case study illustrates three specific mechanisms by which neglected urban village areas were revitalized into active social centers:

Initially, the spatial layout effectively reduced obstacles to social engagement by introducing modular, human-scale furniture systems that fostered welcoming settings promoting unplanned interactions, thereby meeting Oldenburg's essential requirement of accessibility in third places. Furthermore, the interventions promoted a sense of routine place attachment. Longitudinal monitoring demonstrated the establishment of consistent usage patterns centered on the newly installed elements, as community members cultivated daily gathering rituals, a behavioral trait essential for thriving third places.
Furthermore, these spaces played a crucial role in promoting social equality by serving as neutral platforms where migrant workers, long-term residents, and children could interact on equal footing, temporarily disrupting existing socioeconomic hierarchies. This phenomenon aligns with findings in established literature on third places (Oldenburg, 1999).
Remarkably, these social achievements were attained through minimalistic urban acupuncture instead of costly redevelopment projects. The spontaneous rise of self-organized events such as impromptu markets and community gatherings indicates that these areas transformed into what Koolhaas (1995) referred to as "social condensers" - spaces that actively foster and enhance social interactions.

4.2. Professional Paradigm Shift

The Dual Agency of Landscape Architects

Our research reveals an emergent professional identity that combines two complementary roles:

As spatial strategists, practitioners in our study developed modular systems employing "temporary permanence" design principles, integrated design-for-disassembly features to accommodate evolving spatial needs, and balanced aesthetic considerations with stringent safety requirements;

As community facilitators, they translated technical parameters into accessible co-design workshops, mediated between grassroots preferences and municipal regulations, and created visual communication tools to overcome literacy barriers.

This dual agency challenges conventional design practice in three significant ways:
It demands new skills in participatory design ethnography;
it requires conflict resolution competencies for contested spaces;
it necessitates mastery of ephemeral urbanism techniques.

The results indicate a pressing necessity for curricular revisions in the field of landscape architecture education, specifically focusing on:
community engagement methodologies, temporary installation techniques, and post-occupancy evaluation protocols.

5. Conclusion

5.1. Key Contributions and Findings

This research contributes on participatory micro-interventions as a placemaking approach to rejuvenate public spaces in densely populated informal settlements, offering implications for landscape architecture and urban design. The results, obtained through an action-research methodology conducted in Shekou Weizai, Shenzhen, unveil several key insights:

1. Community-led incremental upgrades play a crucial role in enhancing the utility and accessibility of public spaces, thereby strengthening the concept of tactical urbanism in environments with limited resources.
2. The emergence of social infrastructure is facilitated by micro-interventions that promote spontaneous sociability, especially among children and caregivers, leading to the development of collective stewardship, which is a crucial factor in sustainable placemaking.

These results confirm the theoretical integration of Action Research (iterative co-design) and Tactical Urbanism (agile prototyping) in the study, providing a reproducible framework for effecting socio-spatial change in informal urban settings.

5.2. Limitations

While impactful, the study presents methodological and contextual constraints:

Short-term observations underscore the importance of conducting longitudinal studies to evaluate the long-term sustainability of social and ecological effects.

The effectiveness of the model in larger settlements or diverse socio-cultural settings necessitates comparative landscape research to assess scalability and cultural transferability.

Despite participatory frameworks, equity-sensitive design strategies (e.g., age-inclusive programming) demand deeper integration.

In the end, this study proposes the concept of micro-interventions as a form of urban acupuncture, illustrating how micro-scale, community-focused design can effectively adjust socio-ecological systems within urban villages. By reconceptualizing urban villages as arenas for collaborative creation rather than deficiencies, the research promotes a design approach centered on processes that emphasize the active involvement of residents and interdisciplinary collaboration. The key task moving forward is not solely in creating physical spaces but in establishing cooperative structures that support fair and flexible urban development.

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RESEARCH ON THE RENEWAL DESIGN OF PUBLIC SPACE IN XINGFENG SUBDISTRICT, BEIJING FROM THE PERSPECTIVE OF AGE FRIENDLY PERSPECTIVE

TOPIC: Guiding cities with society: Participatory approaches and governance strategies

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Abstract
China's urbanization has reached a new stage of high-quality renewal. As the capital of China, the renovation of old urban areas in Beijing is one of the core tasks for the development and construction of the capital city. Xingfeng Subdistrict is located in the southern part of Beijing's Daxing District. Xingfeng Subdistrict is the core urban area of Daxing District and is a typical unit based community. In the 1980s, there were many residential areas built with the investment of factories and enterprises. The aging trend of Xingfeng Subdistrict community is obvious, as most of the factories and enterprises in the 1980s have stopped production or moved to more suburban areas of the city for production. The retired residents generally have lower incomes, and the funding for community renovation mainly comes from government funds. Improving the quality of public space in the community has become a key issue for urban renewal in Daxing District. The residential population of the community includes indigenous people, migrant workers, and population from the core area of the capital. The public space of the community includes the entrance and exit of the community courtyard, the green square inside the community, and the original bicycle parking area. These areas are usually used for the entry and exit, parking, and daily leisure of the elderly and children. How to update and transform them to ensure safety, usability, adaptation to the natural environment of the region, and inheritance of regional culture is the key problem to be solved in the design of the community's public space renewal. Public participation is an important source of basis for the design of community public spaces. Due to the complex composition of community members and the diverse age composition of families, we conducted public participation through methods such as visits, surveys, questionnaires, and stakeholder discussions. A total of 286 visits were conducted, covering different ages, occupations, and community space distribution, providing important support for the design of community public spaces. After the renovation and transformation, the efficiency and effectiveness of community residents' space utilization have been significantly improved. The questionnaire shows that residents' satisfaction has reached 86%, providing a reference implementation path for the design of old community renewal.

Text

In the context of accelerating global urbanization and population aging, the creation of inclusive and diverse urban public spaces has emerged as a critical strategy for addressing profound shifts in social structures. The WHO Global Age-Friendly Cities Guide (2020) underscores the centrality of community public spaces in residents' daily lives and advocates for age-inclusive, child-friendly, and socially-oriented design strategies to facilitate intergenerational

integration \cite{Yang2018}. This concept is increasingly becoming a key directive in urban renewal efforts worldwide.

As China transitions from rapid urban expansion to an era of stock-based urban renewal, urban public spaces are confronted with the dual imperatives of quality enhancement and functional restructuring. According to data from the Seventh National Population Census, individuals aged 60 and above now account for 19.8% of China's population, while those aged 65 and above comprise 14.9%, signaling the nation's entry into a moderately aged society. Simultaneously, the implementation of the three-child policy has led to a fluctuating yet rising trend in the proportion of the child population. These demographic shifts have placed new demands on the design and governance of urban public spaces—necessitating responses that accommodate the diverse needs of different age groups, foster intergenerational cohesion, and promote social inclusion.Within this context, exploring pathways for community public space renewal from an age-friendly perspective is not only a practical response to demographic transformation, but also an essential embodiment of the "People-Centered Urban Development" paradigm and a vital step toward advancing social equity \cite{Tang2021}.

Xingfeng Subdistrict in Beijing serves as a representative case of aging urban neighborhoods. The area encompasses both aging residential compounds—many with building ages exceeding 20 years—and newly developed housing zones. Public spaces within the subdistrict are characterized by prominent issues such as inadequate infrastructure, limited functional diversity, and intergenerational conflicts, making it an ideal case for studying age-friendly public space transformation.

This study investigates strategies for updating community public spaces through the lens of all-age inclusivity. Grounded in the specific context of Xingfeng Subdistrict, the research combines field investigations and resident demand assessments to explore the practical application of age-friendly design principles. The objective is to enhance the quality of life for community residents while providing both theoretical insights and practical models for China's broader urban renewal efforts. Ultimately, this research aims to offer adaptable design strategies for optimizing public spaces in similar urban communities and to facilitate a paradigm shift from functionally segmented urban environments to inclusive, shared, and age-friendly community spaces.

1. Research Progress on Age-Friendly Community

Against the backdrop of varying demographic aging trajectories, research in developed countries has shown a marked pioneering focus on addressing the diverse needs of age-inclusive communities. Originating as a foundational concept for age-friendly communities, the "Lifetime Homes" model, proposed in the early 1990s, advocates for a shared spatial system of housing, service facilities, and environmental amenities accessible to residents of all age groups. Empirical studies conducted by scholars such as Keyes L and Rader C have synthesized the core characteristics of age-inclusive communities, highlighting multiple essential attributes: high accessibility, strong inclusivity, safety and aesthetic appeal, comprehensive provision of facilities and services, and a heightened sense of belonging among residents \cite{Bovaird2016}.

In terms of practical exploration, various countries have developed regionally distinctive development pathways. The United Kingdom's "Lifetime Communities" initiative centers on universal design principles, employing technical guidelines to optimize housing adaptability and enhance the quality of life for residents across all age groups. Germany's "Multi-Generational House" model transcends the traditional kinship-based approach to elder care by spatially organizing intergenerational living units to foster socially supportive public interaction environments. Japan's "Two-Generation Living" concept prioritizes both the independence of generational households and the meticulous creation of spaces that facilitate intergenerational exchange. Meanwhile, the United States' "Co-Housing Communities" emphasize an organic balance between private residential spaces and open communal areas, promoting neighborly assistance and community self-governance through shared kitchens, fitness zones, and reception rooms. Collectively, these practices reflect a systemic concern for the multi-dimensional construction of spatial, social, and cultural elements \cite{Li2019}.

In contrast, research and practice concerning age-friendly communities across the lifespan in China have started relatively later. Early efforts primarily extended theories of age-friendly and child-friendly cities to the community level, with policy directives focusing predominantly on the core groups of "the elderly and children." The 2020 "National Standards for Model Age-Friendly Communities" established an evaluation framework emphasizing the adaptation of residential environments, transportation facilities, and social participation to the needs of older adults. Similarly,

the 2021 "Guidelines for Building Child-Friendly Cities" explicitly called for the inclusion of distinctive facilities such as "micro-spaces" and "play corners" tailored for children. Nonetheless, from a theoretical research perspective, existing studies reveal a clear limitation in scope, often concentrating on spatial needs of specific age cohorts \cite{Wang2024}. Research integrating the needs of residents across all age groups and investigating spatial adaptability remains insufficient. Given the heightened demands faced by contemporary urban community renewal, standards for cultivating age-friendly communities should not be confined to these segmented approaches but instead expand to encompass dynamic, life-course-spanning environmental constructions.

In summary, the conceptual framework of public spaces within age-friendly communities encompasses three core dimensions. First, demand inclusivity, which entails addressing the differentiated needs of diverse age groups. Second, intergenerational integration, emphasizing the dismantling of age-related social barriers and promoting intergenerational interaction through shared spaces. Third, sustainable adaptability, requiring spatial flexibility that can dynamically optimize functional layouts in response to demographic shifts, thereby facilitating seamless, age-inclusive community interaction.

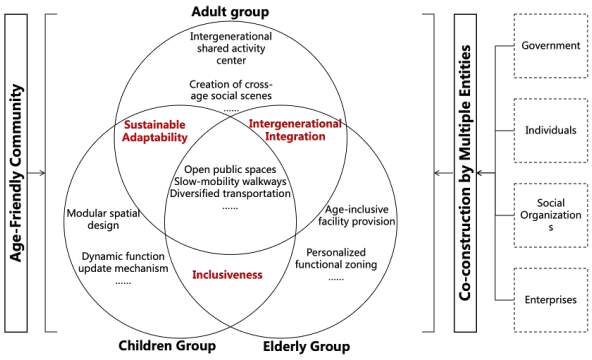


Figure 1. Conceptual Framework of Age-Friendly Communities

2. Research Scope and Methodology

2.1 Research Scope

Xingfeng Subdistrict is an administrative division under the jurisdiction of Daxing District, Beijing, covering an area of 9.7 square kilometers. Geographically positioned at the intersection of Daxing New City and the Daxing Airport Economic Zone, it serves as a prominent area showcasing the capital's new gateway image. Xingfeng Subdistrict borders Guanyinsi Subdistrict to the east, Linxiaolu Subdistrict to the south, Huangcun Town to the west, and Qingyuan Subdistrict to the north. It constitutes a core zone for urbanization within Daxing District, characterized by convenient transportation, a complex mix of old and new developments, intricate property rights relationships, and diverse community landscapes. The area faces urgent demands for urban renewal.

The study focuses on three categories of core public spaces within Xingfeng Subdistrict: open outdoor areas, semi-public activity venues, and street corner spaces. These spaces are not only primary sites for residents' daily activities but also key targets for age-friendly renewal interventions. The resident population distribution within Xingfeng Subdistrict is relatively balanced across age groups: children aged 0–12 account for 12%, adolescents and young adults aged 13–35 represent 32%, the working-age population aged 36–64 comprises 37%, and seniors aged 65 and above constitute 19%. This demographic diversity provides a rich sample for analysis. Given these characteristics, the public spaces within Xingfeng Subdistrict have been selected as the research setting to explore the spatiotemporal behavioral patterns of residents across different age cohorts and to propose targeted renewal strategies.

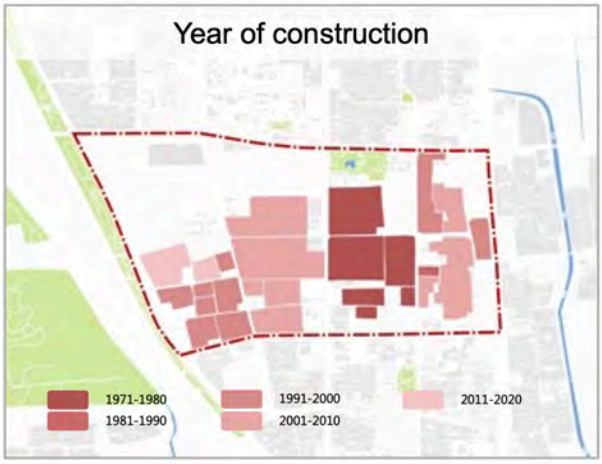


Figure 2. Year of Construction of Community in Xingfeng Subdistrict

2.2 Methodology

The Public Space-Public Life (PSPL) survey methodology serves as an assessment framework for evaluating urban public spaces and associated civic behaviors \cite{Wang2021}. This approach integrates qualitative and quantitative analyses to characterize human activities within public realms, thereby generating evidence-based optimization strategies for enhancing spatial quality and meeting communal needs. Centered on human interactions across diverse typologies and scales of urban public spaces, the PSPL method investigates relationships

between spatial configurations and public life dynamics through systematic observation of citizen utilization patterns. Its application enables objective evaluation of public space performance in aging communities, facilitating contextually appropriate revitalization measures.

Employing the PSPL protocol, this study conducted field investigations across five public spaces within the case study area during clear-weather weekdays and weekends. Observations were systematically performed during morning, midday, and evening peak activity periods to document activity typologies, spatial preferences, and intergenerational interaction frequencies across demographic cohorts. Stratified interviews were administered to guardians of minors, elderly residents, and middle-aged/young adult cohorts. Spatial utilization patterns were analyzed through participatory mapping and systematic behavior counting techniques. Subsequent evaluation incorporated dual metrics of functional performance and intergenerational inclusivity, culminating in the formulation of age-friendly community space regeneration strategies.

3. Results

3.1 Analysis of Demographic Needs

Behavioral patterns within Xingfeng Subdistrict exhibit pronounced age-based stratification and temporal coupling. Older adults emerge as primary daytime users, engaging in sustained low-intensity activities excluding midday breaks. Solar-exposed zones like the south-facing police station wall serve as core gathering spaces for sun-bathing, casual socialization, fitness walking, cultural activities, and child-minding. Notwithstanding, their needs for dedicated social spaces, age-adapted facilities, and intergenerational interaction areas remain inadequately supported by existing infrastructure.

The working-age cohort demonstrates compartmentalized utilization patterns: weekday usage peaks during morning jogging-commuting hybrids and brief evening home-return pauses, while weekends reveal divergent behaviors—younger adults seek external recreational alternatives due to limited community space functionality, whereas middle-aged residents prioritize child-centered outdoor activities. Both subgroups exhibit constrained community engagement and activity diversity attributable to current spatial limitations.

Schoolchildren concentrate activities during morning, afternoon, and evening transitions, with post-school hours dominated by organic play and peer socialization in residence-proximal spaces ensuring parental visibility. Crucially, all three demographics exhibit temporal convergence during dawn/dusk periods: morning hours feature purpose-driven activities with low spatial cohesion, while evenings shift toward leisure-oriented behaviors. This diurnal overlap intensifies intergenerational contact, revealing significant potential for optimizing public spaces through temporal functional hybridization and deliberate intergenerational scenography.

3.2 Diagnostic Analysis of Public Space Deficiencies

Public space deficiencies within Xingfeng Subdistrict manifest in three critical dimensions: infrastructural inadequacies, functional monism, and vitality depletion. Physically, service facilities prove quantitatively and qualitatively insufficient—beyond issues of derelict lots accumulating waste and disorderly non-vehicular parking, the solitary fitness equipment cluster isolated in the northeast corner suffers from poor accessibility. Compounded by shading from adjacent 15-story towers, this area receives critically low annual sunlight exposure (e.g., merely 40 minutes of direct winter daylight at the police station's southern wall, falling below the 1,100 lux-hour threshold for elderly activity zones), severely constraining outdoor engagement, particularly among older residents.

Functionally, a significant mismatch exists between the community's multigenerational demographics and unidimensional spatial offerings. Existing spaces primarily accommodate basic circulation, greening, and limited exercise functions, with substantial areas dominated by vehicular parking. This configuration fails to provide dedicated zones for children's play or working-age social interaction, nor does it offer appropriate congregational spaces for seniors, thereby inadequately supporting diverse activity needs.

These deficiencies collectively engender suboptimal space utilization, transforming marginal and fragmented areas into negative spaces through functional incongruity. Field surveys indicate over 60% of residual spaces remain underutilized or abandoned. Resident interviews further reveal 80% of elderly respondents perceive erosion of place identity, evidenced by outdated or abandoned community noticeboards. Consequently, residents increasingly gravitate toward external venues like Nanguan Park, exacerbating intra-community vitality loss and underscoring the imperative for: (1) Infrastructure augmentation; (2) Functional hybridization; (3) Proactive vitality regeneration strategies.



Figure 3. Current Situation of Communities' Public Space in Xingfeng Subdistrict

3.3 Community Public Space Renewal Strategies under the Concept of Age-Friendly Design

An essential strategy in renewing community public spaces within an age-friendly framework is the establishment of a collaborative design mechanism that actively involves residents across all age groups. The core principle of an age-friendly community lies in recognizing and respecting the diverse needs of individuals at different life stages. Therefore, the conventional "designer-led" approach must be replaced by a participatory model encompassing the entire process—from needs assessment and program decision-making to co-construction and shared use \cite{Vanderbeck2015}. This ensures that children's requirements for play safety, the middle-aged population's need for convenient social interaction, and the elderly's demand for comfort and accessibility are all addressed systematically within the design framework.

A practical illustration of this strategy is the renovation of the Xinghua Dongli Neighborhood Center. Originally a 1,045 square meter outdated auxiliary facility plagued by inefficient spatial segmentation and disorganized commercial use, the project underwent a comprehensive transformation. The design team began by constructing a detailed inventory of facility issues and a community needs map. These were informed through a combination of household interviews, structured questionnaires, and other participatory methods to capture resident input. The facility was then re-envisioned to support a multi-functional program, including an elderly dining hall, fresh food convenience services, and children's activity spaces. After developing an initial proposal, the team conducted targeted environmental assessments—including solar access and noise impact analyses—for adjacent buildings. A community design review meeting was subsequently organized, where multiple design options were presented and the final plan was selected through a public voting process. This iterative and inclusive approach ensured a precise alignment between resident needs and design responses, embodying the principle of responsive, people-centered spatial renewal.

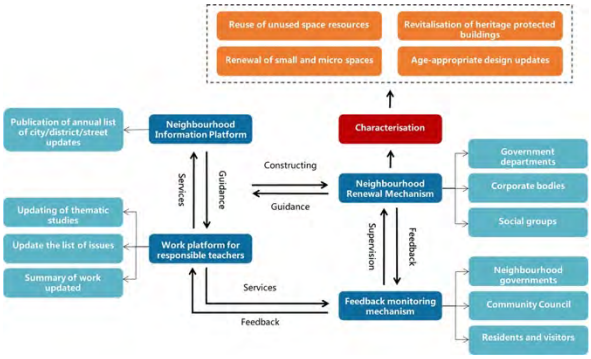


Figure 4. Public Participation, Supervision, and Feedback Mechanism for the Renewal of Communities' Public Spaces in Xingfeng Subdistrict

Another key strategy in the renewal of public spaces under the age-friendly concept is the creation of high-quality, intergenerational cultural spaces. The quality of age-friendly spaces is not only reflected in the physical modifications that make them accessible for both the elderly and children, but also in the cultural empowerment that fosters emotional connections across generations \cite{Kathryn2020}.

A notable example of this is the renovation of the Huangcun Zhongli Boiler House. Originally an idle boiler house and its surrounding courtyard, this project aimed to breathe new life into the space while respecting the original architectural features. The updated design incorporated new cultural functions into the existing building, transforming it into a vibrant community hub. The repurposed space now houses a community service center, a book bar, an activity center, and an open plaza, catering to the cultural needs of local residents. Fully accessible facilities, including ramps and rounded corners, were integrated throughout the space, ensuring inclusivity. The outdoor area was enhanced with low-allergen plants, and the layout of the space was carefully considered to accommodate various activities, with features such as a small stage and supporting electrical infrastructure. Post-renovation, the public space not only meets the diverse needs of the elderly for rest and socializing, children for cultural experiences, and middle-aged adults for fitness activities, but also strengthens the emotional bonds between neighbors. Through the display of vintage items, the inclusion of a community cultural wall, and other elements, the space redefines the social fabric of the neighborhood and serves as a paradigm of public space that embodies local cultural cohesion.



Figure 5. Comparison before and after the renovation of the boiler room in Huangcun Zhongli

A third strategy involves the development of a flexible and adaptive system for community public spaces. In response to common challenges faced by aging neighborhoods—such as limited maintenance funding and shifting demographic structures—age-friendly spatial renewal must balance current needs with future adaptability \cite{Zhang2023}. This necessitates a design framework based on three principles: functional integration, lightweight maintenance, and spatial flexibility.

A representative case is the micro-space renovation at the south entrance of Fuqiang Community, which encompasses an area of only 163 square meters. The site presented two key constraints: part of the land lies outside the official boundary of the community, placing it outside the jurisdiction of community property management despite its role as a key entry point. Additionally, as the land is classified for residential use, it cannot be transferred to municipal authorities for long-term maintenance. The design strategy responded to these constraints by first removing temporary structures and upgrading the pedestrian circulation system at the entrance. A courtyard wall was introduced to clearly separate interior and exterior spaces. Internally, the design addressed the lack of essential community facilities by installing parcel lockers and space for temporary public health infrastructure such as quarantine tents. Externally, the space was reimagined as an open and welcoming community gateway. Low-maintenance vegetation and durable hardscape materials were selected to minimize long-term upkeep. The use of tiered platforms helped create a semi-enclosed environment that prevents illegal parking while simultaneously offering areas for rest and social interaction.



Figure 6 Comparison before and after the renovation of the south exit of Fuqiang Xili

4 Discussion and Conclusion

4.1 Discussion

This study, based on the practice in Xinfeng Subdistrict, Beijing, validates the effectiveness of the three-dimensional framework—Demand Inclusivity, Intergenerational Integration, and Sustainable Adaptability—for the renewal of age-friendly community public spaces. In comparison to Western models such as “lifelong communities” or “multigenerational housing,” the collaborative design mechanism proposed in this study emphasizes governance by diverse stakeholders based on the characteristics of China’s "unit-based" community system \cite{Tang2022}. Through surveys involving 286 participants, a demand map was constructed, combining government financial support with resident decision-making participation to form a localized renewal approach.

The study finds that the cultural empowerment embedded in intergenerational integration spaces activates stronger community emotional identity than purely physical environmental changes. This resonates with the Japanese concept of “two-generation living,” which emphasizes the creation of social interaction spaces. However, in terms of spatial flexibility, this study presents an innovative solution to the challenges of limited funding and dynamic demographic changes in aging communities by implementing a “micro-space lightweight maintenance” strategy.

It is important to note the limitations of the current study: First, while the survey sample covers all age groups, there is a lack of long-term follow-up data on the effects of space usage. Second, the impact of spatial renewal strategies on the community's economic vitality has not been deeply explored. Third, the study only provides a static statistical analysis of the needs of diverse populations; future research could combine big data technologies to monitor space usage trajectories and establish multi-objective optimization models and decision support tools for scenario simulations, or introduce a sociological perspective to analyze the role of age-friendly spaces in community capital regeneration.

4.2 Conclusion

The renewal of aging community public spaces from an age-friendly perspective is a key measure to address demographic transformation and enhance urban livability and social inclusiveness. This study, taking Xinfeng Subdistrict in Beijing as a case, constructs a “Mechanism-Space-Culture” integrated strategy for the renewal of aging community public spaces under the age-friendly lens. The study shows that through an all-process

public participation mechanism, the needs of elderly facilities, children's play safety, and social needs of middle-aged and young adults can be accurately addressed. Additionally, by leveraging industrial heritage revitalization and integrating regional cultural symbols, intergenerational emotional bonds can be effectively redefined. The use of functional integration and lightweight maintenance design enhances spatial adaptability to demographic changes. After the renewal, resident satisfaction reached 86%, confirming the practical value of this strategy.

This study provides two key insights for the renewal of aging communities in China: First, it is necessary to break away from the "designer-led" model and establish a collaborative governance network involving the government, residents, and professional teams. Second, spatial renewal should go beyond the optimization of the physical environment and focus on a "function-culture-society" system-wide update. Future research could extend to comparative analyses of different urban types or explore the application of smart technologies in the dynamic adaptation of age-friendly spaces.

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CO-DESIGN COMMUNITY RESILIENCE ALLIANCE UNDER UNCERTAINTY: A CASE IN HARRISBURG, PENNSYLVANIA, USA

TOPIC: Taking communities into account in public consultation

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Keywords: Co-Design Research, Community Resilience, Climate Justice

Abstract

Co-Design is a community-centered and place-based approach, involving diverse actors to foster collaboration founded in shared decision-making and mutual learning and co-creation of knowledge and solutions, aligning with equity, inclusiveness principles to achieve justice. Co-Design Research Framework applies Co-Design approach to develop meaningful design research processes and outcomes through transdisciplinary collaboration that leverage community assets and address community needs. Under the uncertainty of socio-economic-political and climate change impacts across local to global scales, it is critical to ensure the investment in climate actions and design research are community-centered and help cultivate capacity for building community resilience and rectifying injustice. We applied the framework in a workshop with communities in Harrisburg, Pennsylvania, USA, where the neighborhoods are historically segregated and disinvested, and the generations of population are systemically under-resourced and vulnerable, especially when facing climate change-associated hazards such as extreme floods and heat.

The Co-Design approach was applied to recruiting workshop participants and co-development of workshop agenda with community members. The one-day workshop was attended by twenty diverse stakeholders representing grass-root community activists, not-for-profit organizations, city employees, state representative officials, educators, researchers, and practitioners. The workshop included three interactive sessions: one session of ice-breaking activities and two designed sessions with the intention of connection and collaboration. The Co-Design approach aligns with community's vision of community-driven initiatives aiming to break down systemic barriers and support grassroots efforts. The community defines resilience by adaptability, leadership, collaboration, and education, despite facing barriers such as fragmented infrastructure development, governance structure, and limited resources. They view limited adaptive knowledge, food insecurity, spatial fragmentation, and a lack of shared vision as pressing challenges. To enhance resilience, the community identified critical assets such as nature restoration, sustainability education for youth, and a strong focus on equity and justice, while working to build trust and improve resource sharing across sectors.

This ongoing project continues to evolve to include an application for a grant informed by the workshop and further collaboration with communities with a goal to build Community Resilience Alliance network to sustain community work. To support this effort, an online collaborative platform was created enabling ongoing engagement between the Harrisburg community and the project's transdisciplinary team. This project demonstrates that Co-Design Research Framework is a continuous and reiterated process to co-develop action-based research and community-centered practices to co-produce knowledge and co-create innovative solutions to address community needs, build community resilience, and address climate justice.

1. Introduction

Co-Design is a collaborative approach in an interactive and reiterative process amongst all actors who have influence and who can be impacted by the decisions made. Diverse stakeholders, including but not limited to, institutions, community members, users, designers, and researchers share their knowledge and perspectives, and collaboratively develop a practical, rather than a theoretical understanding of the community priorities. Co-design is a collaborative process, through which the discovery of tacit knowledge can lead to building a shared community vision, empowering the community to take control over their built environments [1].

We propose a Co-Design Research Framework integrating Co-Design approach into design research process, which emphasizes community-based action research that has a practical solution to address community's needs (Figure 1). We applied the framework with Harrisburg community.



Figure 1. Co-Design Research Framework applies Co-Design approach to intentionally engage with community in each step of design research process to identify community assets and needs and co-generate knowledge, solutions, and assessment.

2. Study Area

The City of Harrisburg is the state capital of Pennsylvania, USA, located 106 km west of Philadelphia in Central Pennsylvania (Figure 2). Based on the 2024 U.S. Census estimates, the total population is 50,649, composed of 43.9% African Americans, 32.5% White, and 25.0% Hispanic or Latino, self-identified by race [2].

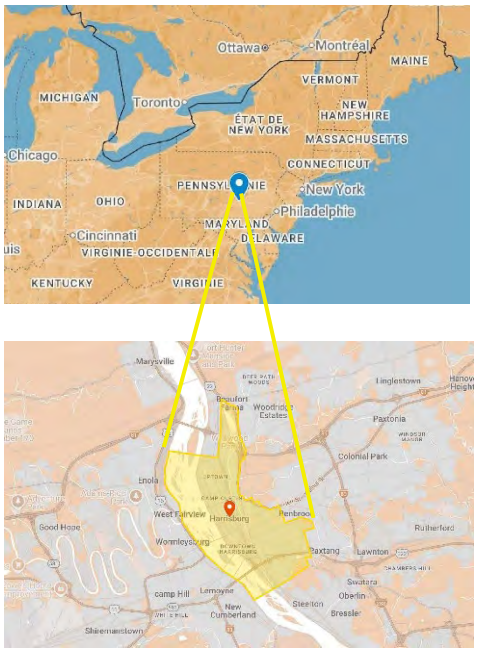


Figure 2. City of Harrisburg is the state capital of Pennsylvania, USA, along the Susquehanna River

The Harrisburg-to-Steelton corridor, along the banks of the Susquehanna River, were historically redlined communities since the 1930s (Figure 3) and are identified as highly socially vulnerable and under-resourced today, especially when facing climate change-associated hazards such as extreme floods and heat. Climate justicescape outlines the spatial inequity of climate change impacts on socially vulnerable communities who are exposed to climate change associated hazards in addition to lacking infrastructure and technological capacity to adapt and cope with change [3].

These challenges are rooted in a legacy of so-called 'redlining' planning practice in early 1900s in the

United States because of zoning segregation and institutional discrimination to African Americans. The past institutional system put in place has contributed to systemic injustice in the built environment and generational inequity due to disinvestment of infrastructure development, close proximity to hazardous waste and facilities, and unequal distribution of social services and resources. As a result, communities under systemic inequity and vulnerability disproportionately bear the burdens of environmental degradation, disasters, public health challenges, and broader environmental and climate injustice, which undermines community resilience and sustainability [4].

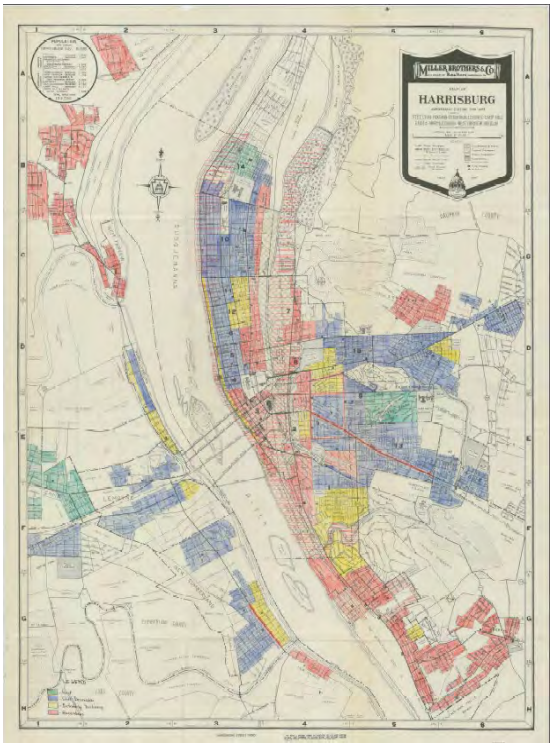


Figure 3. A map illustrating the redlined areas in Harrisburg in 1930 where the neighborhoods were considered as high-risk for real estate investment. [Source: https://digitalharrisburg.com/harrisburg-redlined/]

3. Method

We applied a Co-Design approach to generate a list of participants derived from community leaders and their networks with a goal of starting the project from the beginning to be collaborative and community-centric, leveraging existing community assets. The list included diverse stakeholders ranging from state representatives, city council or representatives, city and state employees, not-for-profit organizations, community activists, community leaders, and community educators. Penn State research team identified additional researchers and outreach specialists. This strategy also allowed some community members to lead the initial outreach process and leveraged existing trust in local networks and further aligns with a grassroots process. Once the participant's contact list was finalized through these collaborative efforts, formal invitation emails were sent by Penn State research team. The primary community contact and the community leader were also consulted in the initial development of the workshop agenda as well as the selection of workshop location.

The workshop was structured around three interactive sessions: a) ice-breaking activities, b) interactive session to 'Connect,' and c) interactive session to 'Collaborate.' The "Connect" session featured five activities designed to foster relationships among participants. Participants were grouped into teams of three. Each activity posed a question for discussion over 10 to 15 minutes, followed by a 3-minute summary of the group's key points. Participants wrote down notes on chart pads and sticky notes, which were then displayed and shared with other groups.

The "Connect" session included questions:

- How do you define community resilience?
- How do you envision the process of community-driven initiatives?
- What is one pressing challenge to community resilience in Harrisburg?
- What is one thing your organization can do to enhance community resilience in Harrisburg?

The "Collaborate" session focused on co-designing research questions. Participants synthesized earlier discussions and collectively developed research questions that reflected their group's shared interests. Following this session, a potential grant opportunity was introduced to support the community's initiatives and further the university community partnership. Participants then engaged in an activity to tailor their research questions to align with the grant requirements.

The workshop concluded with a reflective activity in which community members were invited to write a message to the Harrisburg community of the year 2525 as a way to share their vision for the community.
The data transcribed in chart pads and sticky notes was later summarized and thematically analyzed

through content analysis. The findings are summarized in a written report shared with the participants.

4. Results

The one-day workshop was attended by twenty active participants, including the research team, meaningfully contributed to sharing information and discussions. Their diverse background provided rich perspectives on complex and nuanced topics.

4.1. Community-Defined Community Resilience

Participants defined community resilience as a blend of adaptability, responsive leadership fostering social cohesion, and robust collaboration for collective action, underscored by continuous community-based education. A strong emphasis was placed on leadership rooted in trust to unite diverse groups towards common shared goals. Collaboration, particularly when aligned with existing local efforts, was highlighted as a powerful engine for collective action and strengthening service networks. Community-based education, seen as the ongoing sharing of knowledge within the community, also emerged as critical, including both youth and adult continued education.

However, the path to resilience isn't without hurdles. Attendees pointed to significant barriers, including fragmented infrastructure development, governance inefficiencies, and limited access to resources. Financial constraints, particularly for emergency response, and the burden of state-owned properties compounded these issues, alongside a lack of transparency regarding available community resources. The uncertainty in sustained federal funding adds an additional layer of complexity to existing challenge.

4.2. Community-Driven Initiatives

The community envisions initiatives as collaborative endeavors involving diverse stakeholders, including the city, non-profits, residents, and youth. These efforts should encompass outreach, education, capacity-building, and strategic partnerships to secure funding, translate scientific knowledge into practical solutions, and amplify local needs. Such initiatives are seen as crucial for dismantling systemic barriers, especially those related to infrastructure development such as hazardous housing, and for advancing environmental justice by "correcting past sins." Participants also saw these initiatives as a way to scale up and formalize grassroots innovation, though concerns about inefficient governance (referred as "too many cooks in a kitchen"). It highlighted the need for breaking silos and building stronger coordination across sectors.

4.3. Community-Defined Challenges and Community Assets

A range of interconnected challenges were identified, including limited access to adaptive knowledge and education (e.g., difficulty finding resources, misconceptions about research), spatial and physical fragmentation in connectivity due to limited regional collaboration and transportation planning efforts. One key area of concerns is the pervasive food insecurity. Some neighborhoods were described as "food deserts," where there lacks both structural access to healthy food and community knowledge on gardening. Furthermore, a shared community vision is hindered by communication breakdowns and psychological resistance to change.

Despite these challenges, Harrisburg possesses considerable assets. Community members are actively engaged in nature restoration, erosion control, greenways, and protecting ecosystem services, leveraging local expertise like master gardeners. Education, particularly in sustainability and watersheds, is a cornerstone, equipping youth with practical skills. Equity and justice are central, with efforts to link environmental challenges to public health outcomes and elevate diverse voices. Resource sharing and a comprehensive planning approach further support these initiatives, with ongoing efforts to build trust and ensure youth representation in decision-making. Finally, Penn State has had some successful precedence of action-based research embedded in the Harrisburg community, which considers a great asset to build upon.

4.4. Co-Design Future Research

The workshop concluded with participants co-designing research questions centered on three critical areas: a) food security, stressing the importance of healthy food choices, accessibility, availability, and affordability, starting with questioning federal institutional definition and how to sustain supports for community gardens, b) overcoming the digital divide in education (including nutrition classes), enhancing public health (linking environmental issues to health equity), and c) addressing infrastructure development barriers such as flooding, renewable energy, affordable and sustainable housing development. The community also emphasized the need for visualization tools for

storytelling, community-led participatory research, and empowering youth through intergenerational knowledge sharing and career opportunities. Securing governmental funding and navigating existing resources was highlighted as essential for supporting these collaborative endeavors.

5. Discussion

The Co-Design research workshop brought together community members to collaboratively explore the facets of community resilience, envision pathways for community-driven initiatives, pinpoint pressing challenges, and identify existing assets with a goal to build a Community Resilience Alliance to foster community stewardship.

The Co-Design recruitment strategy proved highly effective, not only by leveraging a network built on mutual trust but also by researchers proactively forging new connections across communities. This approach was key to ensuring a diverse representation of stakeholders in the workshop, which included community leaders, governmental representatives, not-for-profit organizations, educators, and researchers.

During the workshop, the community shared their collective understanding of resilience, identified primary challenges and assets, and envisioned community-driven initiatives. This tacit knowledge is crucial for building a shared vision and unifying grassroots efforts by linking top-down with bottom-up processes through the Penn State-Harrisburg community partnership [5]. Effective facilitation was also vital; it fostered an inclusive environment and provided equal opportunity for everyone to share their individual knowledge and perceptions. This, in turn, deepened interactions among participants, offering researchers a valuable opportunity to enhance their understanding of Harrisburg communities' tacit knowledge.

Community engagement and time present a tension into improving the understanding of researchers of Harrisburg communities' needs and priorities. While the workshop relied solely on facilitation, to provide more space for the communities to voice their knowledge, it would have benefited from training to enable and empower the community of the technical aspects of the research process. To prevent time and energy exhaustion, the last session on collaboration for developing research inquiries would greatly benefit from training community members in advance about forming research questions and equipping them with the proper communicative and technical tools to articulate their priorities. This training would further empower participants and allow researchers to amplify their voices. Co-Design research questions is a crucial first step toward applying for grants that can support communities' grassroots efforts and strengthen the university-community partnership. Co-applying for research grants can bolster the community's innovative problem-solving by leveraging the diverse expertise of all participants. By centering community voices in research and action, the Co-Design Research Framework seeks to address systemic injustice, improve public health, and build climate resilience. It does so by amplifying local assets and enhancing the community's capacity to sustain and advance its initiatives over time.

The primary aim of the workshop is to initiate conversations for building Community Resilience Alliance, a network of resources, organizations, and individuals dedicated to sustaining community-driven climate initiatives beyond the scope of federal funding. The workshop leverages existing community assets while strengthening the partnership between Penn State and stakeholders across Greater Harrisburg to ensure long-term impact and shared stewardship. This is an ongoing effort and a slow process. The proposed next step includes an application for a grant informed by the workshop outcomes and continued engagement with communities to co-develop the proposal. To support this effort, an online collaborative platform was created enabling ongoing engagement between the Harrisburg community and the project's transdisciplinary team. This platform provides a space for the community to stay updated on the project's progress and to continue conversations that may lead to future potential collaborations across Harrisburg and beyond.

6. Conclusion

Building upon existing efforts within the community, the Co-Design Research Framework and the workshop methodology offer a unique opportunity to strengthen relationships with diverse community partners and stakeholders, laying the groundwork for co-designed, actionable strategies that prioritize community needs, integrate local knowledge and assets, and leverage the existing network to form a greater safety net in sustaining and advancing community's work in the face of climate challenges and socio-economic-political uncertainty.

The processes and findings from the Co-Design Research workshop, such as data collected from community-based definition on climate resilience, community assets and needs, serve as critical foundation for climate justice planning that includes social-ecological-technological systems assessment and identifies priorities for community projects and policy implementation [6].

This project demonstrates how Co-Design approach could contribute to a collective vision, integrated strategies, and innovative solutions that can elevate impacts, sustainability, and resilience in communities.

Acknowledgments

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DESIGNING SPACES FOR NEW STORIES THROUGH A CULTURE OF COLLABORATION

TOPIC: Participatory Approaches and Governance Strategies

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Keywords: Public Space, Community-Initiated, Landscape Architecture, Professional Practice

Abstract
Community-initiated landscape architectural projects and developments are multifaceted endeavors made more complex by the fact that many communities often find it difficult to secure initial funding, develop comprehensive stakeholder groups, and align diverse programmatic needs with actionable design feedback. This presentation explores the 'build-up' process of supporting a community-rooted vision through the design process, identifying and securing financing, and sustaining community support through extended design and implementation phases.

This "build-up" or "community-led" design methodology can best be parsed through the lens of one recently completed and one in-progress St. Louis-based (USA) community-led neighborhood park projects — Love Bank Park in south St. Louis and Peace Park in north St. Louis. The presentation Authors and their collaborators, who represent the steward organizations, supporting institutions, and the design team, speak to the uniquely iterative community engagement processes and methods that were utilized to develop park visions and phased construction projects.

Love Bank Park, formerly an empty lot, was partially activated by community members who placed basketball hoops there in 2015, instantly creating an active community destination.

Building on this grass-roots momentum, Love Bank Park underwent a nearly decade-long community-led design process. Opening to the public in 2024, the park features an open plaza space with seating, chess tables, shade trees and planted areas provides a welcoming place for neighbors and visitors to gather and relax - or during community festivals, provides a place for concerts, dances and other activities. Designed with permeable pavers, permeable asphalt, rain-gardens and planted areas, the entire park site is a community programming asset but also a demonstration landscape for sustainable design and sustainable storm-water management.

Located in the economically depressed College Hill neighborhood of North St. Louis, Peace Park consists of multiple adjacent lots that sit along the eastern edge of a major roundabout which hosts one of the city's most recognized landmarks at its center, the Grand Avenue Water Tower – the oldest water tower in the city and the world's largest Corinthian column. The overgrown site had been informally used as a community gathering point and donation site. After Otis Woodard, a member of the community who had been stewarding maintenance of the parcels, passed away; community members came together to determine that the best way to preserve his legacy will supporting the clean-up and revitalization of the neighborhood was to develop the site as a public park. Working together to enact an extensive community engagement and design program, a collaborative coalition

of neighborhood residents, 4 Municipal Departments, 4 regional or local non-profits, a cohort of faculty from a local university, and the Design Team came together to develop the park vision.

Both parks have a long-view in mind, so while the literal physical "build-up" symbolizes one finish line, the maintenance and on-going ownership strategies for the space are key to the longevity of effective placemaking and continued trust amongst the community and partners involved. To that end the panel unpacks how the two projects have sourced capital to build and maintain the spaces, the land ownership models created to ensure neighborhood access, and the coalition-based institutional agreements that make it all possible.

Text

1.1 Love Bank Park

The vision for Love Bank Park was to create a multi-functional and environmentally sustainable public space on Cherokee Street - one of the most multi-cultural and inclusive commercial corridors in the City of St. Louis, and which previously lacked any public gathering spaces. A melting pot of latinx, black, and various immigrant communities[1], Cherokee Street is a vibrant cultural hub that nevertheless has experienced consistent structural disinvestment; blighted by poverty, drugs, and violence. The project site, formerly a vacant lot, was partially activated when neighbors installed a basketball hoop in 2015, instantly creating a community destination and setting the stage for the park to come.



Figure 1. Existing Conditions of the lots that would become Love Bank Park

Building on this grass-roots momentum, a newly formed Community Improvement District (CID) brought Arbolope Studio on board in 2016 to begin conceptual planning and engagement for a community park, and to assist with grant application development for the Metropolitan Sewer District Project Clear Grant Program, which provides

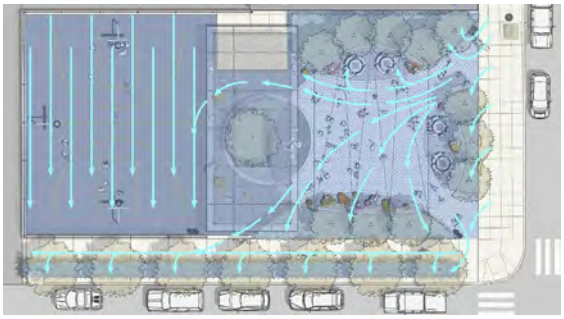


Figure 2. Hydrological Analysis, a part of the MSD Project Clear Grant Application process.

reimbursements to projects within the St. Louis Metro area with a demonstrated capacity to capture stormwater and prevent sheet-flow runoff into the combined sewer system.



Figure 3. Resident and visitor surveying was conducted across a multi-year span.

This initial effort kicked off an 8-year design and engagement process in collaboration with a diverse group of stakeholders, such as the CID Board, community and business owners.

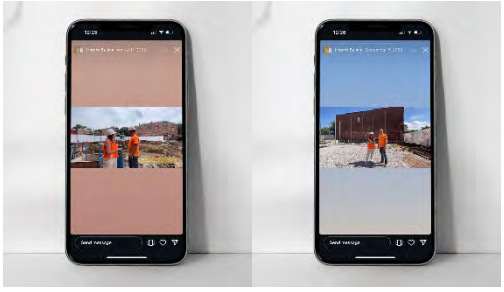


Figure 4. The Design Team even produced a weekly social media video series daylighting how the Park was being designed and built.

Moreover, the CID and Design Team worked with area youth to form engagement groups and bring their voices to the project process.



Figure 5. Volunteers and community members staff one of the many all-ages engagement events on the Park site.

On the financial side, finding comprehensive backing and institutional support was nearly impossible. Large corporate lenders were not willing to loan significant capital to a CID with little to no history tackling capital projects at this scale. To make matters more difficult, even while a large volume of residents and community members made small contributions, a substantial amount of funding was required to bridge the project until MSD reimbursements could take effect. However, after years of partner building work, a collection of local credit unions and smaller institutions formed a coalition of financial partners, who were able to work with the CID to develop a construction loan that worked within the unique constraints of the project model.



Figure 6. Paver engravings celebrate the micro-donations that made the Park possible,

What resulted from this mosaic-like funding effort was the development of a public park that was funded by the community, for the community, without any exterior corporate or tax-based funding.



Figure 7. Engagement prompts placed along the CID to promote community member engagement with the design process.

After almost a decade of engagement, the final community-co-authored design was completed and construction began.

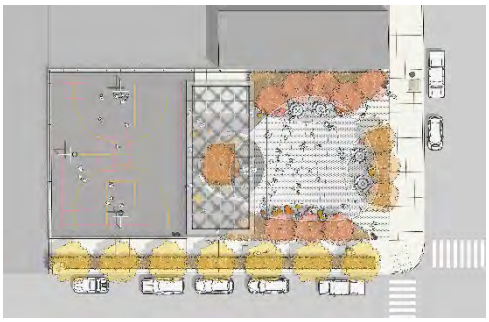


Figure 8. Illustrated Plan of Love Bank Park

Love Bank Park provides space and infrastructure for a variety of activities. The curved geometries of the Park are inspired by Venn diagrams - in which overlapping curves define program elements and allude to the desires of the Cherokee Street community to create a welcoming and inclusive neighborhood for all.



Figure 9. Illustrated Perspective of Love Bank Park with program and feature notation

A permeable plaza space inspired by Latin-American plazas includes seating, chess tables, shade trees and planted areas provides a welcoming place for neighbors and visitors to gather while also serving as a large catchment area for stormwater run-off.

During community festivals, this space hosts concerts, dancing, theatre productions, and other neighborhood cultural activities. A large basketball court in the northern half of the park–the first permeable basketball court in the region–supports both full and half-court play. Between the two spaces, a shade pavilion pierced by a specimen Catalpa tree creates a welcoming seating space, connecting the two dominant park program areas.

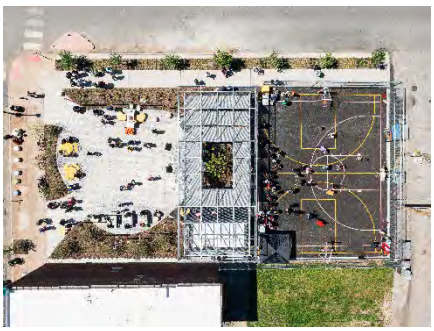


Figure 10. Plan view of the completed Park, opening day (Spring, 2024)

Facilitating multiple types of gatherings and programs simultaneously, this small but mighty park was an instant success when it opened to the public in the spring of 2024. During the opening weekend, youth played pick-up basketball while mariachis (a regional style of Mexican music and performance) played and residents danced. Two months later, a theatre company put on Shakespeare to a standing-room-only crowd, while a basketball game was carried on mere feet away.



Figure 11. Members of the community gather for annual concerts and theatre productions

With over 90% of its total surface now permeable and with a regional planting palette, Love Bank Park also serves as a demonstration landscape for sustainable design and storm-water management.



Figure 12. Native plant species create pollinator habitat and frame program zones.

A formerly abandoned asphalt lot is now the heart of the community, and a real testament to the quality of public space that can be created when designers and communities come together to co-author spaces for new stories.



Figure 13. Love Bank Park on opening day (Spring, 2024)



Figure 14. Nightly basketball pick-up game at Love Bank Park

1.2 Peace Park

Located in an economically depressed area of North St. Louis, Peace Park is a new coalition-built public park in the College Hill neighborhood, the only St. Louis City neighborhood that previously lacked any parks and that has suffered from substantial blight, municipal and commercial disinvestment, and a lack of infrastructural development – a result of historic redlining, structural racism, and city-wide population decline.



Figure 15. Diagram showing the progression of blight in the project area

The park is sited on a collection of consolidated commercial and residential lots at the corner of a major roundabout which hosts one of the city's most recognized landmarks at its center: the Grand Avenue Water Tower – the oldest water tower in the city and the largest free-standing Corinthian column in the world[2].



Figure 16. The Grand Avenue Water Tower receives a new coat of paint as a part of early site preparation.

While once densely populated, this corner lay vacant for years before being temporarily stewarded by a neighbor into an informal community donation center and garden. As the neighborhood continued to decline, so too did the site.

Spurred by a 2018 report documenting social determinants of health disparities in the region, a broad coalition of community stakeholders was formed to lean into past efforts and to transform the site into a lasting community asset. The Landscape Architect joined the coalition shortly thereafter and was tasked with translating the site's assets into a site-specific design.

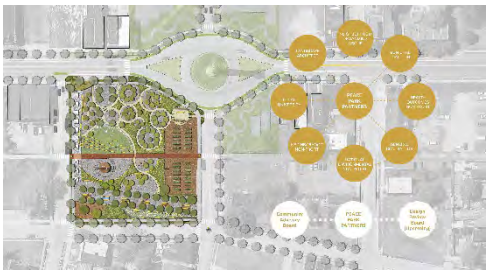


Figure 17. Diagram showing the progression of blight in the project area

Foundational design goals included:

- Create an inclusive and welcoming College Hill community anchor
- Develop a design that anticipates future growth and connections
- Create a high impact but low maintenance landscape with realistic implementation
- Leverage project partnerships and community resources



Figure 18. Neighbors and volunteers worked to leverage the Park development as an opportunity for collective momentum around neighborhood improvements.

Utilizing extensive community feedback, the design team wove together the community's desired program features into a phased masterplan that was formally and conceptually inspired by the "peace circles" of the peace sign. Phase 1, completed in 2024, consists of programmatic "circles" connected by sinuous, tree-lined ADA accessible walkways and stormwater bioswales.



Figure 19. Photograph of the Phase I Model made for use in community outreach.

Program "circles" include: the Gateway Pavilion entrance plaza; a new diversified orchard with regionally appropriate fruiting trees and shrubs; an outdoor exercise circuit; a centralized gathering space oriented around a (future) interactive basketball "tree"; a sidewalk plaza ready for pop-up markets and more; terraced perimeter seating walls taking advantage of the original site topography; and an amphitheater.



Figure 20. Outreach events brought the community onto the site to share in major design milestones and provide continues feedback.

The project also utilized low-carbon footprint materials including locally sourced limestone fines pathways; woven bamboo for the pavilion; locally-made site furniture; and gabion basket site-walls filled with salvaged bricks from the demolition of neighboring condemned buildings.



Figure 21. Phase I nears completion.

Additionally, large areas of native and prairie-inspired planting beds buffer sidewalks and park spaces from the surrounding street noise and pollution; form borders and backdrops for distinct program spaces; slow, direct, filter, and absorb stormwater run-off; provide pollinator, wildlife, and forage habitat; and create a seasonally-dynamic yet serene landscape. Thousands of donated plants, including the park's diverse collection of trees, were planted in waves throughout 2024 by dedicated volunteers from the community, the design team, and the broader coalition. The Second & Third Phases of the park will complete the transformation of the full block in the near future.



Figure 22. Phase II Axon View



Figure 23. Phase III Axon View with Program and Feature Annotations

The Gateway Pavilion was designed and built in the spring 2023 semester by Wash U

students as part of an OSEP supported seminar class led by an Architecture Professor and Registered Architect from the Sam Fox School of Design and Visual Arts. The students were given a mandate to create an iconic entrance to the Park which could serve as a protective shelter, a bus stop, and a comfortable meeting point for residents of College Hill.



Figure 24. Neighborhood and student volunteers work to construct the Pavillion

Influenced by the winding paths around circular programmatic nodes and soft beds of native grasses and edible shrubs, the students worked with the Landscape Architecture team and broader coalition to blend seamlessly into the curvature of the site design. The final tree-like, dome form of the Pavilion, constructed by students through workshops with over fifty volunteers from the St Louis area, was ultimately made of a weave of bamboo strips, allowing for a mesh-like architectural form to stretch across the plaza. Completed, the Pavillion frames key views and creates a safe and inviting portal into the park; dialogues with the monumentality and ornamentation of the adjacent historic water tower; and references the iconic St. Louis Gateway Arch, visible in the distance.



Figure 25. View of Phase 1 from the Pavillion

Multi-programmatic & sustainable by design, both the Park and Pavillion work together to create a unified transformation of a vacant corner into a vibrant, community-owned green space.



Figure 26. View of Phase 1 and Pavillion

Peace Park is truly a coalition-built landscape. The project is a testament to the power of interdisciplinary collaboration between architecture, landscape architecture, and engineering disciplines, and it demonstrates how leveraging project partnerships and community resources can help create transformative spaces for the public good.

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CONTESTED LANDSCAPES, MIGRATORY MOVEMENTS AND THE EVERYDAY ACTIONS OF CARE AND REPAIR

TOPIC: Guiding cities with society: Participatory approaches and governance strategies

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Keywords: contested landscapes, migration, everyday actions, care, repair

Abstract
This paper explores the intersection of migration, contested landscapes, and the everyday practices of care and repair in the context of geopolitical conflict and displacement, with a particular focus on the Mediterranean region. It investigates how spaces shaped by forced mobility—ranging from urban peripheries to informal camps—are transformed into sites of socio-spatial negotiation and resilience. By introducing the concept of *ecologies of repair* [1], the paper examines how human and more-than-human actors participate in the recovery of fractured environments and relationships, offering a counter-narrative to dominant securitisation and technocratic approaches to post-crisis reconstruction. The analysis draws on contemporary cases in Lebanon and Palestine to reflect on how communities resist erasure and foster forms of relational reparation amidst conditions of temporariness, ecological decline, and geopolitical uncertainty.

1. Introduction

Global catastrophic events—whether political, environmental, or military—continue to pose significant challenges to societies worldwide. The implications of global unrest are deeply embedded in both physical and social infrastructures, where an erosion of cultural identity, persistent conflicts, and military occupation engender intricate, contested landscapes. These landscapes, affected by disputes over land use, resource allocation, cultural heritage, environmental degradation, and political power, serve as both products and arenas of crises, where histories of violence, colonial legacies, and systematic injustices intersect.

This study focuses on contested landscapes to examine current manifestations of socio-ecological disruption in war-torn territories. Violent and armed events underscore the intricate connection between human misery and ecological degradation and strain. Conflicts lead to population displacement, habitat damage, ecological fragmentation, and the disruption of human and more-than-human relationships. Such dynamics require an enhanced ethical and analytical framework that recognises the material and biological interconnections among species and habitats [2].

The methodology is based on a relational understanding of landscape that actively challenges binary distinctions among nature and culture, as well as between human and nonhuman entities. We highlight the co-constitutive and reciprocal nature of all living systems, integrating notions of distributed agency, contextual knowledge, and shared vulnerability.

Drawing on the posthumanist concept, the paper considers landscapes not merely as passive environments for human activity but as actively engaging in social, political, and ecological processes [3]. This paradigm promotes an approach rooted in care, accountability, and collaborative stewardship, thereby fostering more ethical interactions with vulnerable settings. One of the most evident indicators of these dynamics is observable at Europe's borders, especially in the Mediterranean region. The basin serves as a site for analysing the

impact of violence and displacement on landscapes and community responses characterised by acts of care and repair.
The paper explores the concept of ecologies of repair, highlighting the creative, contextual, and multispecies practices that mend damaged habitats and relationships. Drawing on readings about everyday acts by individuals navigating instability and injustice, repair is described as a dynamic and ongoing process rather than merely a technical solution or a return to previous states.

2. Migration and displacement in the Mediterranean

As violence and crises proliferate at the edges of Europe and the wider Middle East, migration patterns have intensified. The Mediterranean, historically a nexus of migration, trade, and cultural exchange, has evolved into a highly politicised region characterised by mobility restrictions. Migrants and displaced persons navigate hazardous routes, encountering militarised borders, legal limbo, and escalating mortality rates. Yet these movements also produce new spaces of transit and stasis—from informal tented camps and urban edges to detention centres and informal housing—where the rural and urbanscape are reconfigured under the pressure of emergency, displacement, and precarity.
Notwithstanding heightened securitisation, migrants persist in their movement, motivated by necessity, aspiration, and the imperative of survival. Their mobility reflects the Mediterranean's intricate and multifaceted history of exchange. As noted by Braudel (1995), the sea has historically served as a dynamic arena for many entities to assert territorial claims, regulate flows, and wield geopolitical power. Contemporary border regimes represent a new phase in this history—one defined by unparalleled human vulnerability and the militarisation of humanitarian spaces. However, in recent decades, the rise in irregular migration has drawn attention to the increasingly dangerous routes used and the alarming number of migrant fatalities. Individuals seeking refuge in Europe via maritime routes pass through various transit points and temporary locations before, if fortunate, being assimilated into urban environments. These spaces of temporary stasis – makeshift camps, parks, streets, and detention centres – significantly influence urban landscapes characterised by elevated levels of socioeconomic vulnerability and high exposure to natural and anthropogenic hazards. The transformative impact of mass migratory fluxes, often stemming from improvisation rather than thorough planning measures, is altering places, localities, and cities, creating contested landscapes that necessitate more focused urban research. These practices are rarely linear or institutional. They may include rebuilding damaged dwellings using salvaged materials, tending to community gardens that feed both people and ecosystems, or maintaining cultural rituals that assert identity in places of exile. Such actions, while often overlooked in formal recovery narratives, offer critical insights into how communities adapt to instability and reconstruct meaning in new spaces. To interpret these phenomena, we employ the notion of ecologies of repair. This framework reframes repair not as a final act of restoration, but as an ongoing, relational, and contingent process. It encompasses not only the repair of physical infrastructures but also the healing of social ties, the revival of cultural practices, and the reconstitution of multispecies relationships. In doing so, it challenges dominant paradigms of post-conflict or post-disaster reconstruction, which often prioritise technical efficiency over situated knowledge and overlook the deeply embedded forms of agency that exist in displaced and marginalised communities.

3. Ecologies of repair and care

War-affected regions function as evolving organisms that undergo continuous transformation, shifting from states of devastation to transient structures, progressing from deterioration to revitalisation, and from waste to valuable resources.
The environment is in a constant state of evolution through ceaseless transformation and reconstitution, shaped collaboratively by humans and more-than-humans actors. Building on recent post-humanist perspectives, in this study, we applied the concept of ecologies of repair borrowed from Blanco-Wells (2021) to understand how communities at war address the degraded environment and repair the socio-ecological harm caused by conflict through everyday practices of resistance, remediation, and mutual care. This generates processes of reparation - characterised by the persistent reuse and recycling of materials and ideas- for damaged ecologies and communities. This engagement aims to mend the damages caused by armed conflicts and to transform the conditions of coexistence among diverse life forms.
In my observation and interpretation of the situation on the ground, I noticed that reparative actions are persistently implemented throughout all

phases of the conflict, tirelessly addressing environmental, social, and infrastructural damages. By examining these constant evolutions from an ecological perspective, it was evident that collaborative practices of caring and repairing, which characterise cyclical transformations of life under conditions of warfare, were present in the affected areas. Those practices based on reparative thinking involved perceiving and listening for life-affirming potentials- both past and present- by mapping connections, reconfiguring familiar concepts, and remaining receptive to the lessons inherent in ongoing global developments [4]. While acts of repair are visibly manifested in daily activities, the act of care often remains subtle at first glance, despite its crucial role in ensuring the survival of both human and non-human others within our worlds. Nonetheless, closer inspection revealed care in small acts, such as soil nurturing, food cultivation, and a deep attachment to the land. It manifested through various forms of resistance against exploitation and appropriation by those in authority, as reflected in the daily behaviours of individuals and communities confronting threats. This underscores the complex relationships, issues, and practices encompassed by care [5]. As Joan Tronto and Bernice Fischer [6] articulate, de la Bellacasa asserts that care 'includes everything that we do to maintain, continue, and repair 'our world' so that we can live in it as well as possible. That world includes our bodies, our selves, and our environment, all of which we seek to interweave in a complex, life-sustaining web' [7].

4. Everyday practices of care and repair: Lebanon and Gaza

Drawing upon the prevailing circumstances in Lebanon and Palestine under Israeli occupation, this paper investigates how communities residing in regions of prolonged crisis respond to dispossession and ecological degradation through a variety of everyday reparative actions. The study defines the concept of the everyday in accordance with Lefebvre's [8] assertion that characterises it as a residual space where basic needs are fulfilled, thereby enabling the emergence of what are regarded as higher functions within our society. It encompasses all activities integral to individuals' means of survival.

In the aftermath of the events that transpired on October 7, 2023, fragile landscapes have emerged in the Gaza Strip and South Lebanon, marked by a significant deficiency in essential services and an absence of normalcy in societal behaviours, activities, mobility, and daily practices. While the conflict is ongoing, a sense of instability couples with the mass destruction and the humans' and more-than-human scars. Extensive territories have been erased of historical structures and polluted by military devices. The use of highly polluting military munitions, including high-impact explosives and incendiary devices such as white phosphorus, has substantially deteriorated the environment, adversely affecting soil, air, and water quality. Agricultural production has been eradicated, and the terrain has become compacted due to the incursion of military vehicles and forces. The accumulation of solid waste and debris from the numerous damaged buildings, vehicles, and vegetation is resulting in significant environmental hazards. This debris encompasses hazardous materials, including unexploded ordnance, depleted uranium fragments, cluster munitions, flechette rounds, fuel-air explosives, which detonate on impact and subsequently again, and white phosphorus, as well as Dense Inert Metal Explosives. The destruction of water infrastructures - wells, desalination plants, pipes, sewage lines –hinders the well-being of the entire population and endangers agricultural production. As a result, citizens have been compelled to abandon their residences, resulting in the evacuation of entire villages and the displacement of thousands of individuals.

In both regions, armed conflicts and political and economic crises have induced rapid and often irreversible transformations of both the physical landscape and the socio-cultural fabric. Urban and rural ecosystems are disrupted, agricultural systems are dismantled, and traditional landscape knowledge—critical for maintaining biocultural resilience—is lost. The violence inflicted upon both people and land results in habitat destruction, biodiversity loss, increased risks of species extinction, and the amplification of climate-related hazards. Together, these processes threaten ecosystem functionality and compromise the long-term viability of both human and more-than-human communities.

However, landscapes are not passive victims of conflict, but active agents shaped by—and shaping—the forces of global geopolitics and ideology. The territorial reconfiguration of war zones reshapes everyday life, embedding insecurity and risk into the lived experience of those inhabiting affected areas. In this context, the concept of a right to landscape emerges as both a right to dwell and to belong, and as a broader legal and ethical imperative to recognise the agency and rights of nature itself. In such situations, repair is

both political and material. It involves contesting the spatial strategies of military occupation or state neglect, while simultaneously cultivating alternative forms of belonging, memory, and ecological stewardship.
The reparative actions I was able to assess through the reading of reports, maps (Beirut Urban Lab, Planet Lab, Forensic Architecture), social media video and images, and discussion with locals on whatsapp, extend beyond the human, recognising the agency of animals, plants, materials, and landscapes themselves, and aligning with a more-than-human perspective that sees recovery as a collective effort, distributed across species and scales. This inclusive view of agency reconfigures who and what is considered a stakeholder in the rebuilding of fractured worlds.

Moreover, I discovered that while normalcy has been significantly disrupted, life has persisted, coexisting with death and chaos. Individuals, communities, and various forms of life have undergone transformations, collectively creating diverse normalcies as they have coped with and adapted to dire circumstances. They have repaired damaged structures and objects, constructed new transient settlements amidst their unstable existence, and the ecosystem self-regenerated in pursuit of a new equilibrium. The continuous conflicts and wars in both Lebanon and Gaza have, over time, fostered a profound and progressively developing expertise in crisis management and resource allocation. Frequently shaped by years of adversity, local knowledge is perpetually refined, adapting and evolving in response to each new challenge. This pragmatic understanding, often undervalued as 'uneducated', intermingles with advanced knowledge and formal expertise, culminating in the establishment of a distinctive cultural framework for survival. The replication of adaptive practices, along with the revitalisation of traditional methods and ecological knowledge, is deemed essential for recovering disrupted livelihood systems, reinforcing cultural identity and social cohesion and the cultural and environmental resilience necessary for repairing degraded land.
The study and analysis of the situation in Lebanon and Gaza have been conducted through an explicit acknowledgement of the capacities for agency and practices that encompass not only humans but also non-human entities. Emphasis has been placed on the daily practices of resistance and adaptive capacity exhibited by both the land and individuals engaged in a reciprocal relationship essential for survival. This intricate network of relationships is characterised as a socio-ecology of repair. Within this context, reparation has been comprehensively interpreted as the ongoing actions, practices, and methods aimed at amending what is perceived or experienced as broken. Indeed, it is within this framework of care that life manifests with creative intensity, notwithstanding the presence of destruction and ecological degradation.
In scenarios where solutions are unsustainable and temporariness is inherent, repairs have emerged as both transient and contingent, encompassing spatial and material practices that evade comprehensive theory and established norms. This phenomenon resonates with the Arabic term "sumud," which translates to "steadfast perseverance."
Consequently, those acts of repair have been interpreted as a meticulous and diligent reorganisation of damaged elements, serving as rituals of survival aimed at achieving liberation. Repair is seen as the action of restoring, replacing parts and putting together what was broken. The 'repair mode' in Lebanon and Gaza utilises the underlying assumptions, imagery, and mythology of degradation, positioned alongside the assurance of economic and ecological restoration redemption.

5. Discussion and Conclusion

The paper examined contested territories in the Eastern Mediterranean region, and through the case studies of Lebanon and Palestine, offered reflections on contemporary conflicts and violence that inflict considerable damage and lead to the deterritorialisation of individuals and cultures. It emphasised the everyday creative social forces directed at reconstructing fractured relationships and damaged ecosystems within communities affected by internal displacement and migration. This endeavour is facilitated through a clear acknowledgement of the capacities for agency and practices that encompass not only humans but also animals, objects, and various materials.
Within the wider framework of deterritorialisation and resettlement, reparation is understood as continuous initiatives, practices, and methods designed to address perceived or experienced injustices. It is against this backdrop of care that life expresses itself with creative vigour, even amidst destruction and ecological decline. When solutions lack sustainability and temporariness is a fundamental aspect, repairs are seen as both fleeting and dependent, incorporating spatial and material efforts that bypass expansive theories and conventional standards.
The paper contributes to a broader rethinking of reparation, not as a juridical endpoint, but as a continuous socio-spatial practice embedded in daily

life. It suggests that amidst temporariness and precarity, the act of repair becomes a form of resistance, a strategy for survival, and a proposition for more just and inclusive futures. These ecologies of repair offer a compelling counterpoint to top-down interventions, proposing instead a mode of recovery rooted in situated knowledge, ethical cohabitation, and collaborative world-making. underscoring the creative socio-ecological forces and practices that have emerged to rehabilitate fractured relationships and damaged ecosystems.

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CLIMBING THE LADDER OF CITIZEN PARTICIPATION, THE PARTNERSHIP BETWEEN DESIGNERS AND RESIDENTS AS A NEW PROJECT PARADIGM

TOPIC: Guiding cities with society: Participatory approaches and governance strategies

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Abstract

Public landscaping seems likely to remain the domain of experts. Despite a certain enthusiasm, participatory urbanism struggles to convince in its modern form. The public is suspicious and disengaged, and the obtained results are scarce and rarely used. Planning experts themselves struggle to articulate project and participatory processes. Far from the counter-power defended by the 1960s' urban social movement, participatory urbanism has become institutionalized and a tool for legitimizing the established power. Struggles to protect and develop democratic participatory spaces have been gradually monopolized and channeled by planning professionals.

Arnstein compared the citizen participation degrees to an eight-level scale divided into three categories: Non-participant, Tokenism, and Citizen Power.

Urban designers expect the consultation to provide solutions or validate the project, dismissing divergent or belligerent statements. Thus, participatory urban planning does not seem to deliver on its promise of collaboration between residents and the designers of their living space. This leads to a doctrine of "doing for" rather than "doing with," totally opposed to modern democratic aspirations. And yet, people represent an extraordinary database, both quantitative (the sheer sample size) and qualitative (diversity of lived experiences, social classes, and ways of experiencing the same site). Their site experience is particularly valuable given the project management's pace over a relatively short period.

What legitimacy do we have in deciding, among experts, what the future entails for a living space for decades to come, without ever questioning its inhabitants, those directly affected? Many projects are challenged by their users, not only in the "how" but also in the "why". Many more fail to grasp the usage's challenges in all their dimensions, particularly human and social, limiting themselves to purely technical considerations.

To restore participatory urbanism's ambition, we must imagine new institutions and logic leading regional planning. To create a society that places the partnership between designers and residents at the center of the project approach, we must identify the landscape architect's role. We're advocating for a participatory urbanism based on the "democracy of the most concerned" model. Concretely, all stages of the urban project, particularly the planning process, would be carried out for, with, and under the control of the inhabitants impacted by the design or political issues under discussion. These users must be mobilized and trained in advance so that their opinions are enlightened by a global understanding of the issues, enriched by the contributions of their experiences.

In this study, we will try to characterize a new model of negotiated coordination, allowing all voices to express themselves and all visions to be confronted on a common basis, an urbanism of compromise. Such a paradigm shift raises many questions, but there are plenty of benefits: strengthening the legitimacy of political decisions, improving the project's quality, fostering civic engagement and social cohesion... Not to mention the emergence of streets and neighborhoods defined in their atmosphere by the community from which they sprang. What co-designer could be more committed and relevant than the one who will inhabit the project for the next 30 years?

Text

Despite a certain enthusiasm, participatory urbanism struggles to convince in its modern form. The public is suspicious, disengaged, and the obtained results are scarce and rarely used. Planning experts themselves struggle to articulate projects and participatory processes.

During our studies, our first contacts with landscape projects are already shaping a certain vision of what the processes are supposed to be like. We're imbued with a very design-oriented vision, and our first real participative approaches are only available as an option during the last years.

We are told very early on that we're supposed to take care of the living, improve people's quality of life. Then, when do we have the time to ask, to understand?

1 The landscape as a specialist's matter

1.1 What's the ladder? Where do we stand and why?

Arnstein, an American sociologist, wrote A ladder of citizen participation in 1969 [1]. In her work, she's critical of participatory processes in relation to urban planning and design. In this piece, written a year after the events led by French students in 1968, she identifies three categories : Nonparticipation, Degrees of Tokenism (counterfeit power), and Degrees of Citizen Power) and eight steps Manipulation, Therapy, Informing, Consultation, Placation, Partnership, Delegated power, Citizen control, to describe each possible level of citizen participation.

If we're considering the landscape planning system and most of the project it produces, we're stuck in the Degrees of tokenism category, oscillating between Informing, Consultation and Placation depending on the project and its leaders. In this category, several protagonists get to share their visions, their knowledge and they're even able to defend a position. However, the project is not co-constructed, and no real opposition power is given to the population. More often than not, citizen participation stands as a token to legitimate planning even when most parameters are already set in stone. The effectiveness of a participatory approach that works depends a lot on the planners' willingness, a condition that endangers participatory if not met.

I.2 Landscape architect, an unstable role in urban projects: questioning our position and possible evolution

Being a crucial part of planning and design, landscape architecture should be at the center of a project's organization, but nowadays we are still far from it. There are still a lot of parameters endangering the sector, keeping us from having global thoughts regarding our methods and purposes.
First, it's not uncommon for landscape architects to be deprived of project leadership, benefiting other planning professionals or designers, less prone to consider landscape in its entirety. Furthermore, we're isolated as professionals and our jobs are not well protected, nor well-paid. As a group, and as the result of all the above, it is not our priority to question the way we work, the time we take to create, the people we work with or for. Our stance lacks some perspective even though we're the best prepared as urban project mediators due to the inherent nature of landscape architecture [2]
For the same reasons, we're not in total capacity for transmitting or conducting exchanges. We started to understand landscape and landscape design in its mobile dimension and its capacity to evolve in time, but questioning a site as a preliminary condition does not often benefit this time. The participatory urbanism's quality thus depends on the designers' goodwill, their capacity to make sacrifices and the values they're willing to defend. It results in virtuous participatory approaches mostly represented amongst the small-scale projects, where it is easier to bring together the community, and the landscape architects have an easier time choosing their priorities.

I.3 An institutionalized participatory urbanism working against a shared approach

With the growing enthusiasm came a political interest, resulting in "consultations", a global world designating the interactions between public and political powers, planners and citizens in a controlled environment. This way of mobilizing the communities is poorer in its capacity to question various subjects, and partially devoid of real contributions from the most concerned spheres. Project leaders can therefore use it as a form of tokenism to justify their legitimacy to act and think for the majority instead of having to face a valid counterpower. Planners and designers can lead the debate as they prefer, choosing what voices matters to fit their own visions, and excluding divergent opinions, choosing to answer the "how" instead of the "why".
The participatory approach is shifting from a popular movement in the 70s, to a market dynamic, an argument able to sell an urban project. Landscape architects go through it to appeal to their employer more than to engage the communities through democratic processes. Participatory approaches thus tend to look more like a communication campaign than a place for people to take their environment into their own hands
Thus, a dichotomy emerges between the desire to channel and regulate participatory processes and the latter's very essence: a movement issued coming from the bottom to contradict or counterbalance them.
By examining two case studies, M.-H. Bacqué analyzes the evolution of local movements mobilized and organized around the development of popular neighborhoods, which professionalized themselves to continue to exist as a counterpower, forming an opposition capable of making decisive decisions. The author shows that it is partly the integration of democratic debate with potential conflicting entities, as well as spatial and financial independence, that allows this richness to be preserved over time. Entities don't necessarily conform to pre-existing models.
With the population's growing enthusiasm to take part in decisions that directly concern them, the model is crumbling. The recent popular uprisings in France in opposition to major development projects are a glaring example.

2 Why we should climb the ladder of citizen participation

2.1 Knowledge sharing

Modern urban planning was first and foremost constructed as a science, capable of rationalizing the organization of human societies and their activities. The 1950s saw the emergence of rational comprehensive planning, drawing on the evolution of economic sciences and computer predictive models to analyze, understand, and predict the dynamics that affect a city. While this movement met with some success in planning road systems or in the design of new cities, it encountered its limits: regardless of the computing power, the number of factors taken into account, or the refinement of predictive models, the city remained too complex to be summed up in a simple equation [4]. The behavior of residents or economic actors remained unknowable.

How can we obtain the information needed for urban planning? What are the foundations for an urban project? One way to address the knowledge of the terrain and uncertainty of a real, lived, and perceived situation is through pre-programmatic involvement of the protagonists most involved in the project. It must therefore be accepted that a longer pre-project period is required. This can be assumed to have a positive impact on the adjustment times currently required for planning (which is a cumbersome process) once it has been established off-site. The desired effect is to bring the programmatic reality of the supposed plan closer to the reality of the territories.

While the pace of a landscape project is long-term, one of plant growth and soil construction, profitability constraints encourage landscapers to be content with a cursory diagnosis and a superficial understanding of the challenges of the territory.[5] Local residents possess enormous cumulative experience of the site; they have practiced it in all seasons, for decades. Involving citizens in the development of the project, particularly in its pre-planning phases, provides access to a considerable amount of knowledge, experience, and a detailed understanding of the needs it faces. But only if we give to the people the space and the tools to express it in a manner that is both faithful to their experience and relevant to the project approach.

2.2 Collective mobilization

"*Urbanization yes, but when and for whom?*" [6] These are the words with which the residents of the Alma district of Roubaix challenged the public authorities, who were seeking to wipe out the working-class neighborhood and replace it with residential blocks. Many projects provoke incomprehension, rejection, and even resistance from citizens who consider these interventions opaque, unilateral, and out of touch with reality. "*We know nothing, we are nothing, we count for nothing,*"[6] affirmed the residents of the Alma district. Urban planning has nevertheless been constructed as a collective, multidisciplinary discipline, but it still seems reluctant to bring residents into the discussion.

The neighborhood's residents formed a collective[1] and, with the help of consulting architects commissioned by the state[2], proposed a counter-project that favored the renovation of the urban fabric over its replacement. Drawing on the knowledge of the residents and the technical capabilities of the architects, the counter-project was realized and celebrated with several architectural awards.
To achieve such a success, such a delicate balance of power, it required a strong and organized citizen mobilization, as well as sufficient technical support to appear credible in the eyes of the public authorities and propose a counter-project that was desirable to all.

"*No more secrets, no more projects drawn up in closed workshops, no more unilateral decisions that dictate the destiny of city dwellers.*"[6] These demands for transparency, debate, and

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compromise resonate more than ever today, when the collision of economic interests and ecological issues adds a new level of conflict. The dichotomy between the concerns expressed by citizens - ecology, social issues, inclusiveness - and the projects led by authorities cannot be resolved unilaterally in an unbalanced power relationship between planners and citizens.

2.3 Citizen and democratic issues

Urban policies are among those that have the greatest impact on our lives, yet they remain highly opaque. How can we demand accountability on a subject we know nothing about, especially when we discover the project on the construction site notice board? Of course, residents are represented in these processes by their elected representatives, but is this pyramidal architecture of representative democracy the most relevant? Can a mayor elected by an entire city decide alone on issues that only concern a specific segment of its population?

The democratic legitimacy of the urban project is called into question when the political impetus comes from only a handful of elected officials and when residents' protests have no room to express themselves, no avenues for action. Some project owners timidly attempt to open the space to citizens, through symbolic measures or highly controled debates, for fear of the emergence of a resident protest imagined as counterproductive and chaotic. In this tokenized citizen participation controlled by public authorities, population mobilization is weak, and contributions are often limited to individual grievances.

Citizen consultation cannot be left solely in the hands of public authorities, otherwise it becomes a mere extension of political will, a hollow, biased, and sometimes manipulative approach. We cannot be satisfied with symbolic consultations or half-hearted approval extracted from disengaged residents. Conversely, residents' consent must be free and informed.

We must create a space for collective dialogue, neutral and open, which allows for the emergence of a true urban counter-power, the voice of the people. Increasing citizen participation in landscaping projects also increases their democratic legitimacy and by extension, the approval and support they will receive from the residents. We must build the city with the citizens, but to do this, we must give citizens the means to express a voice as strong as that of elected officials and technicians.

This counter-power would not be an obstacle or an enemy of design, but a formidable driving force of the urban project, capable of bringing out knowledge, ideas and ultimately consensus on what the territory of tomorrow should become. It contributes to a common elevation of all planning stakeholders, but also of the public debate as a whole by giving the population the space and knowledge to invest in their living environment. Ecological or social demands that could be crushed by an economic imperative will have to be taken into account if they are carried by a solid and independent counter-power.

3. The democracy of the most concerned as a new paradigm

3.1 General concept

Like the urban planners of the mid-20th century, we drew on economic science to found our model of participatory democracy applied to urban projects, from Devine's "negotiated coordination"[7] model. This theory can be summarized as the "democracy of the most concerned model" : the more a community is affected by a decision, the more it must be involved in the decision-making process.

Transposed to urban planning, decision-making power is divided equally between each interest group: the public force (state or community),

residents, interest groups (associations, communities) and companies. It would no longer be a matter of simply consulting residents on a project, but of giving them equal importance to the other stakeholders in the urban project. The notion of democracy of the most concerned implies a hierarchy of voices: only the residents of a street should be consulted for the development of a trees alignment, while all the inhabitants of the neighborhood will be represented for the development of a park.

The adoption of such a hierarchy, much more horizontal than the one we are accustomed to in our capitalist societies, calls for more negotiation, debate, and compromise to arrive at a situation that satisfies all parties. It opens up the scope of decision-making; public property becomes social property. To paraphrase Jaurès, public space is the heritage of those who have none. It is therefore natural that those who will receive this heritage should be the first to be consulted and the privileged protagonists of the urban project.
In such a model, where each stakeholder has a voice and influence over the final decision, multilateralism is essential. Important decisions will have to be negotiated to obtain the consent of each interest group, even if it means agreeing to compromises and adjustments.

This model requires consideration of the interests of other parties in debates and can bring major issues, particularly ecological ones, to a level equal to, if not higher than imperatives of profitability. Since everyone must publicly justify and defend their position, they are quickly confronted with their own contradictions and, faced with a range of common problems, are encouraged to move away from individual profit. It is impossible here to make a contested decision in the secrecy of an office or architectural firm.

3.2 Conditions of implementation

The ambition to climb the ladder of citizen participation raises several questions. How can representatives be designated for the affected population?
We note that in participatory approaches, the populations who get involved are often retired people, free from the time and financial constraints that prevent other citizens from engaging in democratic life. To represent all segments of a group, we propose randomly selecting representatives who will defend the group's interests and motivations during project working meetings. The random selection ensures both the impartiality of the selection and the diversity of the profiles represented. These representatives will be offered reimbursement or even remuneration for their work, allowing them to attend debates and working meetings with peace of mind. This combination of random selection and remuneration ensures that neither the actives nor the precarious are excluded, and allows every voice and interest to be expressed publicly.

In order not to limit popular expression to the project's working meetings alone, and to avoid a concentration of decision-making power in the hands of the group's representatives to the detriment of those represented, spaces must be created and maintained to allow the spontaneous emergence of criticism and the control of democratic action. These measures will guarantee the independence and representativeness of the counter-power thus created.

3.3 The landscape architect’s role in this new model

Landscape architects already have several ways of intervening in landscape projects. The project managers, still too rare, provide a technical and global vision. They are the guarantor of a project direction that brings together the voices of specialists, even the most technical, political authorities, and the most directly affected people.

The landscape designer bears new responsibilities. They do not work for an abstract entity but for people to whom they are

accountable. Their work must be able to tolerate contradiction and even opposition, which requires longer design periods. They guarantee the integrity of the role assigned to them and convey a democratic voice. The involvement of different and contradictory voices also provides an opportunity to question models that are still very prevalent today despite the inconveniences they cause (suburban housing, artificialization related to cars, etc.). Questioning the method of producing urban projects also means questioning urban imaginaries.

The landscape consultant, also underrepresented, assists project owners and can support individuals or municipalities in developing their projects early on. They are the first step in ensuring the public's access to reference values and academic and scientific knowledge in landscape design. They play a role in site preparation and an educational role. They synthesize the state of knowledge of the territory.

As stated previously, the landscape designer naturally plays a mediating role. Consulting and educational spaces would thus benefit from being developed, as they are more neutral spaces, free from the weight of project issues and power struggles. It is thus possible that new roles will emerge to advise the communities concerned.

Conclusion

With their growing popularity, participatory approaches have gradually seen their intentions distorted. Political and institutional co-optation has turned them into cumbersome machines, incapable of fully expressing democratic voices in the face of a poorly functioning landscape project. This has led to participation through consultation, which allows public authorities and specialists to legitimize their practice without suffering the contradictions of the populations concerned, who are ill-equipped to confront and express their own knowledge of their living spaces and their desires for those spaces.

The democracy of the most concerned, which positions the voices of residents as the starting point of the development project, establishes a new, more egalitarian framework for the landscape project. The latter is enriched by the visions and knowledge of multiple, committed stakeholders who will bring it to life over time and give it its full meaning.

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WELL-BEING DESIGN GUIDE FOR PUBLIC HOUSING IN HONG KONG

Proposed Well-being Design Guide in Hong Kong Public Housing

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Keywords: Well-being Design Guide, Public Housing, Participatory Design

Abstract
This paper briefly examines the Well-being Design Guide and the implementation progress of pilot projects. The Well-Being project is led by the HKSARG Housing Bureau and Housing Authority, with participation from a diverse assembly of interdisciplinary consultant teams that place a high value on authentic listening. The teams consist of experienced professionals, including consultants in design thinking and innovation, architects, landscape designers, visual designers, urban planners, scholars in building and real estate, experts in engineering and management, nursing professionals, and social workers.

By applying "design thinking" and "participatory design" with collaborative input from Public Rental Housing (PRH) residents, the team conducted systematic research and integrated their findings into a resident-centric design guide to enhance the sense of well-being in Hong Kong's public housing estates. The goal is to facilitate the design of simple yet comfortable and livable public spaces within these estates, cultivating a sense of ease and well-being among the residents.

Through extensive research analysis, literature reviews, resident interviews, community surveys, professional discourse, and practical reflections on real-life experiences, we have developed a Well-Being Design Guide that applies to Hong Kong. This design guide is intended as a reference for new public housing estates and for improvement works in existing estates, which house more than one-third of the Hong Kong population. Considering its application, the impact of the design guide will be monumental.

1. Background

As one of the most densely populated cities in the world, Hong Kong possesses a complex yet unique urban design and living culture. Currently, a significant portion of the city's population resides in public housing. In 2022, the Chief Executive's Policy Address set the goals for Hong Kong's public housing to "enhance quantity, speed, efficiency and quality". The Well-Being project focuses on "quality enhancement". It seeks to create public spaces, facilities and estate environments in future public housing that are more holistic and that enhance residents' sense of Well-Being and fulfillment. The Well-Being Design Guide is a set of ideas we can practice, apply and carry out together within the details of everyday life.

The research is to analyse strategies and indicators to promote well-being by enhancing the estate environment, public spaces, and facilities in Hong Kong's Public Housing using the Well-Being Design

Guide. This involves a comprehensive approach that integrates understanding the urban landscape and public housing typologies, engaging stakeholders through design thinking methodologies, developing well-being concepts and metrics, and prototyping design strategies.
Design Thinking is a human-centric approach to problem-solving that focuses on empathy, definition, ideation, and prototyping. It involves an iterative process of defining problems and brainstorming ideas to address user-specific pain points, challenge existing assumptions, and test new solutions collaboratively with stakeholders, practitioners, and operators. This bottom-up approach concentrates on user needs and desires, contrasting with traditional linear, top-down planning methods.

The 16-month research aims to understand residents and the estate environment, advocate for and define well-being, engage and align stakeholders, and understand and cultivate well-being concepts.

2. Research Method

2.1 Literature Review and Case Studies

The literature review aims to develop a preliminary design framework for enhancing well-being in future public housing developments, addressing critical knowledge gaps through four interconnected research questions and objectives.
The first research question explores how subjective well-being factors among Hong Kong public housing residents compare to Western contexts. This investigation reveals well-being as a multi-layered concept with five essential levels: physiological needs, safety needs, love and belonging, self-esteem, and self-actualisation. While traditional public housing policies have primarily addressed basic physiological and safety needs, today's complex social environment necessitates consideration of higher-level well-being aspects.

Our research identified eight dominant well-being concepts organised into three key domains: physical, social, and perceived. The physical domain incorporates Health & Vitality, Green Living & Sustainability, and Urban Integration. These elements directly affect residents' access to healthcare services, availability of healthy food options, connection to natural environments, and opportunities for active lifestyles.

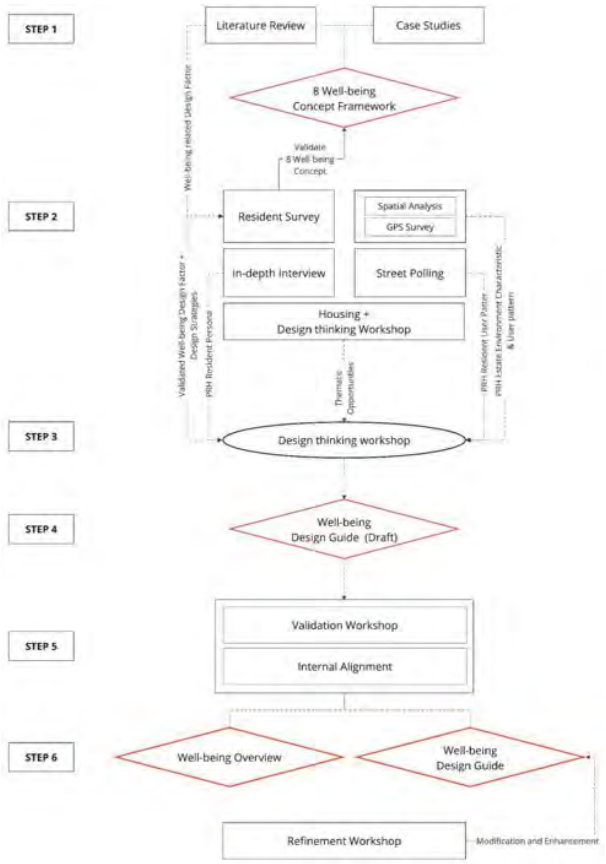


Figure 1. Research Process

The social domain examines how architectural design influences community interaction through thoughtfully planned communal spaces. Meanwhile, the perceived domain addresses how housing environments contribute to residents' sense of identity and place attachment, ultimately fostering a more profound sense of belonging and well-being within their community.

These initial findings evolved throughout the research process, culminating in developing eight comprehensive well-being concepts that provide a framework for understanding and enhancing resident well-being in public housing contexts.

The second research question investigates design factors contributing to subjective well-being through a socio-technical lens, analysing six core components: People, Infrastructure, Goals/Metrics, Processes/Procedures, Culture, and Technology. While physical infrastructure forms the foundation, our research emphasises that empowering residents and stakeholders is crucial for driving local innovations. Despite the inherent challenges in engaging citizens and nonprofit organisations, their involvement contributes valuable

experiences and resources that strengthen public cohesion.

The third research question examines global architectural approaches supporting well-being in Public Housing, with particular attention to implementation strategies and successful practices across different contexts. Our investigation revealed two significant patterns in innovation: first, the prevalence of incremental improvements through minor upgrades to existing procedures, tools, and standards, and second, the necessity for spontaneous responses to complex challenges during implementation.

The fourth research question addresses the development of a preliminary well-being design framework for future public housing initiatives. This framework is built on three key principles: cross-sector stakeholder engagement and data-driven decision-making using empirical evidence; integrated feedback loops that bridge diverse stakeholder perspectives; and streamlined communication channels and optimised design processes through critical pathway development.

To deepen our understanding, we analysed 15 representative case studies demonstrating how public housing design enhances resident well-being locally and globally. While each project emphasises specific well-being concepts, most address multiple aspects simultaneously, illustrating the interconnected nature of well-being in housing design. These case studies provide valuable insights into successful implementation strategies and innovative approaches to enhancing resident well-being through thoughtful architectural design. Effective design strategies have been evaluated, refined, and integrated into the well-being design guide, prioritizing those most applicable to public housing developments.

2.2 Spatial Analysis

26 new and old public housing estates were analysed. Public housing has evolved through distinct phases, reflecting different approaches to resident well-being and various challenges. Hong Kong's public housing evolution demonstrates distinct design philosophies across different periods. Under our analysis, old public housing estates were designed to emphasise fundamental functionality while fostering strong community bonds.

These developments prioritised human-scaled environments that promoted social cohesion through thoughtfully planned interaction spaces.



Figure 2. Old estates (Sai Wan Estate) urban analysis map



Figure 3. Old estates (Sai Wan Estate) estate facility analysis map

The designs incorporated natural ventilation and passive cooling strategies, complemented by flexible, multi-purpose spaces adapted to community needs. These estates maintained strong neighbourhood identities, often preserving cultural heritage elements, and featured traditional retail and community facilities that served as social anchors. Old estates were usually located in developed cities with high accessibility within districts and included basic biophilic elements and green spaces, though these were less extensive than in later developments.

New development public housing marked a significant shift towards more comprehensive planning approaches. These estates were typically developed on a larger scale, often in virgin land designated for new town development. They featured sophisticated amenity planning and programming, improved connectivity and accessibility to surrounding areas. Integrating

modern retail and social facilities reflected evolving lifestyle needs, while climate-resilient design strategies became more prominent. These estates emphasised environmental considerations, including tree preservation and biodiversity enhancement.



Figure 4. Public Square (Queen's Hill Estate)

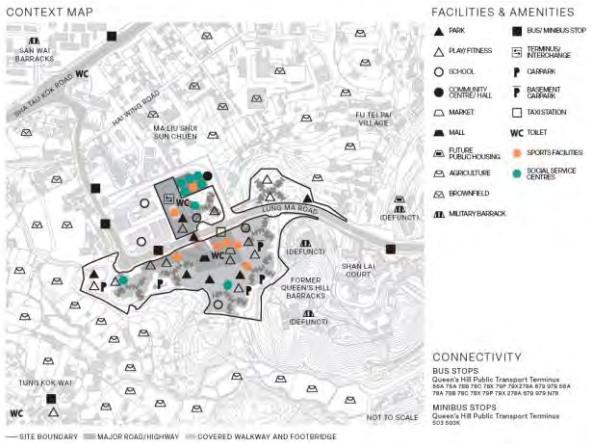


Figure 5. New Public Housing Estates in New Development Areas (Queen's Hill Estate) urban analysis map



Figure 6. New Public Housing Estates in New Development Areas (Queen's Hill Estate) site

The developments aimed for self-sufficient neighbourhood planning that supported the estate and contributed to broader district and neighbourhood development, creating more sustainable communities.

2.3 Community Engagement:

A portable public engagement station (the Well-being Express) in the form of a vehicle to conduct a behavioural study spanning 17 districts, employing multiple research methods to gain deep insights into community needs. The study gathered data through 850 street polls and strategically located polling stations. This approach was complemented by an Ideas Bank system that captured both structured feedback and spontaneous suggestions from residents for community improvements. A crucial study component involved collaborative mapping exercises, during which researchers and residents jointly identified zones significantly impacting well-being. This spatial analysis helped understand movement patterns and social interactions, culminating in Well-being Snapshots for each estate that established baselines for future improvements.



Figure 7. Well-being Express Community Engagement

2.4 Qualitative Research - Indepth Interview

In-depth interviews conducted across 17 Hong Kong public housing estates revealed residents' multifaceted perspectives on well-being, encompassing physical, social, and economic dimensions. The research methodology, employing 'Well-being Express' as an engagement tool, facilitated 181 semi-structured interviews focusing on residents' daily experiences and environmental perceptions. This method bridged the gap between residents' holistic daily needs and practical design implementation, ensuring that the design guide

responded to genuine community requirements while remaining within the feasible implementation scope.

2.5 Behavioural observations

Behavioural observations employed multiple data collection methods, including systematic street polling, structured site visits, and environmental behaviour mapping. These methods provided insights into how residents utilise and interact with public spaces within their estates and broader district resources. The research team implemented GPS tracking with a representative sample of residents over seven-day periods, documenting their movement patterns and daily community interactions. This quantitative data was enriched through semi-structured interviews exploring residents' spatial preferences, usage patterns, and perceived barriers to accessing community resources.

2.6 Statistical analysis

Statistical analysis revealed significant positive correlations between the eight well-being design concepts and residents' subjective well-being, with correlation coefficients ranging from 0.119 to 0.209 ($p < 0.01$). While these values confirm consistent positive relationships, their modest magnitude suggests that physical design elements, though contributory, are not dominant determinants of residents' overall well-being.

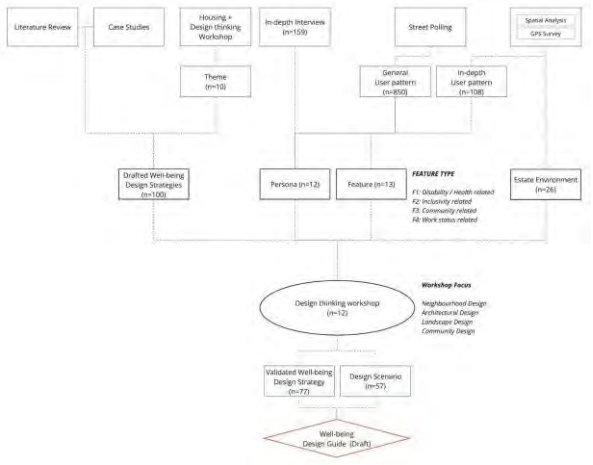


Figure 8. Systematic Transformation of Conceptual Insights into Design Scenarios

3. Discussion

3.1. Design thinking workshop

The Design Thinking workshop initiative demonstrated a comprehensive approach to transforming resident insights into actionable design solutions through 12 design thinking workshops. These sessions convened an extensive network of 830 participants, comprising 200 housing department representatives and 630 professionals from diverse fields including architecture, landscape design, property management, healthcare, and social services.



Figure 9. Design thinking workshops



Figure 10. Wellness Concept

The design thinking workshops established a foundational framework for the development of comprehensive well-being design guidelines, which underwent systematic refinement and validation processes to produce definitive implementation protocols.

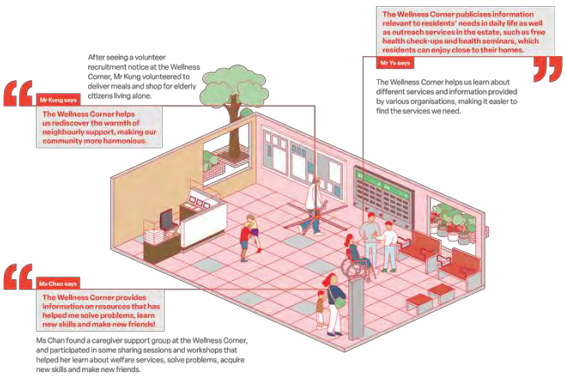
Following the initial workshop phase, the research team synthesized 77+ design strategies and 250+ corresponding design components. Subsequently, through rigorous validation workshops involving multidisciplinary professionals and Housing Authority departmental representatives from both design and management divisions, these preliminary frameworks were systematically evaluated and refined.

This iterative process resulted in the consolidation and optimization of the initial findings into 50+ evidence-based design strategies and 170+ actionable design components, each thoroughly

vetted by various Housing Authority and Housing Department teams for practical implementation feasibility. These validated outcomes serve as the theoretical and operational foundation for design guide formulation, facilitating a paradigm shift in the conceptualization and implementation of well-being-oriented design principles across both new developments and existing public housing estates undergoing regenerative transformations.

A comprehensive statistical analysis examining 79 distinct design factors across eight well-being conceptual frameworks revealed statistically significant correlations with Subjective Well-being (SWB) indices, as evidenced through an extensive survey of 2,200+ residential respondents. The data analysis shows the correlation of the validated design factor that would affect resident well-being. Through systematic qualitative assessment methodologies, including structured listening sessions, resident needs were methodically identified and catalogued.

The ethnographic findings provided critical insights that informed the development and refinement of the Well-being Design Guide exemplar, establishing an evidence-based framework for understanding the relationship between environmental design factors and residential well-being metrics



Figures 11. Wellness Corner

3.2 Individual domain
(1) Health & Vitality (活力健康) , (2) Green Living & Sustainability (綠色生活)
The personal health and wellness framework integrates with the two well-being concepts; Health & Vitality create environments that foster healthy and active living, encouraging physical activities and dynamic lifestyle choices. This complements Green Living & Sustainability, which embraces natural elements, urban greenery, and sustainable design principles.

3.3 Family domain
(3) Age-Friendlines(樂齡安居), (4) Interge-nerational & Inclusive Living (跨代共融)
Neighborhood Care focuses on building supportive communities that enhance residents' quality of life and social connections. The Age-Friendliness concept ensures environments are thoughtfully designed to support elderly residents, enabling them to age in place with dignity and security while meeting their specific accessibility needs. Complementing this, Intergenerational & Inclusive Living creates welcoming spaces that bridge generational gaps and celebrate diversity, fostering meaningful interactions between residents of varying ages, abilities, and cultural backgrounds.

3.4 Community domain
(5) Family & Community Connection (家社互聯), (6) Urban Integration (城市連結)
Estate Facilities can enhance community connectivity in two distinct ways. First, through Family & Community Connection, it develops lively neighbourhood spaces that naturally encourage social interactions and community participation while strengthening family relationships through shared experiences and activities. Second, the Urban Integration concept focuses on improving accessibility by developing efficient networks that link communities with the broader urban environment. By combining these approaches, neighbourhoods become internally connected and externally integrated, creating living spaces that successfully balance intimate community life with easy access to city-wide opportunities and amenities.

3.5 Society domain
(7) Upward Mobility (增值上流), and (8) Perception & Image (地方形象)
Social Value advances community development through two key approaches. Upward Mobility establishes supportive environments that connect residents with essential social services and community resources, enabling them to overcome challenges while nurturing their potential and confidence for personal advancement. The Perception & Image concept builds community belonging, motivating residents to care for their shared spaces and public facilities actively. These

combined elements strengthen neighbourhood identity and create pathways for resident success, driving positive social change and sustainable community growth.

4. Conclusion

4.1 A comprehensive Concept Guide

The Well-Being Design Guide encompasses a comprehensive Concept Guide that presents a systematic overview of the integrated well-being initiative. The Overview provides a methodologically rigorous yet accessible exposition of the research protocols and empirical outcomes that informed the development of the Well-being Design Guide.

4.2 The guide translates concepts into practical applications through Innovative Design Solutions:

“Wellness Corners” serve as purpose-designed environments enabling cross-institutional collaboration among governmental departments, district authorities, and social welfare organisations. These centralised spaces provide permanent settings for resident interaction, health screenings, and service delivery.

“Universal Service Bays” provide flexible infrastructure that supports diverse service delivery. These adaptable areas accommodate mobile healthcare units, community services, and temporary programs that can change based on resident needs, with standardised utility provisions ensuring operational efficiency.

“Communal Fitness Playscapes” reimagine recreational infrastructure through multi-generational design, accommodating varying physical capabilities. These spaces integrate traditional exercise equipment with playful elements and social gathering areas, encouraging physical activity across age groups.

“Age-friendly Amenities” include specialised design elements enhancing elderly mobility and social engagement. Features such as enhanced lighting, appropriate seating heights, weather protection, and clear sight lines support ageing in place within inclusive environments.

“Integrated Nature” strategically incorporates natural elements throughout estates, creating therapeutic landscapes that facilitate stress reduction and psychological well-being, from contemplative gardens to active urban agriculture plots.

“Pedestrian-centric Experiences” optimise mobility infrastructure with ergonomic walkways, efficient vertical circulation, intuitive wayfinding, and strategically placed rest areas, creating accessible circulation networks accommodating residents of all physical abilities.

4.3 The design guide's implementation demonstrates remarkable scalability through three major initiatives.

“The Well-being Design Pretest” applies comprehensive strategies to five selected estates, serving as living laboratories to evaluate effectiveness and refine approaches. These showcase the full range of well-being concepts, providing valuable feedback for ongoing development.

“The HAppy Family Project” focuses on facade enhancement and environmental improvements in approximately 20 existing estates annually.



Figure 12. The Universal Service Bay in Hin Fat Estate provides a convenient space to facilities activities, such as health talks and checkup service, to promote the physical and mental well-being of residents.

These interventions demonstrate how even modest physical changes, when strategically aligned with well-being principles, can significantly improve the resident experience.

The “HAPPY GREEN FAMILY” initiative implements landscape improvements in approximately 20 existing estates annually, creating diverse vegetation and tranquil outdoor spaces, enhancing the connection to nature within urban



Figure 13. Before the enhancement work of the central plaza of Hoi Lai Estate



Figure 14. After the enhancement work of the central plaza of Hoi Lai Estate

environments. Meanwhile, district-level improvements, coordinated among different government departments, demonstrate the guide's influence beyond individual estates. Implementation extends beyond physical infrastructure to include complementary programming, with over 7,780 residents participating in community activities ranging from estate culture tours to health-oriented events. Professional knowledge transfer occurs through symposiums, workshops, and exchange tours with housing officials from mainland China and international contexts.

5. Way forward

The entire Well-Being Design Guide consists of eight booklets on the eight well-being concepts and a Spaces Index. Together, these booklets elaborate on design options pertaining to each well-being concept and include 50 well-being strategies and over 170 design suggestions. The design guide aspires to help design teams and professionals understand various design concepts and ideas thoroughly and to serve as a reference for the future design of new public housing estates and the improvement works of existing estates.



Figure 15. Well-Being Design Guide consists of eight booklets on the eight well-being concepts and a Spaces Index

Acknowledgments
The Well-Being project is led by the HKSARG Housing Bureau and Housing Authority, with participation from a diverse assembly of interdisciplinary consultant teams.

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JUST TURN UP: THE SOCIAL INFRASTRUCTURE OF INFORMAL SPORT.

TOPIC: Guiding cities with society: Participatory approaches and governance strategies

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Keywords: Leisure, greenspace, participation, inclusion, health.

Abstract

The 'Just Turn Up' research project explored the multiple ways in which informal sport activities in everyday urban spaces support different forms of sport practices, wellbeing and urban belonging in socially and ethnically diverse cities. This paper focuses on the social infrastructure of supporting informal sport and ensuring that it is genuinely inclusive. What is the role of design in relation to community organising and health or greenspace policy actors? To test the nature of participation in 'less governable' and often 'un-guided' forms of greenspace use, we have adapted a Pattern Analysis approach [1,2] to integrate physical, social and organisational requirements.

The research was an interdisciplinary and inter-sector project, integrating expertise and methods from landscape architecture, sociology, sports management, public health and performance poetry. Drawing on case studies in London and Sheffield, UK, this two year Economic and Social Research Council (ES/W008343/1) funded research project has examined how informal sport activities in everyday city spaces support social interaction and forms of urban belonging in diverse communities. We worked with six case study groups chosen to represent a range of different types of sport: cricket, cycling, urban walking and a migrant women's yoga group, as well as basketball and ecuavoley (ecuavoley is the Ecuadoran variant of volleyball). We used qualitative methods of observation, interviews, participation and arts engagement, and also interviewed 34 local and national stakeholder organisations across different areas of policy and practice.

Our findings show that informal sport has many positive benefits for wellbeing and inclusion yet is not equally accessible to everyone. From an organisational, design or policy perspective, it can feel difficult to know how to support informal sport because it is… informal. We have drawn on the fieldwork from our research into a range of informal sports to create a list of 33 'patterns of requirement'. These collectively define the scope of social infrastructure relating to informal sport, ready to be adapted to different typological contexts, demographic groupings and types of sporting activity.

Patterns are varied solutions to problems around taking part in sport in informal settings.

- Participation: we need to enjoy the sport, we need to know what is happening
- Place: we need somewhere to do this, we need extra or different stuff
- Social sustainability: we need to feel part of a group, we need external support.

Different types of sport and groups of participants will have higher or lower needs in these areas. Patterns may be organisational, social or related to the physical environment, and sometimes a combination. Example of the patterns are: adaptable complexity (no.3), open level surface (no.12), DIY markings or adaptation (no.20), non-participants watching (no.24), negotiating with other park users (no.33). We conclude by demonstrating how using the patterns as tools for questioning can help both participants and facilitating

organisations resolve some of the tensions in informal sports including supported vs Do It Yourself, close knit vs socially porous, competitive sport vs healthy activity.

1.0 Introduction

The 'Just Turn Up' research project explored the multiple ways in which informal sport activities in everyday urban spaces support different forms of sport practices, wellbeing and urban belonging in socially and ethnically diverse cities [3]. This paper focuses on the social infrastructure of supporting informal sport and ways to ensure that it is genuinely inclusive. What is the role of design in relation to community organising and health or greenspace policy actors? To test the nature of participation in 'less governable' and often 'un-guided' forms of greenspace use, we have adapted a Pattern Analysis approach [1, 2] to integrate physical, social and organisational requirements.

It's reasonable to want to find ways to support these types of activities. But from an organisational, strategic or policy perspective, it can feel difficult to know how to support informal sport because it is highly varied in terms of participant groups, types of activities and places, and methods of organising. A simple checklist is unlikely to be appropriate.

The conference presentation introduces a resource called 'Supporting Informal Sport, what can go right?' and the key points from this are set out in this paper. I outline a framework based on 'supportive patterns' which can be used as an adaptable tool for supporting informal sport.

- I set out six 'big picture' needs under the themes of participation, place and social sustainability.
- Under these six needs I identify 33 supportive patterns. This list highlights the wide range of ways that groups solve problems, so that things 'go right'. If there's a hitch in getting started or keeping going, potentially there is a pattern that needs to be used.

1.0 The Just Turn Up project methods

Drawing on case studies in London and Sheffield, this two year research project has examined how informal sport activities in everyday city spaces support social interaction and forms of urban belonging in diverse communities. After a scoping study, we worked with six case study groups of informal sport participants using qualitative methods of observation, interviews and participation. The groups were chosen to represent a range of different types of sport: cricket, cycling, urban walking and a migrant women's yoga group, as well as basketball and ecuavoley (ecuavoley is a Ecuadorian variant of volleyball and an everyday sport activity in Ecuador). We also interviewed local, regional and national policy makers, think tanks, service providers, community groups, professionals andorganisations working in sport, greenspace planning and management, migration support, health and wellbeing, community and social inclusion. We conducted 58 interviews with sport participants, 34 interviews with policy actors and engaged in approximately 800 hours of observation and participation. The ethnographic work was supported by two 'poets in residence'.

3.0 Why support informal sport?

Informal ways of taking part in sport, from basketball and cricket to running and cycling groups, are enjoyed by many people. Our research found that there are many health and social benefits for participants of all ages. But like formal sports, there are still inequalities of who takes part. It is not always easy it is to organise and sustain these informal activities, or for individuals to find an activity that they can enthusiastically and easily join in.

How can we reduce barriers to informal sport? What are the social, practical and emotional requirements that need to be met that means everyone can take part in activities they love?

There might be a perfectly designed park location, but no-one to play with. Or a group of friends keen to compete, but no location that fits the bill. Or maybe both these needs have been met, but there are conflicts with other park users or a logistical issue that means that engagement with the activity gradually dwindles.

This paper is not only relevant for landscape architects involved in the design and management of urban greenspace, but also anyone working

towards public health goals or in community cohesion initiatives.

4.0 Big Picture Needs

These are organised under three headings: participation, place and social sustainability.

Participation
- We need to enjoy the sport
- We need to know what is happening

Place
- We need somewhere to do this
- We need extra or different stuff

Social sustainability
- We need to feel part of a group
- We need external support

5.0 Introducing supporting patterns

The 33 supporting patterns all meet one of these needs. Different types of sport and different groups of participants will have higher or lower requirements in these different areas. Some types of sport are more flexible in terms of place requirements, and not all groups will need external support.

5.1 What defines a supporting pattern?

- Patterns are varied solutions to problems around taking part in sport in informal settings.
- Patterns may be organisational, relational or related to the physical environment, and sometimes a combination of all three.
- Patterns are not specific to one form of sport or type of location.
- It's a pick-and-mix approach. Any informal sport activity will have its own combination of patterns, some need more than others.

5.2 Other research using patterns.

'Pattern language' was originally introduced by Christopher Alexander as a way of identifying reoccurring forms in the built environment [1]. The process outlined in this resource was inspired by an analytical and participatory method developed by Aimee Felstead through her research on co-housing [2].

5.0 Introducing supporting patterns

5.1 Enable Participation

We need to enjoy the sport
1. Playing to the rules
2. Playing to win
3. Adaptable complexity
4. Celebrating progress
5. Sharing skills

We need to know what is happening
6. Regular place and time
7. Personal communication
8. Peer hosts
9. Public info

5.2 Place Resource

We need somewhere to do this
10. Fenced hard surface
11. Surfaced Paths
12. Open level surface
13. Hall
14. Nearby place to sit
15. Ground markings
16. Fixed equipment
17. Obvious meeting point

We need extra or different stuff
18. BYO sports equipment
19. Provided equipment
20. DIY adaptation
21. Nearby storage

5.3 Social Sustainability

We need to feel part of a group
22. Play and chat
23. Socialising after
24. Watchers and fans
25. Pile of belongings
26. Group name
27. Shared food
28. Shared community language
29. Celebrating together
30. Non-sport social connections

We need external support
31. External facilitation
32. Use other park facilities
33. Negotiate with other park users

6.0 Example pattern descriptions

Pattern 2. Playing to win

Informal sport has different levels of competitiveness, but in some contexts players are definitely playing to win. Someone will keep track of points or goals, and a referee may be appointed. The score becomes even more important if money is changing hands; for example the successful team sharing a pot of winnings, or gambling taking place among the onlookers.

Pattern 8. Peer hosts
In well-established groups, one member sometimes emerges as the 'lead enthusiast'. This person may be particularly important in looking out for new members and making them feel welcome. They may take the lead in 'on the spot' organising of games or kit.

Pattern 14. Nearby place to sit
Watching sport is an enjoyable activity for other park users, and some sports have wider circle of friends and family who come regularly to follow the action. Participants in informal sport also often move between taking part and watching others. In dry weather, a grassy slope is ideal. Other options include nearby benches, a wall to perch on, or bringing movable chairs out from a nearby community centre.

Pattern 21. Nearby storage
It's often extremely helpful if kit can be stored nearby. Even when cheap to purchase, like a yoga mat, it is welcoming for newcomers to be able to provide basic kit. When items are larger, like bikes or poles for nets, this is a significant resource requirement.

Pattern 28. Shared community language
Sporting activities that are reflective of migrant cultures in a particular locality may be formally designed or have evolved to use a shared community language, reflective of the language spoken at home by most or all of the participants. On occasions when new members turn up who are not fluent or able to communicate in this language, a whispered translation is often provided by group members.

Pattern 31. External organisation facilitates
'Just turn up' is a principle of participation, but not always of organisation. Community groups and health and wellbeing organisations can play a role by running activities, providing an activity facilitator, social coordination, kit and sometimes even a venue such as a hall. This format means that participants who are less likely to be able to self-organise are more likely to do sporting activities, but does mean that the activity is reliant on a level of funding.

7.0 Understanding a specific context

We analysed six case studies (cricket, cycling, urban walking, yoga group, basketball and ecuavoley) to record what patterns were present in each setting. Each group evolved in different ways, responding to the type of sport being played, the mix of participants and potential participants, and the location itself.

We found that how groups use patterns to solve their challenges and practical requirements in their own contexts is not neutral, they can support participation in one way but exclude other forms of participation or other participants.

The volleyball group was a key activity within a strong social network. Organising the activity required high levels of self-initiation and required negotiations with other park users. The participants to had high levels of skill, it wasn't a game where beginners could join in.

Indicative patterns: 1. Playing to the rules 2. Playing to win 20. DIY markings or adaptation 29. Celebrating together 30. Non-sport connections.

The beginner's cycling group had loose social arrangements. There was a friendly atmosphere during the activity, but this did not generally develop into wider community networks. It's reliance on high levels of external resource made it vulnerable to changes in funding.

Indicative patterns: 3. Adaptable complexity 5. Sharing skills 19. Provided equipment 22. Play and chat 31. External facilitation.

Questions

- For existing informal sport activities, can you map they patterns that are already being used?
- If something not working well or is not sustainable, is there a missing pattern that could address the problem?

8.0 Thinking with patterns

Whether you have an interest in this topic because you want to improve health in your area, or are supporting community activities, or have some input into a local park (or all of these), the six 'big picture' needs and associated supportive patterns

can help identify specific and achievable actions to support informal sport.

Questions relating to group aims:

- For the desired activity and participant group, what's the most important pattern under each need?
- Is one of the big picture needs more important because of the kind of group or kind of activity? How many of the patterns listed under this need might be useful?
- Is a new type of space needed? How could you find or advocate for this space?
- Do any of your missing patterns require additional funding or people?
- Are any of the patterns important to you in combination?
- If you want to engage new participants in an informal sport, which patterns will be most important for them to know about in advance?

In using the 33 supporting patterns, whether for analysing the current situation or exploring potential changes, try and involve as many different participant and collaborator voices as possible. You are encouraged to experiment with using the patterns as discussion starters or solution ideas.

9.0 Conclusion

The purpose of this paper was to introduce a resource for practical use by a range of organisations, including but not limited to landscape architects working in practice. Our research had a specific focus on groups of first-generation migrants or with migrant heritage, and found multiple benefits to taking part in informal sporting activities. We also gained a better understanding of the barriers to taking part, which generally meant that there was pattern of self-organisation by those who are male, fit and young. By using a pattern language analysis, we were able to demonstrate a range of different ways to tacking challenges of inclusion and of the sustainability of informal sports groups.

10.0 Acknowledgements

Website:
https://sites.google.com/sheffield.ac.uk/justturnup/home

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PARTICIPATORY DESIGN STRATEGIES FOR COMMUNITY GARDENS IN TRANSITIONAL PERI-URBAN DISTRICTS OF THE PEARL RIVER DELTA REGION

TOPIC: Guiding cities with society: Participatory approaches and governance strategies

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Keywords: Community gardens, Participatory design, Community construction, The Pearl River Delta region, Transitional Peri-urban community

Abstract

Community co-governance, an approach emphasizing public participation, is gaining traction in China amid integrated urban-rural development initiatives. Community gardens have emerged as focal points of interest due to their dual capacity to deliver ecological benefits and strengthen social cohesion. As one of China's most economically vibrant regions with the highest urbanization rate, the Pearl River Delta region has experienced rapid urbanization that has led to the emergence of Transitional Peri-urban Communities in urban fringe areas. These hybrid settlements retain vestiges of traditional rural spatial structures while absorbing institutional and cultural transformations driven by urbanization. The heterogeneous stakeholder dynamics in TPCs raise a core design challenge: For whom should community gardens be designed? This study employs the Community Gardens of representative TPC in the PRD, to examine tensions between top-down public space planning and bottom-up community needs. Participatory design is proposed as a methodology to bridge this divide. Through four months of participatory observation combining fieldwork and interviews with residents, community workers, and managers, using semi-structured and unstructured interview methods. The research developed a tripartite collaboration framework: designers (providing technical expertise), grassroots organizations (facilitating coordination), and residents (implementing and maintaining gardens). Findings reveal that participatory garden construction enhances both environmental quality and social capital. By synthesizing natural assets, local landscapes, and community labor, the project improved green spaces while strengthening residents' place attachment. Notably, long-term TPC residents—despite environmental urbanization—retain distinct resource perceptions shaped by rural livelihoods. Compared with the exquisite green environment of urban communities, they crave the "practical efficiency" of gardens rather than the landscape elements of "formal aesthetics". For example, the hardened impervious ground has become a popular scarce resource because of its more diversified use functions (such as resting, dancing, gathering, drying crops, parking vehicles, etc.). This divergence prompts critical reflection: Whose needs define garden design? The study suggests that professional expertise must adapt through social engagement, guiding the landscape through society will be one of the important paths to achieving a beautiful living environment in the future.

1. Introduction

With China's urbanization advancing, urban development is gradually shifting from "incremental expansion" to "revitalizing existing stock." The spatial scale of focus is narrowing from the macro urban level down to the micro community level [1]. Concurrently, the development model is evolving from being dominated by a small group of

professionals towards participatory decision-making involving multiple stakeholders. Consequently, community governance emphasizing public participation is gaining prominence in China. Community gardens, recognized for their significant role in urban ecological development and social relationship building, are also attracting increasing attention [2]. As the fundamental unit of social governance, communities see their gardens serving as focal points for the complex demands of diverse stakeholders. These gardens function not only as effective channels for residents to engage in community public life and build social networks, but also as crucial platforms for grassroots community governance. Typically, community gardens refer to green spaces within communal areas where residents engage in public activities or cultivate vegetables and flowers. They fulfill residents' daily leisure needs while providing a platform for cultural exchange and social integration. Thus, they represent an effective approach to improving the community environment, fostering social interaction, and enhancing residents' well-being and sense of belonging. Current research on community gardens primarily focuses on community building, public participation mechanisms, and ecological sustainability [3]. Key concerns in Chinese community garden practices include enhancing ecological benefits and promoting residents' physical and mental health alongside quality of life [4, 5]. Simultaneously, community garden initiatives in major Chinese cities like Shanghai, Shenzhen, and Beijing demonstrate the feasibility of multi-stakeholder participation and sustainable development. These initiatives effectively align with broader objectives such as renovating old communities, implementing urban micro-renewal, and advancing social governance.

As one of China's most economically dynamic regions with the highest urbanization rate, the Pearl River Delta (PRD) region inevitably faces challenges stemming from rapid urbanization, such as rural-urban integration and fragmented spatial structures. To promote integrated urban-rural development, the Transitional Peri-urban reform has emerged as a crucial initiative to dismantle the urban-rural dual structure [6]. Many urban villages and peri-urban villages have implemented this government-led Transitional Peri-urban community (TPC) system. This transition integrates urban and rural governance mechanisms and resources, triggering a dual transformation within the former villages: villagers become residents, and rural management transitions towards urban community governance. These transformed communities exhibit characteristics of both urban and rural areas. They typically feature high building density, scarce public green spaces, and diminishing traditional village landscapes, leading to residents' urgent demand for environmental improvement [7]. Consequently, community gardens, serving as vehicles for urban renewal, have become a pivotal intervention for enhancing the living environment and rebuilding community identity.

Although community garden initiatives exist in the PRD region, existing research predominantly focuses on functional development, infrastructure construction, and landscape enhancement. Deeper exploration into issues such as the excavation of local culture, multi-stakeholder participation mechanisms, and sustainable operation remains relatively scarce. Facing the diversity and complexity of stakeholders within transitional TPCs, a primary question requires clarification: for whom are these community gardens designed? In these transitional communities, how can participatory design pathways be employed to simultaneously enhance environmental quality, preserve regional landscape and cultural characteristics, and strengthen residents' cohesion and sense of belonging? This constitutes a critical issue demanding urgent resolution. This paper takes the typical Transitional Peri-urban community garden project in the PRD region as an example to explore the effective path of participatory design of community gardens in the urban-rural transition zone, with the aim of providing relevant suggestions for the construction of Transitional Peri-urban community gardens and community governance in the PRD region.

2. Materials and Methods

2.1 Research Genesis and Context

This study selected *Shatou* Community in *Shunde* District, Foshan City, Guangdong Province, as the empirical case. Located in the central area of *Jun'an* Town, *Shunde* District, Foshan City, Guangdong Province, *Shatou* Community is an ancient village preserving the largest number of Lingnan-style historical architecture in *Jun'an* Town. In 2002, it merged with *Liangcun* Natural Village to form *Shatou* Community, making it a typical TPC. As of July 2023, *Shatou* Community comprised 1,157 households with a registered population of 4,780 residents. In recent years, the community has conducted the ongoing "Beautiful Courtyards" campaign, encouraging residents to participate in planting activities around their homes and within

their courtyards. Since September 2024, *Shatou* Community has engaged diverse stakeholders—including residents, university student designers, horticulturists, and community artisans—in collaborative design discussions and construction efforts. This process has established a solid foundation for participatory community garden initiatives. To date, *Shatou* Community has successfully constructed six community gardens (Figure1, Table 1). Members of our research team organized and participated in the entire process of one specific project within this initiative: the "*Baiye* Garden".

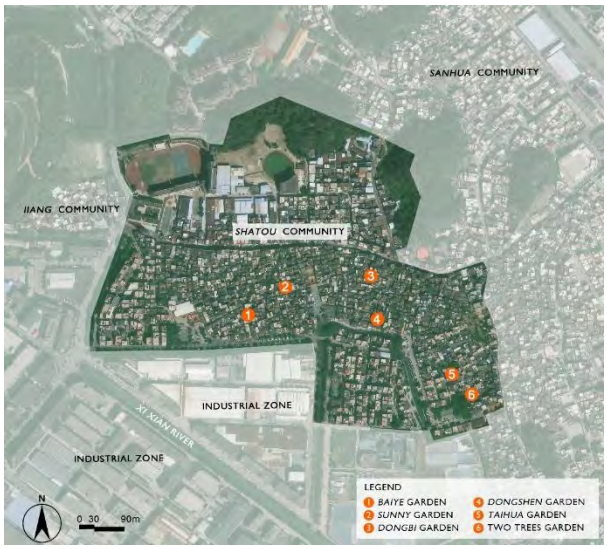


Figure 1. Location of the case site.

Table 1. Details of the community gardens.

Number	Name of Garden	Area （㎡）
1	*Baye* Garden	70
2	Sunny Garden	90
3	*Dongbi* Garden	20
4	*Dongshen* Garden	60
5	*Taihua* Garden	30
6	Two Trees Garden	115

2.2 Participatory Process and Path

We established a tripartite collaborative mechanism involving: 1) Designers (providing professional guidance), 2) Community Managers (facilitating social relationship coordination), and 3) Community Residents (responsible for garden implementation and maintenance) (Figure2). This mechanism was applied alongside the SPAR model to facilitate participatory community garden development. The SPAR model represents a participatory design approach comprising four iterative stages: Search (S), Plan (P), Act (A), and Retrospect (R) (Figure3).

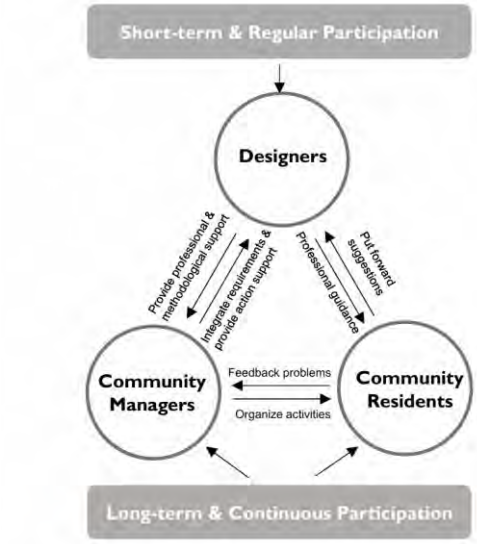


Figure 2. The tripartite collaborative mechanism.



Figure 3. The SPAR model.

During the Search stage, our research team conducted multiple on-site surveys and engaged in a 4-month period of on-site participatory observation. We employed semi-structured and unstructured interviews to facilitate in-depth discussions with key stakeholders, including local residents, community workers, and managers. Through these methods, we collected and documented essential community information, environmental characteristics, distinctive local cultural features, and specific suggestions from residents regarding community gardens.

During the Plan stage, professional designers led the process by establishing a sustained interaction mechanism between designers, community organizations (e.g., neighborhood committees), and local residents. Through methods such as brainstorming sessions, roundtable discussions, and design workshops, residents collaborated with designers to develop concrete action plans and garden design proposals. This participatory approach enabled residents to gain a comprehensive understanding of the design development process and implementation steps.

During the Act stage, community managers mobilized volunteers—including university students and social workers—to support local residents in garden construction. Crucially, residents served as the primary actors and builders

throughout the implementation process. This collaborative building approach gradually fostered both collective memory and enhanced community cohesion.

During the Retrospect stage, we reviewed the entire project process and outcomes while gathering resident feedback based on actual garden usage. Concurrently, we established a community garden operations team, bringing together community organizations, residents, and designers to collaboratively formulate long-term management and operational strategies. For instance, following the completion of the *Baiye* Garden, we organized subsequent activities such as stone painting workshops and plant impression art sessions, integrating nature-based aesthetic education into the participatory community garden initiative.

3. Results

3.1 Enhancement of Benefits

The community garden initiative demonstrates that participatory development yields significant environmental, social, and individual health benefits. It effectively integrates natural elements, vernacular landscape resources, and cultural assets within the community, resulting in enhanced greening quality and improved residential landscape aesthetics. Through collaborative engagement in the garden project, local residents—including migrant tenants—developed increased familiarity with one another. Many participants reported improved neighborly relationships, greater community cohesion, and a strengthened sense of belonging following the initiative (Figure4). Furthermore, residents' involvement in garden construction, plant cultivation, and nature-based aesthetic education workshops provided physical exercise and mental stress relief. This active participation contributed positively to their overall physical and mental well-being (Figure5).



Figure 4. The implementation process of participatory community gardens.



Figure 5. Community residents participated in the creation of the garden.

3.2 Urban-Rural Differences

Our findings reveal distinct perceptions held by *Shatou's* original villagers, shaped by their long-standing rural livelihoods and experiences. Despite residing in increasingly urbanized community environments, their understanding of local resources and aesthetic preferences differs significantly from those of urban residents. Compared to the meticulously manicured greenery often valued in urban communities, these residents prioritize the utility of gardens over purely "formal beauty" or "ecological" landscape elements. Notably, many expressed a preference for hard-surfaced plaza spaces over expansive green areas within their community. These plazas offer diverse utilitarian possibilities—such as resting, dancing, social gatherings, crop drying, and vehicle parking—that better align with their practical needs and lifestyle. These unexpected findings prompt critical reflection: For whom are community gardens ultimately designed? They suggest that "textbook" professional knowledge requires refinement through participatory social practice. Socially-guided landscape design thus emerges as a vital pathway towards achieving high-quality human settlements in the future.

4. Discussion

4.1 Heterogeneity and Complexity of Urban-Rural Transitional Spaces

TPCs in the PRD region epitomize the heterogeneity and complexity inherent in urban-rural transitional spaces, manifesting ignificant contradictions across spatial, social, and cultural dimensions. Spatially, these communities commonly exhibit high building density coupled with a severe shortage of public green space. While retaining the spatial fabric of traditional villages during urbanization, they typically lack systematic green space planning. This fragmented spatial structure

imposes multiple constraints on community garden siting and layout, necessitating innovative placement within interstitial building gaps and underutilized plots. Culturally, tension exists between the erosion of traditional village landscapes and the ongoing construction of modern community identity. Although *Shatou* Community preserves Lingnan-style historical architecture, residents' interpretations of local culture often diverge from those of professional designers. Existing research highlights the prevalent fragmentation of cultural identity within the region's urban villages. Consequently, cultural continuity in transitional spaces cannot rely solely on preserving physical landscapes; it must also activate residents' cultural agency through participatory design.

4.2 Methodological Suitability of Participatory Design

The tripartite collaborative mechanism based on the SPAR model (Search-Plan-Act-Reflect) demonstrates significant adaptability within TPC contexts in the PRD region. The phased SPAR framework facilitates resident participation throughout the entire garden process—from decision-making and implementation to monitoring. Concurrently, the immersive observation and semi-structured interviews conducted by the design team captured residents' authentic needs through combined "insider-outsider" perspectives. The revealed preference for hard-surfaced activity spaces, for instance, validates the universal value of participatory design in urban-rural transitional settings. Furthermore, the operation of the tripartite mechanism (designers-community managers - community residents) yielded substantial effectiveness. This multi-stakeholder collaborative approach demonstrably enhances design acceptance. Nevertheless, the limitations of participatory design emerged in practice. Existing research indicates that professional facilitation by designers can inadvertently perpetuate "epistemic hegemony" [8]. This potential pitfall is exemplified when landscape aesthetics prioritized in design proposals diverge from residents' utilitarian needs.

4.3 Challenges to Community Garden Sustainability

Despite the demonstrable contributions of participatory garden initiatives to environmental and social benefits, their long-term sustainability remains a significant challenge. Scholarly inquiries have documented that initial resident enthusiasm for participatory garden development often wanes following project completion [9]. Consequently, sustaining resident engagement in garden maintenance and management during the operational phase becomes critical. This challenge is intrinsically linked to the absence of institutionalized participation channels and long-term institutional mechanisms for garden operation [10]. Furthermore, sustainability challenges manifest in the imbalance between funding and maintenance costs. Community garden projects frequently lack market viability, exhibiting excessive reliance on short-term government subsidies and a dearth of stable funding sources. This creates a persistent dilemma for continued upkeep. Therefore, community-driven garden development must extend beyond short-term construction towards establishing economically sustainable models that ensure long-term viability through a socially-guided approach.

5. Conclusion

This study, through a representative TPC garden case in the PRD region, reveals both the opportunities and challenges of participatory design within urban-rural transitional spaces. Compared to participatory practices in mature Western communities or rural Chinese villages, the distinctiveness of the PRD transitional zone lies in its inherently unstable social structure. The collision of traditional and modern cultures, intertwined interests of original villagers and new urban residents, and historical complexities surrounding land tenure collectively shape the unique complexity of participatory design in this context. Future research and practice should prioritize the contextual adaptation of participatory methodologies. This involves integrating residents' utilitarian needs with multi-dimensional objectives encompassing ecological and aesthetic goals. Simultaneously, it necessitates developing institutionalized participation mechanisms, establishing sustainable funding and maintenance systems, and enhancing the depth of community cultural engagement. Only by empowering residents to become active interpreters of local culture can community gardens truly evolve into effective vehicles for resolving contradictions within transitional spaces and fostering community integration.

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MIGRATION, THE PURSUIT OF TERRITORIAL JUSTICE, AND CITY TRANSFIGURATION: A LANDSCAPE ARCHITECTURE APPROACH

TOPIC: Guiding cities with society: Participatory approaches and governance strategies

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Keywords: Landscape, Territorial-Social Justice, Urban transformation, Socio-ecological Resilience

Abstract
Migration is a central force reshaping urban and territorial systems in the face of global crises such as climate change, armed conflict, food insecurity, and forced displacement. It is not simply a spatial movement, but a temporal and transformative process marked by vulnerability, adaptation, and agency. Migrants often encounter precarious conditions, including legal uncertainty, lack of shelter, and limited access to essential services. In this context, landscape architecture offers critical tools for engaging with complex geographies and evolving social ecologies. Migratory processes produce diverse types of settlements along borders, urban peripheries, and transit corridors. While some are state-managed—such as refugee camps—others arise informally through collective and autonomous migrant practices. Among these, spontaneous settlements stand out: often self-organised, they may evolve into permanent urban spaces defined by cultural and social bonds. These environments illustrate how migrants are not merely passive actors, but active shapers of space and identity. Borders are no longer fixed dividers but become dynamic zones of negotiation and reinvention. Migration challenges static conceptions of territory, demanding design strategies that are inclusive, adaptable, and responsive to both environmental and social change. Landscape professionals play a vital role in creating spaces that foster resilience, justice, and belonging. This article explores how migration can be understood not as a disruption but as a catalyst for reimagining cities and territories. By shifting the focus from crisis to transformation, we call for more humane and constructive spatial responses—ones that acknowledge the complexity of mobility while promoting integration and equity. Migration reshapes not only the physical landscape, but also our understanding of identity, community, and the possibilities of shared futures.

Migration, the Pursuit of Territorial Justice, and City Transfiguration: a Landscape Architecture Approach

I. Introduction

Migration is a central force reshaping urban and territorial systems in response to climate change, conflict, and displacement. It is a dynamic process marked by vulnerability and transformation, often

giving rise to varied settlement types—formal, informal, and spontaneous—particularly in border zones and urban peripheries. These sites reflect how migrants reshape both space and society, challenging static notions of identity and territory. In this context, adaptive and inclusive design approaches become essential.

This article contributes to current debates by clarifying key concepts and proposing that migration, rather than being a crisis, can be a

catalyst for more just, resilient, and integrated landscapes.

This study methodology combined; on field observation, secondary source analysis, and structured data systematisation. Interviews, academic publications, journalistic material, and on-site insights insides.

The article is organised in three sections. Section 1.2, Setting the Scene, discusses the relevance of migration in the urban landscape within contemporary global challenges. Section 1.3, Migrants and the Urban Transformation, examines how spatial structures and border dynamics interact with migrant-led settlement and territorial claims. Section 1.4, Final Remarks, synthesises the main findings, framing migration as a transformative force in the production of space and the pursuit of territorial justice. We will now go on to develop each one of them.

1.2 Setting the Scene

Demands emerging from the global political agenda— in response to the effects of urban growth, climate change, food insecurity, biodiversity loss, population displacement, and war— highlight the urgency and relevance of ongoing environmental crises, which continue to expand without boundaries. These challenges call for committed and innovative solutions to lead the current transfiguration of our urban areas and cities.

1.2.1 Migration and the Urban Realm

In her book *Social Urbanism*, Maria Bellalta (2021) explores urban transformations in a city-based context through the integrative lens of Landscape Architecture. Her approach offers a renewed framework for understanding the complexity of these issues, aiming to establish new paradigms and strategies rooted in a holistic, multi-scalar, and multifunctional vision.

Human relocation, as a global phenomenon, has increasingly led to communities' evacuation and resettlement and the proliferation of both temporary and permanent refugee and migrant encampments. The precarious state of people's health is closely linked to the absence of safe territories and adequate living conditions. Whether in transit or upon arrival in new destinations, the vulnerability of these groups escalates significantly, as does the emergence of psychosocial and territorial justice conflicts. (Bauböck, R. 2006; Miranda, M. 2023)

Migration is a recurring and complex phenomenon linked to urbanisation, cultural exchange, and humanity's evolving relationship with the environment. It is often due to the above-mentioned factors, including climate change and social pressures, resulting in peoples¨ movement to other locations, regions or countries. It takes place through developed to natural territories, upon urban and rural areas, jungle, wilderness, transitional land as well as the sea. It is not just a spatial phenomenon. Migration is a process over time. From short-term flows of people to longer-term and resettling. The types of movement it causes can weaken trust and community ties but also encourages adaptation and cultural integration (Castles, S et al, 2009).



Figure 1. *Human migration routes currents trends.* Source: Wikimedia Commons (2022).

Today, "Migration" is also, a highly controversial term, largely due to limited understanding of the phenomenon. The diversity of forms, types, processes, actors, motivations, and socio-economic and cultural contexts makes comprehension challenging. Additionally, measuring, predicting, and interpreting its effects is difficult (Bauböck, 2006).

However, such measurement is crucial for defining, studying, understanding, and developing solutions.

According to the International Organization for Migration (IOM) Report (2024), global demographic shifts have reached an unprecedented scale, with an estimated 281 million international migrants worldwide. This represents the largest population displacement ever recorded in human history. Of this total, 48% are women and 10.1% are children, accounting collectively for approximately 163.3 million individuals. A gender-based analysis of these figures reveals distinct vulnerabilities and lived realities, particularly for those experiencing ongoing cycles of uprooting and resettlement.

1.2.2. Landscape Vision and Challenges

As noted in the previous section, mobility, displacement, and perception define the everyday experience of migrants. Movement occurs along corridors, with settlement and shelter taking place across a wide diversity of temporary sites—some of which evolve into varying degrees of permanence. The natural, urban, or interface condition is characteristic of these spaces, which, as previously mentioned, are deeply affected, among others, by the processes of urbanization and the impact of climate change (Nagle, A et al 2025).

Diverse communities, according to their specific needs and aspirations, hold different visions and aim to achieve distinct outcomes. In the context of migration, such differences give rise to conflicting expectations and interests that must be acknowledged and, where possible, reconciled (Pedroli, 2017).

This diversity inevitably leads to conflicting expectations and interests. Global change, environmental degradation, social unrest, ethnic tensions, and armed conflict further exacerbate these potential disputes. Our professional duty is to address such challenges by proposing thoughtful and effective solutions—including those that help to cultivate a renewed, genius loci a contemporary spirit of place and sense of belonging that accommodates shifting identities within the ongoing processes of population-driven transformation. The increasing mobility of populations challenges traditional understandings of place. Masoud (2023) argues that "landscape is the site where equity, identity, and belonging must be negotiated across populations in motion," making it crucial to acknowledge continuous reshaping and plural perspectives in its design and management.

Authors such as Milligan (2015), in Anthropocene Environmental Design, affirm that environmental change is constant—though not always perceptible or predictable. Landscape designers contend with this reality permanently, and a growing number of practitioners are now turning their attention to adaptive approaches. Chris Reed and Nina-Marie Lister (2020), in Projective Ecologies, chart ecological transformations within the biological and earth sciences, exploring their implications for design practice. Landscape architects and urban planners are increasingly adopting a more organic framework grounded in flexibility, resilience, and adaptability, while also integrating a systems-oriented perspective (Demo, 2024). Concurrently, they are distancing themselves from an overdependence on this very framework and from mechanistic models centered on equilibrium and control (Jankilevich, 2024), all while maintaining respect for the cosmovision that unites present generations with their ancestral beliefs and knowledge. (Jankilevich & Tardin-Coelho, 2022). The challenge for landscape and landscape architects is to find valid solutions which, in addition to providing an appropriate response to the environmental needs. at the same time, contribute to preserving the identity and sense of belonging of migrants—even in contexts marked by constantly shifting spaces, communal settings, and temporalities.

Through alternative perspectives, scholars such as Cepic (2011) ask: What happens when people abandon the landscape with which they identify as they move elsewhere? What becomes of their sense of place and identity? Through this vision, they also question: How do migrants alter the landscapes of the new places they settle in? Likewise, through what emotions and perceptions do they transform their places of origin once reintegrated, in cases of resettlement? (Bellalta, 2021).

In this context, Jeff Hou (2013) asks: To what extent do migrants transmit their customs and traditions into new environments—and with what benefits? Also worthy of mention are studies that have explored the impact of land use changes resulting from the pressures exerted by different types of migratory forces on territorial configuration (Garcés, A., 2006; Díez A. et al., 2021).

Migration will continue to play a key role in shaping territorial configuration over the coming decades, highlighting the need for greater professional involvement in landscape design (Tovar & Lamy, 2017). Policies that overlook the importance of landscape management—particularly when addressing issues related to migration and the integration of spatial, natural, and cultural factors—are likely to fail.

1.3. Migrants and Urban Transformation

Displacement drives migrants across the globe in pursuit of territorial and social justice, along the migratory corridors and reaching to the gates of the desired destination sites. Their journeys traverse vast geographies, including urban regions and cities. This ongoing movement and transit often result in temporary settlements and shelters—

some located along borderlands, others within urban spaces. Often, these sites evolve into varying degrees of permanence, gradually reconfiguring the physical and social fabric of both borders and cities.

1.3.1 Territory and the Components of Migratory Spatial Structure

The territorial expression of population displacement covers spaces in which migrants' daily lives and actions unfold. These spaces may be understood as components of the territoriality inherent to the migratory spatial structure. We broadly identify three key elements:

- Migratory or displacement corridors
- Border zones
- Emerging Settlements at the corridor-border intersection and in urban areas and their periphery.

The emerging settlements vary in form, modality, and temporality—particularly at the intersections between migratory corridors and border zones. They also appear within urban and peri-urban areas of countries traversed by these corridors, initially as temporary or transient stays, occasionally developing into permanent new neighborhoods, reshaping the urban fabric and the townscape.



Figure 2. *Distribution and Location of the Components of the Migratory Spatial Structure in Mesoamerica. Source:* Author, 2025

We identify three types of migrant settlements: formal, informal, and spontaneous.

- Formal settlements include refugee camps, detention centres, and border control facilities—state-managed, permanent structures often marked by insecurity and repression.
- Informal settlements arise through migrants' collective agency and include two subtypes. The first forms near borders before entry and is typically short-lived.
- Spontaneous settlements (a subcategory of informal), develops within transit or destination countries.

These are self-organised, with variable durations—some temporary, others evolving into permanent neighbourhoods shaped by shared cultural or ethnic identities, reflecting how migrants actively adapt space to meet their needs despite precarious conditions. Such areas are inhabited by migrant populations with varying degrees of legal status. The study of how these neighbourhoods take form offers compelling evidence of the richness and value of cross-border cultural integration (Hou, 2013).

As mentioned earlier, emerging settlements vary in form, modality, and temporality—particularly at the intersections between migratory corridors and border zones. They also appear within urban and peri-urban areas of countries traversed by these corridors. Initially intended as temporary or transient stays, such settlements may occasionally evolve into permanent new neighbourhoods, reshaping the urban fabric. We can distinguish three categories of such settlements: formal, informal, and a subcategory of the latter that may be referred to as spontaneous.

Formal settlements are characterised by a limited number of cases, which are generally insufficient, insecure, and even repressive. These include border control points, detention centres, and refugee camps—typically planned, constructed, and managed by state authorities on either side of national borders. Such settlements are usually intended to be permanent in nature.

Informal settlements, by contrast, while also marked by insecurity, arise as a form of collective construction led by the migrants themselves. We identify two types. The first emerges on the side of the border prior to entry into the intended destination; these are generally short-lived and precarious. The second type is what we refer to as spontaneous settlements. These arise within the territory of an in transit or destination country and are likewise self-managed by migrants. Their duration varies—some exist for only a few months, while others gradually evolve into permanent

neighbourhoods, often organised by nationality or ethnic group.

Such areas are inhabited by migrant populations with differing degrees of legal status. The study of how these neighbourhoods take shape offers compelling evidence of the richness and contributions of cross-border cultural integration (Hou, 2013).



Figure 3. *Formal and informal settlements: Repression versus Collective Construction.* Source: Compiled by author 2025. Based on https://www.reuters.com/news/picture/migrant-caravan-reaches-us-border-idUKRTS1P9TW/ (2018) and FAO (2021) https://acortar.link/X7cigb,

1.3.2. Regarding Borders

Without necessarily resorting to the grotesque and extreme construction of walls, border edges in some cases serve as administrative divisions, cultural barriers, or arbitrary lines of segregation imposed upon natural landscapes which, historically, have constituted unified entities. Yet borders are not fixed; they evolve over time. Just as such shifts have led to unnecessary—and at times painful—partitions, a shift in paradigm can imagine the opposite. This is evident in the work of authors such as Teddy Cruz and Fonna Forman (2017), who, in the context of California, propose softening borders through the integration and continuity of landscape. A further example is offered by Gabriel Díaz Montemayor (2024), who describes the Mexico–United States border conflicts and advocates for the reunification of landscapes fragmented by historical and political reasons.

These cases suggest that borders and migratory processes can, through the management of innovative solutions, serve to reunify places and reconnect landscapes that were arbitrarily divided. Our study aligns with these perspectives, while placing additional emphasis on the need for security—one of the greatest injustices faced by migrant populations.

1.3.3 Migrants, the Reshaping of the Urban Fabric and the City

In the preceding subsection (1.3.1), we addressed the phenomenon of informal settlements which, through demographic shifts, reflect the geographies of relocation. We also noted that these settlements emerge through various modalities with respect to temporality and permanence. In this section, we aim to examine how such processes of repopulation underscore the role of migrants as both agents and drivers of urban transformation.

Migration, as a global phenomenon, manifests specific characteristics that become particularly visible and measurable in urban contexts. In certain instances, displaced populations occupy peripheral urban areas; in others, they settle in declining or depopulating neighbourhoods, thereby rendering their presence tangible.

Through the appropriation of urban space—often organised along lines of nationality or ethnicity—migrants contribute to active repopulation processes and reinsert themselves into the life and structure of the urban fabric (Lejeune, C. et al., 2024).

This scenario, among others, evidences the pivotal role that migrants can play as transformative actors in contemporary cities.

Migration studies has prompted, both in theoretical analysis and in empirical or planning-oriented approaches, the development of spatial mapping as a diagnostic and monitoring tool.

In what follows, we present its application in three case studies across three countries—one in Europe and two in Latin America.

Firstly, we examine the case of Nottingham in the United Kingdom. Secondly, we analyse two metropolitan areas in Latin America: in South America, the Greater Metropolitan Area of Buenos Aires, Argentina; and in Central America, the metropolitan area of San José, Costa Rica. See details as follows.

Regarding Nottingham, international migrant location density is mapped per spatial unit at the district level

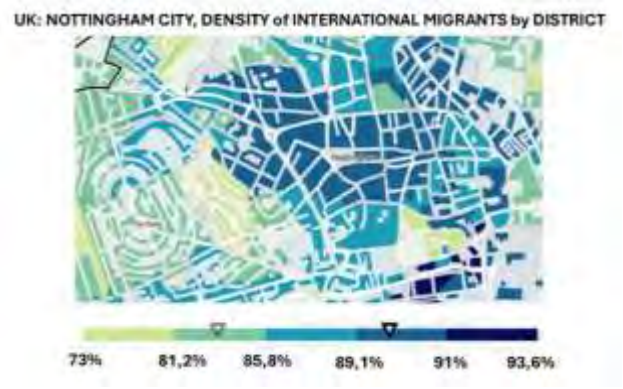


Figure 3. *Nottingham international migrants location by district.* Source: Compiled by author 2025. Based on British Office of National Statistics, Census 2021.

In the case of Buenos Aires, the mapping illustrates the spatial distribution and density of migrants from neighbouring countries at a regional scale.

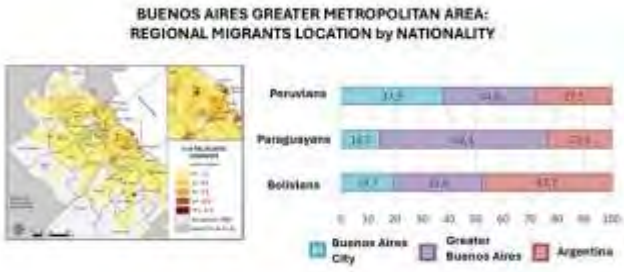


Table 1. *Buenos Aires: Regional migrants location by nationality.* Source: Compiled by author. Based on Gabriela Mera (2018). https://www.redalyc.org/journal/4070/40705554501l/html/

In relation to Costa Rica, the focus is on migrants from Nicaragua—the largest migrant group in the country—whose distribution is represented both as a percentage by district and in terms of agglomeration levels based on population size.

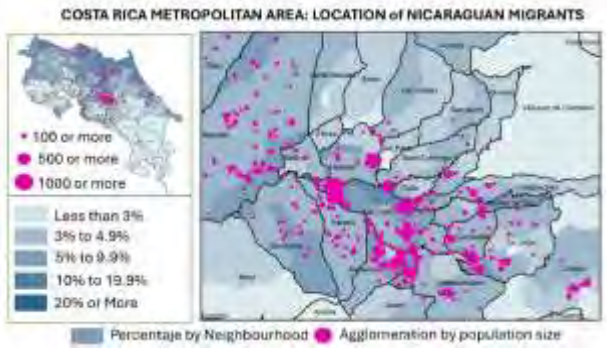


Figure 4. *Metropolitan distribution of Nicaraguan migrant settlements in Costa Rica*. Source: Compiled by author. Based on Richelle Winkler (2011). https://ccp.ucr.ac.cr/observa/Mapas-Migracion

1.3.4 The struggle for territorial justice and meaningful safe environments

One of the most pressing injustices faced by migrant populations is the insecurity of the spaces they inhabit throughout displacement and resettlement—processes often marked by coercion or necessity. A meaningful response lies in the ability to manage territories that guarantee physical, legal, food, and shelter security (Jankilevich, 2024).

From a legal perspective, critics have noted that much of today's international migration legislation was shaped in the aftermath of World War II, with a focus on persecution and asylum. While still relevant, this framework does not fully address contemporary drivers of migration such as economic opportunity and the search for better living conditions. Scholars argue for updated legal approaches more aligned with these current realities, as seen in the evolving policies of countries like Canada and Australia (Hathaway, 2005).

At the same time, growing global mobility has revealed gaps in legal recognition for both regular and irregular migrants who settle long-term. Despite their economic and social contributions, many remain excluded from political participation due to lack of citizenship. This legal precarity is often reflected in limited access to services, instability in legal status, or the looming threat of deportation—challenges that continue to shape the everyday lives of migrant communities.

This adds an essential dimension to migration: the long-term inclusion of migrants and their evolving relationship with public institutions. Especially during prolonged and uncertain regularisation processes, this aspect significantly influences migration decisions in contexts like the United States, present policy (Correa, J. et al., 2022).

1.4 Concluding Remarks

Migration stands as one of the most transformative forces shaping contemporary urban and territorial realities. As examined throughout this chapter, it transcends mere spatial movement, influencing the very fabric of cities and landscapes.

Migrants are not only subjects of displacement, but active agents in the reconfiguration of built and lived environments. Informal and spontaneous settlements, migration corridors, and evolving border zones exemplify how territorialities emerge from conditions of flux, urgency, and adaptation.

In this context, the discipline of landscape architecture holds relevance. Its capacity to engage with complex systems, layered temporalities, and contested spaces offers a unique framework for responding to the challenges posed by migration. Landscape is not only the backdrop of movement—it is a dynamic interface where identity, memory, justice, and belonging are omnipresent
As argued by Masoud (2023), landscape becomes the site through which equity and inclusion must be actively constructed across populations in motion.

The growing scale and complexity of global migration calls for innovative spatial strategies rooted in adaptability, resilience, and social sensitivity. Landscape architects are thus called upon to design inclusive, multifunctional, and context-aware environments—spaces capable of accommodating shifting populations while preserving cultural integrity, fostering integration, and promoting territorial justice within a rapidly transforming world.

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FROM NEIGHBORHOOD AUTONOMY TO MULTI-PARTY CO-CREATION: COLLABORATIVE GOVERNANCE INNOVATION FOR COMMUNITY RESILIENCE IN DESHENGMENNEI STREET HISTORIC DISTRICT

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Keywords: Collaborative Governance; Community Resilience; Historic Districts; Multilateral Participation; Spatial Quality

Abstract

With the transformation of urban governance from traditional administrative control to multi-participation, the construction of community resilience in historical districts requires innovative governance mechanisms. This study takes the comprehensive improvement project of the spatial quality of the Deshengmen Inner Street in Beijing as a case example to explore the application and effectiveness of participatory methods and collaborative governance strategies in the renewal of historical districts. The project implemented a three-level collaborative governance framework of "street-community-block" to achieve a transition from traditional neighborhood self-governance to modern multi-party co-construction. Using a deep participatory approach, the study conducted precise surveys of five key groups through Colloquium and questionnaires to collect public opinion. The survey revealed differentiated needs among different groups, while summarizing three core issues of common concern: traffic problems, pedestrian environment problems, and architectural style problems. Based on the survey results, the study proposed a governance model of "government-led, market-driven, and community participation," innovatively adopting a full-process participation mechanism of "joint design, joint construction, and joint management." During the planning and design phase, residents' suggestions were incorporated into the plan; during the implementation and construction phase, volunteers were organized to supervise the work; and during the subsequent management phase, a volunteer team called "Revitalizing the Old City" was established to form a long-term management mechanism. The study results indicate that community resilience construction based on multi-party governance not only enhances the quality of the physical environment but also strengthens the community's ability to adapt to changes. This practice provides an innovative model for the collaborative governance of historical districts and highlights the professional value and social responsibility of landscape architects in promoting community resilience.

Text

Historical districts are facing a dual crisis of spatial quality degradation and insufficient risk response capacity. At its core, this issue is the superposition effect of material decay and institutional fragility, specifically manifested in outdated infrastructure, prominent safety hazards, low functional performance, deteriorating living environments, and insufficient cultural revitalization. Currently, the governance model is transitioning from administrative control to multi-party collaborative

governance, but China's practical implementation must combine local institutional innovation to address its unique challenges. Existing collaborative governance often focuses on the binary relationship between government and market, neglecting the self-organizing capabilities of communities. Meanwhile, the resilience building of historical areas tends to emphasize physical dimensions (such as building restoration and facility upgrades), lacking systematic integration of institutional and cultural resilience. In the Chinese context, the complexity of property rights (such as mixed public and private housing, fragmented ownership) deeply constrains participation mechanisms, and the tension between top-down governance inertia and bottom-up community demands further highlights the uniqueness of the situation.

In response to these challenges, this paper focuses on three core research questions: How can institutional design break the "multi-center governance dilemma" in the renewal of historical street areas? How can architects act as boundary spanners to integrate diverse values? And how can the "co-design-co-construction-co-management" closed-loop enhance the five-dimensional resilience? The research value of this paper lies in two aspects: first, providing theoretical innovation for the governance of historical street areas; second, offering a replicable practical path for the renewal of high-density historical street areas in East Asia.

1. Literature Review

1.1 THE THEORETICAL EVOLUTION OF COLLABORATIVE GOVERNANCE

Collaborative governance theory has evolved through three stages. The first stage (1980s–2000s) was primarily based on Western theories, with the multi-center governance theory (Ostrom, 1990) proposing the establishment of an autonomous network of decision-making centers to break the monopoly of government control. The collaborative planning model (Healey, 1997) emphasized consensus-building among diverse stakeholders to reshape the relationship between "space" and "power." The collaborative governance model (Ansell & Gash, 2008) introduced a four-dimensional framework of "initial conditions," "institutional design," "catalytic leadership," and "collaborative processes," which became a mainstream analytical tool. However, this stage often neglected the capacity of community self-organization and struggled to adapt to the strong-government context in China.

The second stage (2010s–2020s) marked a period of localization in China, where Xuan Xuepeng (2021) highlighted the integration of the Party's leadership into the collaborative governance chain as a core feature. This led to innovations such as inter-departmental coordination mechanisms, the role of experts as intermediaries, and the transformation of government functions into a triad of "limited," "collaborative," and "service-oriented" roles. These efforts aimed to address the "block division" issue and promote governance models such as government-led, community-autonomous, and community-driven approaches. In Beijing, a three-tiered framework of "street-level coordination," "community coordination," and "block-level implementation" was used to resolve the problem of fragmented property rights.

The third stage (2020s onwards) entered the digital age, with technologies such as VR/AR and blockchain enhancing public participation and the transparency of cultural asset management. Digital collaborative platforms have implemented a dual-track mechanism of "online consensus decision-making and offline execution." The governance of virtual spaces, such as the metaverse, has redefined cultural experiences and participation in historical districts. Through theoretical evolution, historical district revitalization has shifted from "government-led" (1990s) to "market-driven" (2000s) to "community empowerment" (2020s), with tourism collaboration activating economic and cultural resilience. Localized tools such as the "street chief system" and "points system," along with physical space transformation and cultural identity building, demonstrate the core advantages of China's approach. In summary, collaborative governance theory has undergone a spiral upward process from Western institutional transplantation, localization, to technological paradigm transformation. China's practice, through Party integration and digital empowerment, has contributed a governance model with distinct institutional features and technological foresight to global urban renewal.

1.2 FIVE-DIMENSIONAL FRAMEWORK OF COMMUNITY RESILIENCE

Community resilience refers to the ability of a community to maintain its basic structure and functions, effectively resist disasters, and recover from them. Based on the practical experience of the environmental quality improvement project in Dingshenmen Neidajie, a five-dimensional framework system has systematically summarized the core elements of community resilience: first, the capacity for disaster

resistance based on physical infrastructure, measured by completeness of architectural style to assess the cultural continuity of historical districts after disasters, reflecting spatial function continuity and the preservation of cultural symbols; second, organizational resilience based on a collaborative governance mechanism, achieved through volunteer teams to realize combining peacetime and wartime flexible mobilization, covering preventive, restorative, and transformational resilience; third, institutional resilience, reflecting the dynamic balance of party leadership and shared responsibility among multiple stakeholders; fourth, technological resilience, realized through IoT sensors and other technologies to achieve real-time monitoring of facility status; fifth, cultural resilience, enhanced through merchant alliances and resident participation to improve self-rescue capabilities. This framework demonstrates a vertical nesting structure where institutional resilience is the top-level design, organizational and technological resilience empower the implementation layer, and physical and cultural resilience solidify the grassroots foundation. It also emphasizes the interactive evolution of all dimensions during the disaster cycle, highlighting the governance characteristics of "an effective market plus an active government" under the socialist system with Chinese characteristics.

Table 1. A Five-Dimensional Framework of Community Resilience

Dimension	Core Meaning	Measurement Indicators (Deng Case)
Physical Resilience	Spatial disaster resistance and functional sustainability	Pedestrian efficiency, landscape integrity
Organizational Resilience	Multi-subject coordination and emergency response	Crisis response speed, volunteer coverage rate
Institutional Resilience	Rule adaptability and authority allocation	Street chief system, points assessment system
Technological Resilience	Digital empowerment and monitoring and early warning	IoT platform, facility monitoring
Cultural Resilience	Collective memory and community identity	Resident participation rate, merchant alliance

1.3 CONCEPTUAL FRAMEWORK

This framework constructs a systematic resilience enhancement system through three pillars: institutional innovation, technological innovation, and action innovation. Institutional innovation is centered around a three-tiered coordination architecture, achieving seamless integration from macro-level planning to micro-level implementation. Technological innovation introduces a participatory Co-design toolchain to ensure deep involvement from multiple stakeholders. Action innovation promotes sustainable practice iteration through a closed-loop of design, construction, and management. These innovations collectively contribute to resilience enhancement: a multi-center network strengthens structural resilience, institutionalized participation reinforces process resilience, and ultimately, the coupling of five-dimensional resilience achieves dynamic balance and adaptability in the overall system.



Figure 1. Conceptual Framework

2.Methodology

2.1 CASE OVERVIEW

Deshengmennei dajie is located in the northern section of the Beijing Central Axis World Heritage Buffer Zone, stretching from the western side of Deshengmen to the western side of Dadiamen, with a total length of over 1,700 meters. It is the north-south axis of the Shichahai Historical Cultural District. Its history can be traced back to the Yuan Dynasty, and during the early Ming Dynasty, it developed into a commercial and residential thoroughfare along with the prosperity of the canal transport. After more than 600 years of evolution, it has witnessed the transformation from the Yuan Dadu to the Ming and Qing Beijing. The street is lined with numerous historical sites, particularly the "One Bridge and Two Temples" (Desheng Bridge, Zhenwu Temple, and Yongquan Temple) as core historical landmarks, carrying the spatial layout and urban cultural memory of the old Beijing city. As a microcosm of Beijing's urban transformation, Deshengmen Neidajie is not only a transportation route but also a significant carrier of urban memory and historical heritage.

In recent years, the street has faced challenges such as insufficient parking, poor environmental quality, numerous illegal constructions, limited green spaces, and inconvenient transportation. To address these issues, the project team adhered to the principle of respecting and returning to tradition, conducting comprehensive renovations, including optimizing road alignment, adding parking spaces, tidying up small green spaces, repairing facades, expanding pedestrian areas, and supplementing greenery. These efforts have improved the quality of the street environment and met the residents' needs for a better life. As the first street-wide renovation

project implemented within the Central Axis World Heritage Buffer Zone and the first major street renovation project in Xicheng District led by the street itself, the Deshengmen Neidajie Space Quality Improvement Project has received strong support from the government and relevant departments and was listed as a key municipal project for the 2023 Capital Environmental Construction. This marks a significant step forward in the protection and renewal of Beijing's old city.

The project is positioned with the overall concept of "a cultural bond between the watchtower and the sea, and a harmonious and elegant life scene." Based on questionnaires from 500+ residents in 7 communities and 100+ in-depth interviews, the project accurately grasps the regional development needs and implements the "reduction in scale and improvement in quality" and "organic renewal" concepts. It constructs a three-level implementation system of "street-community-block," and innovatively proposes twelve comprehensive street space renewal strategies under strong constraints, achieving a "four-dimensional renewal" of spatial form restoration, cultural memory regeneration, community function reorganization, and governance model upgrading. Through the dual driving forces of "cultural heritage transmission and people's livelihood improvement," the Deshengmennei dajie is reshaped into a "calm, peaceful, neighbor-friendly, ancient Beijing-style, and green and healthy" urban public space carrier, forming a full-cycle solution for the protection and renewal of historical blocks: "precise demand, systematic strategy, modular implementation, and long-term maintenance." This provides a replicable and promotable model for the renewal of existing urban areas in the core zone of the capital.

Key protective interventions include:

- "One household, one strategy" restoration of 149 street-facing facades, uncovering 26 historical sites, and restoring landmarks such as the "One Bridge and Two Temples";
- Using the "three-line coordination" technology to optimize traffic organization, adding 708 meters of continuous slow-moving lanes;
- Adding 60 flower pots and 9 pocket parks, increasing green coverage by 25%, achieving "green space coverage within a 500-meter radius";
- Adding 101 parking spaces and 57 non-motorized parking areas, optimizing 9 accessible ramps;
- Formulating a dual list of "basic convenience and quality improvement," introducing 6 traditional old-established brands, and optimizing 12 types of community service facilities.



Figure 2. Scope of Project Implementation



Figure 3. Conducted comprehensive spatial surveys and over 600 resident interviews to identify existing issues, develop a resident needs matrix, and formulate core strategies

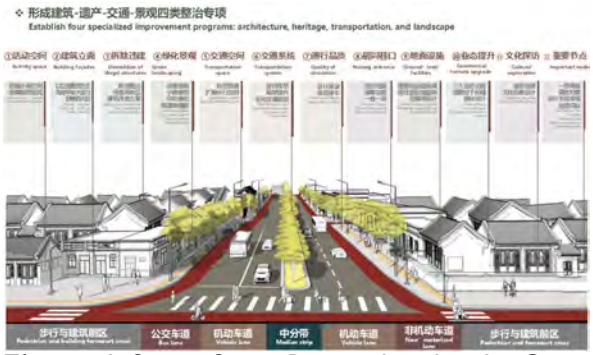


Figure 4. Street Space Renewal under the Comprehensive and Stringent Constraints of 4 Categories and 12 Items



Figure 5. Measurable Key Outcomes

2.2 DATA COLLECTION METHOD

2.2.1 QUESTIONNAIRE DESIGN

This framework realizes a full-cycle closed-loop process from feature description (basic attributes) → current status diagnosis (evaluation layer) → solution generation (demand layer) → innovation exploration (open layer). It integrates a multi-dimensional indicator system to coordinate hardware upgrades (environmental dimension), cultural continuity (social dimension), and service optimization (lifestyle dimension) in community renovation, providing a research tool for urban renewal that is both academically rigorous and practically implementable.

2.2.2 DEMOGRAPHIC DESCRIPTION AND NEEDS ANALYSIS

A multi-subject survey based on 604 valid questionnaires (374 from space users, 80 from management and implementation entities, and 150 from professional supporters) reveals significant spatial governance contradictions in Dening Street. At the level of space users, visitors (69.7% of whom are Beijing locals) primarily aim for leisure and entertainment, while residents (70% aged ≥55 and living in the area for ≥20 years) and merchants (57% engaged in home decoration, building materials, and catering) jointly highlight three major traffic issues: parking difficulties (87%), sidewalk occupation (61% by motor vehicles and shared bicycles), and the lack of rest facilities (73%). They also demand building facade renovations (82% mention private construction and disorder) and historical architectural harmony (76%). Management and implementation entities focus on maintaining spatial order, emphasizing 100% enforcement of anti-illegal parking measures, and requiring industrial integration to coexist with residents' lives (95% mention safety and controllability). Professional supporters propose a regeneration path integrating historical context with modern functions, with planners advocating a three-stage model ("scene creation - cultural identity - industrial cluster") to attract young people (4.2/5.0 demand intensity for youth population introduction). Social organizations emphasize financial balance mechanisms (PPP model feasibility score 3.8/5.0) and sustainable maintenance systems. Multi-source data confirm that improving spatial quality must prioritize pedestrian system optimization (89% demand overlap), while addressing structural contradictions between historical district protection and daily convenience .

Table 2. Data Collection Methods and Key Points

Method	Implementation Highlights	Academic Basis
Stratified Sampling Survey	First category: residents (42%), merchants (18%), visitors (15%) Second category: government (10%) Third category: planners (10%), non-governmental organizations (5%)	Questionnaire Design
Focus Group Discussion	12 sessions, embedded with participatory mapping (Participatory Mapping)	Shijia Hutong Model
Space Behavior Annotation	Track the movement of 200+ pedestrians, quantify pedestrian interruptions	Traffic Evaluation Requirements

2.2.3 TRAFFIC EVALUATION REQUIREMENTS

Construct a "behavior-space node" model based on social network analysis. The model construction includes two parts: the spatial node network model and the behavior network model construction. The three-level characteristics of the network—completeness, structural isolation, and node effectiveness—are analyzed to interpret the public space network and behavior network in historical and cultural districts.

Step 1: The research area is mapped with public space nodes that are frequently used by residents, based on field visits. Using the "New Closest Facility" tool in the Network Analyst module of ArcGIS, the shortest path length between any two public space nodes is calculated. The resulting data is binary processed, where a relationship between nodes is represented as "1" and no relationship as "0", generating a node connection matrix based on spatial distance. This matrix data is then imported into Ucinet software to construct the public space network model of the historical and cultural district.

Step 2: Respondents' behavioral trajectories and stop points are recorded in ArcGIS, and each path is assigned a value. The matrix data is then imported into Ucinet software using NetDraw to visualize the residents' behavior network model.

Step 3: Using the network analysis functions of Ucinet software, the structural characteristics of the public space network and the residents' behavior

network are quantitatively measured. The "network completeness—structural isolation—node effectiveness" features are analyzed: network completeness focuses on the overall structural representation of the network; structural isolation simulates spatial and social isolation phenomena in reality, studying the morphological characteristics of group divisions within the network; and node effectiveness emphasizes the clustering characteristics and individual functional features of the node network.

Table 3. Selection of quantitative indicators for spatial and behavioral network models

Network Feature	Feature Parameter	Definition	Calculation Formula
Network completeness	Density	The degree of closeness or distance between network nodes is represented. In general, the larger the value, the tighter the overall spatial structure	$D=\frac{2E}{N(N-1)}$ D is the density of the network, E is the total number of actual edges in the network, and N is the total number of nodes (or vertices) in the network.
	The average clustering coefficient	The possibility of connectivity between nodes. The higher the value, the stronger the spatial connectivity of the network	$C=\frac{1}{N}\sum_{i=1}^{N}\frac{2e_i}{k_i(k_i-1)}$ e_i is the number of edges between the neighbors of node i, and k_i is the degree of node i (i.e., the number of nodes connected to node i)
	Characteristic Path Length	the average shortest path length between any two nodes (in steps), the smaller the value, the shorter the distance between any two nodes in the network, and the more convenient the connection	$L=\frac{1}{\frac{N(N-1)}{2}}\sum_{i\neq j}d(i,$ d(i,j) is tis the shortest path length between node i and node j.
Structural isolation	Structural isolation	node clustering forms communities, used to quantitatively measure the division of network communities	$Q=\frac{1}{2m}\sum_{i,j}\left[A_{ij}-\frac{k_ik_j}{2m}\right]\delta(c_i,c_j)$ Aij is an element of the adjacency matrix, m is the total number of edges in the network. ki and kj are the degrees of nodes i and j, respectively
	Structural Hole Constraint	The ability of a node to connect to isolated parts of the network is reflected in its structural hole capacity. A higher constraint value indicates that the node has a greater ability to connect to isolated parts of the network	$C_i=\sum_j\left(p_{ij}+\sum_{q\neq i,j}p_{iq}\right.$ The strength of the relationship between node i and node j is denoted as pij
Node effectiveness	node centrality	reflecting the spatial advantages of node positions and the active participation of residents in the network	$Q=\sum_k\left(\frac{e_{kk}}{m}-\left(\frac{d_k}{2m}\right)^2\right)$ e_k represents the number of edges within community k; d_k represents the sum of the degrees of all nodes within community k. m represents the total number of edges in the graph.

In summary, through a comparative analysis of the behavior-space network model, the following characteristics can be identified. Regarding network completeness, the behavior network shows significant correlations with the 800m time-based spatial network in key indicators, indicating that the actual activity range of users is increasingly approaching the theoretical spatial framework of an 800m walking radius . In terms of structural isolation, the spatial network model of the 800m time-based area has a high level of coupling with the behavior network model, both divided into four clusters, with consistent clustering results. This suggests that spatial morphology significantly influences the construction of residents' behavior trajectory networks . As for node effectiveness, while there are differences between the hub nodes in the spatial network and the frequently used nodes in the behavior network, there is also some overlap. Some nodes with high physical connectivity are efficiently used in daily activities, but some high-connectivity nodes remain underutilized, which are key areas for future improvement.

Table 4. Comparison of parameters related to spatial network model and behavioral network model

		5 mins (300m)	Space Network Model 10 mins (500m)	15 mins (800m)	Behavior Network Model
Network completeness	Network Line Connectivity Density	0.0846	0.1987	0.4545	0.3687
	Network Clustering Coefficient	0.727	0.757	0.791	0.950
	Average Path Length	3.235	3.054	1.649	2.034
Structural isolation	Modularity Value	0.695	0.359	0.237	0.389
	Number of Communities	10	5	4	4

Table 5. Comparison of relevant parameters between spatial and behavioral network model

		5 mins (300m)	Space Network Model 10 mins (500m)	15 mins (800m)	Behavior Network Model
Structural isolation	Modularity Value	0.695	0.359	0.237	0.389
	Number of Communities	10	5	4	4

2.3 CLUSTER ANALYSIS

In this study, cluster analysis, as an unsupervised learning method, was applied to identify and classify 23 demands in the urban planning of Denshi Street, ultimately refining them into three core contradiction categories: transportation issues, pedestrian environment issues, and landscape issues. The method followed standard procedures: first, data preparation was conducted, including cleaning and standardizing the 23 demand data (all representing urgent public concerns); second, the K-means clustering algorithm was selected, as it is suitable for high-dimensional data and can efficiently handle urban demand classification; third, the optimal number of clusters was determined using the elbow method, with the best cluster number identified as 3 to ensure maximum intra-cluster similarity and significant inter-cluster heterogeneity; fourth, after clustering, the validity of the results was evaluated using the silhouette coefficient (values > 0.5) to confirm the robustness of the clustering; finally, combined with the case of Denshi Street (the first street project in Xicheng District), the clustering results showed that the 23 demands were condensed into three contradiction dimensions: transportation problems manifested as traffic congestion and unreasonable intersection design, which, according to urban traffic planning literature, led to time waste and air pollution; pedestrian environment problems involved system discontinuity, spatial occupation, and a lack of humanistic care, as emphasized in pedestrian system studies, resulting in reduced safety and comfort; landscape issues focused on building deterioration, landscape imbalance, and environmental disorder; specific manifestations of Denshi Street included chaotic traffic organization, poor pedestrian space accessibility, and insufficient restoration of the "one bridge and two temples" node's landscape. Cluster analysis not only revealed the intrinsic connections between contradictions (e.g., landscape issues exacerbating pedestrian environment degradation) but also provided decision support for data-driven urban renewal, highlighting its value in pattern discovery and practical guidance.

3. RESULTS & DISCUSSION

3.1 A THREE-LEVEL CO-GOVERNANCE FRAMEWORK

This study constructs a "three-tier collaborative governance framework" that effectively addresses the contradiction between the rigidity of the bureaucratic system and the fragmentation of multi-center governance through institutional innovation, achieving institutional adaptation for China's resilient governance. The framework consists of a three-level collaborative system composed of streets, communities, and blocks. At the street level, cross-departmental task forces integrate administrative resources, leveraging information technology to unify the responsibilities of the district government, functional departments, and the street, thereby enhancing response efficiency. Simultaneously, an innovative "street leader system" is introduced, where members of the street party committee serve as overall coordinators, establishing a closed-loop mechanism of "site visits, reporting, feedback, and supervision" to strengthen local management capabilities. At the community level, social organizations are cultivated as hubs for resource integration; for example, the "Revitalization of the Old City" volunteer association implements quantitative incentives, allowing members to earn points redeemable for party membership recommendations and learning opportunities, thus stimulating sustained participation. A merchant alliance co-management mechanism, such as the 12th Factory Bridge, is established through a "Resident and Business Joint Consultation Hall," promoting information exchange between merchants and residents. At the block level, residents are deeply involved in spatial renewal, with design units conducting household investigations and residents participating in the entire design and acceptance process, resulting in "one household, one plan" facade design. Public green spaces are divided into "responsibility fields," with residents forming families to claim them, supported by point incentives and technical empowerment, achieving 60% of the 60 green spaces being maintained by residents. The three-tier collaborative governance framework restructures the governance ecosystem from "government-led—social collaboration—resident participation" through institutional innovation, coordinating bureaucratic resources through the street leader system, activating social capital through volunteer associations, and fostering a sense of community through small-scale claims. By resolving the fragmentation of the bureaucratic system while avoiding the disorder of multi-center governance, this framework provides a replicable institutional model for the refined governance of megacities.

3.2 PROCESS INNOVATION: CO-DESIGN-CO-BUILD-CO-MANAGE LOOP

In the co-design phase, a multi-participation mechanism was established to ensure dual composite resilience, achieving synergistic improvement in both physical and cultural resilience. In terms of physical resilience, digital façade assessment technology was adopted, combined with historical photo comparison and 3D scanning, resulting in a 92% retention

rate of the original appearance of historical buildings, ensuring accurate restoration of architectural structure and exterior. For site-specific points such as No. 196 in Dening, the proposed by residents' ramp design was integrated to address the mobility challenges of the elderly, reflecting the humanistic temperature of age-friendly design. Through a "participatory demand database" mechanism, the project team visited 7 communities and 26 alleys, collected questionnaires, and determined the priority of renovations, ensuring that the design met the actual needs of residents. In terms of cultural resilience, the team implemented a "less is more" restoration strategy, removing external brickwork from the 268th Western Gate to restore the original masonry technique; in the surrounding area of the Mei Lan Fang Memorial Museum, calligraphy inscriptions were used to create landscape features, activating the "one bridge and two temples" historical nodes, and the water-washed stone technique was used to restore traditional wall textures, establishing a recognizable cultural landmark system, truly reflecting the essence of cultural resilience.

In the co-construction phase, an emphasis was placed on technical inheritance and organizational coordination. Traditional artisans were introduced to participate in key restoration work, such as combining volunteer supervision mechanisms to prevent construction inaccuracies and establishing a façade protection inspection team to record construction deviations, ensuring the authenticity and sustainability of the restoration process. At the same time, organizational resilience was cultivated through a "resident-artisan-expert" triangular collaboration mechanism, enhancing community participation and governance capacity.

In the co-management phase, efforts were made to strengthen smart empowerment and institutional innovation. On one hand, the merchant alliance formulated the "parking self-governance agreement," adding 101 roadside parking spaces through staggered shared mechanisms, and the turnover rate of non-motor vehicle parking areas increased by 40%. The "duty patrol team" system ensured long-term cleanliness in stairwell areas, and the integration of old items exchange activated public spaces, systematically building institutional resilience. On the other hand, the 60 small green spaces created through the "demolition of illegal structures to create green spaces" were maintained by the "Green Home Association," embodying the concept of "building one's own home," and strengthening the upgrading of organizational resilience.

These practices demonstrate that the renewal of historical and cultural blocks should empower communities to stimulate internal resilience, and use appropriate technologies to enable long-term governance, achieving the synergistic evolution of physical spaces and cultural ecosystems.

3.3 DESIGNERS, PLANNERS, AND LANDSCAPE ARCHITECTS AS BOUNDARY SPANNERS (BOUNDARY SPANNER)

In the Deshengmennei Street Environmental Improvement Project, designers, planners, and landscape architects transitioned from traditional roles as technical experts and value integrators to institutional designers by adopting a "trinity" approach, successfully acting as boundary spanners (Boundary Spanners) in the process. The core actions of the project focused on two major innovations: first, by translating diverse demands, transforming residents' needs into design language, such as Ms. Dai's "calm" flower bed, which was transformed into a wall-mounted trellis that also serves as a resting area; second, establishing a negotiation platform, drawing on the "Chaoyang Gate model," organizing 12 cross-subject workshops to integrate government, residents, and social forces through a hierarchical negotiation mechanism, resolving traffic and green space conflicts and promoting the co-construction of small green spaces. This transformation marks a shift in Chinese urban planning from a technical orientation to one driven by social resilience, introducing the concept of "Resilience Catalyst" for planners, thereby filling the gap in their social responsibility. The theoretical breakthrough lies in moving beyond the traditional "co-governance" model of responsibility planners to a system-level resilience building, integrating the "absorption-adaptation-reform" capability to enhance economic, social, and environmental well-being.

4.CONCLUSION

4.1 EMPIRICAL ACHIEVEMENTS SHOW

- Improvement of the Physical Environment: The efficiency of pedestrian access has increased by 40%, and the integrity of historical features has reached 92% .

- Governance Capacity Leap: The response time to crises has been reduced to one-third of the original duration, and the participation rate of residents in deliberation has risen from 32% to 79% .

- Theoretical Contribution: This practice validates the applicability of the "government-led, market-driven, community-participated" model in historical districts and clarifies the

key role of architects as boundary spanners in promoting the integration of multi-stakeholder values .

- Practical Significance: This practice provides a replicable path for community resilience building in Stock Space Update, confirming that collaborative governance can achieve sustainable regeneration of historical districts through the coupling of structural resilience (multi-center network) and process resilience (institutionalized participation).

4.2 PROMOTION PATH

The core experience of the Dehengmen Inner Street project can be summarized as refined spatial design, ecological technology integration, multi-party co-governance, and the continuation of historical and cultural heritage. Its promotion path requires scenario-specific adaptation based on the characteristics of different street areas. For example, through vertical greening technology, 60 small green spaces were newly constructed, using vertical green walls (which also provide noise reduction) and movable furniture-based greening (seasonally adaptable) to achieve "green visibility upon exiting." At the same time, the concept of community co-construction and co-governance was introduced, such as the mini garden at No. 120 Deheng, which was proposed and jointly built by residents, enhancing community cohesion. In terms of cultural and commercial tourism integration, historical buildings (such as the reconstruction of the Western-style gate at No. 268) were restored, and traditional brands were reintroduced to enhance cultural experience. The smart operation and maintenance mechanism explored the "urban management service concierge" model to achieve long-term maintenance.

4.3 POLICY PROPOSALS

To enhance urban governance efficiency and community resilience, it is recommended to promote the "Street Leader + Community Planner" dual-track mechanism and incorporate community resilience indicators into the city's evaluation system. In terms of mechanism integration, the Street Leader is typically appointed by the street office director or a deputy leader, who oversees administrative resources, while the Community Planner serves as a technical support, responsible for planning reviews and public participation. The two work together through a "biweekly coordination meeting" system to ensure balanced administrative efficiency and professionalism. Institutional safeguards include incorporating the dual-track mechanism into local "Urban and Rural Planning Regulations" to legally define the status of Community Planners and establish a "base salary + performance bonus" model to strengthen incentives and accountability. In implementation strategies, it is recommended to further establish a "Dual Planner Talent Pool" and promote the "Community Planner Assistant" system to enhance resident participation. At the same time, community resilience indicators should be designed around three dimensions: spatial resilience, social resilience, and management resilience, such as ecological facility coverage, community self-organization capacity, and smart management response, and these indicators should be implemented through tiered evaluations and dynamic feedback mechanisms. Policy coordination can involve establishing a "Community Resilience Fund" and integrating smart management platforms to achieve data-driven resilience assessment and feedback. Ultimately, through the dual driving force of "administrative authority + professional expertise," the transition from fragmented governance to sustainable governance at the grassroots level can be promoted. It is recommended to pilot this model in cities like Beijing and Shanghai, forming a "one city, one strategy" template for promotion.

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HOW DOES OUTDOOR PLACE EXPERIENCE SUPPORT CHILDREN'S WELL-BEING? A STUDY BASED ON PARTICIPATORY WORKSHOPS

TOPIC: Guiding cities with society: participatory approaches and governance strategies

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Abstract

Childhood mental health and well-being are foundational to lifelong development, yet children today are increasingly exposed to psychological stressors. While previous studies have demonstrated the positive impact of urban outdoor environments on children's well-being, limited research has explored how specific types of outdoor spaces and the experiences they afford contribute to children's subjective well-being. This study aims to address two key questions: Which types of outdoor spaces do children perceive as supporting their well-being? What specific experiences within these spaces enhance their subjective well-being? This study adopted a child-centered, interpretivist qualitative approach and was conducted in Guangzhou, China. Three participatory workshops were held with 35 children aged 6 to 15. A multimodal data collection strategy—including sticky-note writing, photo-elicitation interviews, and collage poetry—was employed to capture children's perceptions and lived experiences of "happy places." Thematic analysis was used to systematically trace how well-being was constructed through these spatial experiences. Findings suggest that children's well-being is shaped through a multidimensional process centered on emotional experiences, supported by social connectedness and embodied engagement. Various types of outdoor environments—such as outdoor spaces in daily life, outdoor spaces within other urban blue and green infrastructure, Outdoor recreational spaces with comprehensive facilities, and outdoor spaces in hometowns or those that evoke memories —jointly contribute to well-being by supporting diverse activity needs and enabling emotional projection and meaning-making. Based on these findings, child-friendly urban environments should prioritize the provision of diverse, accessible, meaningful, and perceptually rich outdoor spaces. Policies should ensure children's rights to expression and participation in shaping these environments, fostering supportive settings for emotional and social development. Future research should expand the demographic and geographical diversity of participants, explore age-specific needs, and employ creative methods that enhance children's capacity for self-expression.

Text

1. Introduction

Mental health and well-being are essential across all stages of life, with childhood being particularly critical. These constructs encompass not only psychological disorders and distress but also individuals' subjective perceptions of life quality (Fleckney & Bentley, 2021). However, psychological distress among children has been increasing (Steel et al., 2014). Well-being is multidimensional and culturally embedded, involving both positive and negative elements, and reflecting the alignment among one's emotions, actions, relationships, and life goals (Diener & Ryan, 2009). Childhood thus represents a key developmental period when interventions promoting well-being can yield long-lasting benefits into adulthood.

From a needs-based perspective, well-being is understood as the extent to which available resources meet individual needs (Dodge et al., 2012). Yet access to mental health services and resources remains severely limited, particularly in low- and middle-income regions. Within this context, urban outdoor environments are increasingly recognized as sustainable resources that can uniquely support children's mental health and well-being (Devlin, 2018). Research has shown that supportive environments foster the realization of children's capabilities and the construction of their well-being (Chawla, 2015; Patton et al., 2016).

Urban outdoor environments have been found to promote children's well-being by enabling social interaction, physical activity, and emotional regulation, contributing to social connectedness, identity formation, and place attachment (Norwood et al., 2019). However, most existing studies have focused on macro-level indicators such as accessibility and green coverage, with limited attention to how specific place-based experiences contribute to children's subjective well-being. This study therefore aims to address two central questions:

(1) Which types of urban outdoor places do children perceive as supporting their well-being?
(2) What specific experiences within these places contribute to children's subjective well-being?

2. Method

2.1 Research Paradigm and Design

This study adopted an interpretivist paradigm, grounded in a child-centered research approach that recognizes children as knowledgeable and capable agents who can meaningfully articulate their understandings and experiences of everyday spaces for living, playing, and learning. Rather than conducting research on children, this approach emphasized conducting research with children, prioritizing their right to participation and expression.

Accordingly, a multimodal and participatory qualitative design was developed, combining traditional interviews and focus group discussions with task-based strategies such as photo assignments and sticky-note writing. This design aimed to capture children's diverse modes of expression and experience, while fostering a collaborative relationship between researchers and child participants. It enabled an in-depth exploration of how different types of outdoor places within urban living environments supported children's positive emotional experiences and subjective well-being.

2.2 Participant Recruitment and Data Collection

The study was conducted in collaboration with a nonprofit organization based in Huangpu District, Guangzhou, which facilitated participant recruitment through its community and school networks. A total of 35 children aged 6 to 15 years were recruited to participate in three consecutive child-friendly workshops held between July and September 2024. Among them, 17 children self-identified as female. All participants were native Chinese speakers and possessed basic photo-taking and verbal expression skills. The workshops were held in Xingfuyu Community, Longhu Subdistrict.

Ethical approval was obtained from South China University of Technology. Participation was entirely voluntary, with informed consent secured from both guardians and children. All data were anonymized and used solely for research purposes.

2.2.1 First Workshop

The first workshop involved 27 children. At the beginning, facilitators introduced the core concepts of "outdoor places" and "happiness." Subsequently, 20 children were invited to write about outdoor place experiences that made them feel happy using sticky notes. Additionally, 18 children voluntarily shared their experiences orally. Participants were then assigned a photo task to capture outdoor places associated with happiness using their smartphones or cameras. Prior to the second workshop, a total of 84 photos were collected from 12 participants.

2.2.2 Second Workshop

The second workshop involved 16 children and employed photo elicitation interviews to explore children's emotional responses, memories, and preferences related to the images they had taken. In-depth interviews were conducted with 7 children to explore questions such as: "Why did you take this photo?" "What emotions does this place evoke?" "What do you usually do there?" and "Why do these experiences make you feel happy?" Three additional focus group discussions, each with 5–7 participants, were also conducted. These explored key questions including: "What elements make an outdoor place feel happy?" "What is your favorite place to go?" and "Where does your feeling of happiness come from?" All interviews were audio-recorded, and demographic background information was collected for contextual interpretation.

2.2.3 Third Workshop

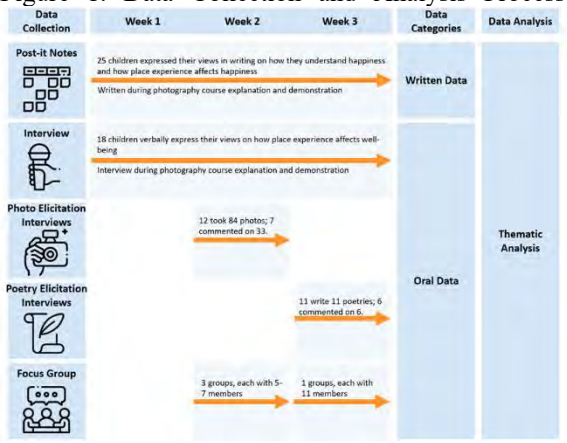
Eleven children participated in the third workshop, where they created collaged poems under the theme "Happy Moments Outdoors" using a set of pre-selected words and phrases drawn from poetry. These included terms related to space, environment, people, activities, emotions, and time, as well as adjectives and verbs for connecting sentence elements. In-depth interviews were conducted with 6 participants, and 5 children supplemented their expressions through additional sticky-note writing. Another round of focus group discussions with all 11 children was held to explore their perceptions of community outdoor spaces and how these environments influenced their well-being.

All written materials from sticky notes were digitized, and interview recordings were transcribed verbatim for subsequent qualitative analysis.

2.3 Data Analysis

Thematic analysis (Braun & Clarke, 2006) was employed to systematically analyze the qualitative data. Transcribed texts were imported into NVivo software and coded following the standard steps: familiarization with the data, generation of initial codes, theme construction, and final theme refinement and naming. The full process of data collection and analysis is illustrated in Figure 1.

Figure 1. Data Collection and Analysis Process



3 Findings

3.1 What kind of outdoor places?

A total of 21 codes related to children's descriptions of outdoor settings were generated, which were subsequently grouped into four overarching themes. Table 1 summarizes the most frequently mentioned types of outdoor places and their representative characteristics, serving as the foundation for further analysis.

Table 1 Types of Outdoor Places Identified by Children

Type of Outdoor Place (Theme)	Subtypes /Examples （Coding）	Characteristics	Illustrative Quotes
outdoor spaces in daily life (n=36)	School playgrounds/sports fields (n=15), community green spaces (n=19), school routes (n=2), and urban comprehensive parks (n=24), etc.	Routinely accessible, familiar and approachable, supportive of children's independent activities, and characterized by a strong sense of community.	"I was very happy playing jump rope with my friends on the school playground." "It was joyful to play football with my friends at the roller-skating field in the neighborhood." "I sat on the slide with my younger brother, chatting and watching the trees."
outdoor spaces within other urban blue and green infrastructure (n=37)	Botanical gardens (n=1), scenic areas (n=1), forests (n=3), beaches (n=5), lakes (n=1), rivers (n=1), and tea fields (n=1), etc.	Not routinely accessible, rich in natural elements, and providing opportunities for contact with nature.	"Climbing Baiyun Mountain was great—the view from the top was beautiful. Having a picnic by Fenghuang Lake made me feel really happy." "I like the flowers in the park, especially snapdragons."
Outdoor recreational spaces with comprehensive facilities (n=21)	Playgrounds (n=10), zoos (n=1), commercial pedestrian streets (n=3), markets and bazaars (n=1), historic districts	Not routinely accessible, well-equipped, conducive to sports and play, featuring strong social and	"I love the amusement park the most; it has thrilling rides." "I was happy to see classical poem lanterns and intangible cultural heritage displays at the market." "Watching the spark-throwing performance at Jiulong Lake was

Children's experiences of happiness in outdoor spaces exhibited rich diversity and individual

differences, strongly shaped by their family routines and daily mobility patterns. Nonetheless, recurring preferences and spatial qualities were identified across participants. These spaces ranged from everyday outdoor places with high accessibility, to nature-rich urban blue–green infrastructures, well-equipped recreational destinations, and emotionally meaningful places such as hometowns.

Outdoor spaces in daily life were described as familiar and accessible environments that supported independent use and fostered a strong sense of community. For instance, some children perceived a warm social atmosphere within their neighborhood, which they linked directly to feelings of happiness. These spaces enabled various core activities such as sports, play, emotional expression, and social interaction. Outdoor spaces within other urban blue and green infrastructure were valued for their natural features and associated sensory experiences. In addition to meeting basic activity needs, these places evoked feelings of calmness, relaxation, and aesthetic pleasure. Outdoor recreational spaces with comprehensive facilities provided facilities for festive events, cultural exploration, and food-related enjoyment, often associated with excitement, novelty, and identity formation. Meanwhile, outdoor spaces in hometowns or those that evoke memories —such as farming with grandparents or socializing in familiar rural settings—thus fostering a sense of belonging and place attachment. In sum, different types of outdoor places supported children's happiness through distinct experiential pathways, depending on their spatial attributes and emotional affordances.

In addition to physical settings, some experiences of happiness were linked to specific environmental elements or transient phenomena, rather than to a particular place type. For example, some children described feelings of happiness when observing weather changes or atmospheric moments, such as sunsets or rain: "The sunset sky looked beautiful and made me feel happy," or "It was raining heavily and the outdoors looked veiled in white." Others expressed symbolic interpretations of nature: "When the pink blossoms fall like rain, it makes me feel happy," or "Lotuses grow out of the mud so beautifully—it makes me feel proud and happy for them." These narratives revealed how children projected emotions onto nature, attributing life, vitality, and companionship to plants and changing skies. Thus, happiness could also be evoked by fleeting details and qualitative features of the environment.

Moreover, specific events or the presence of significant others often served as emotional triggers for happiness. For instance: "Playing volleyball with my teammates made me happy," or "We told a smoking grandpa it was bad for his health, and he finally threw away the cigarette—we felt good." Children also expressed joy from small acts such as hiding from the rain with friends or participating in local festivities like iron-flower performances. One child shared that winning a competition enhanced their appreciation of the surrounding view: "I felt happy bringing home a trophy—the clouds and sunshine looked extra beautiful." Others reflected on the emotional comfort brought by familiar architecture or relocation to better housing. In such cases, the outdoor environment served primarily as a "backdrop" or "container" for emotionally meaningful interactions and events, rather than as the central source of happiness itself.

3.2 What kind of place experience?

Table 2 Types of Place Experience Identified by Children

Dimension of happiness (Theme)	Type of happiness (Theme)	Subtypes/Examples (Coding)	Activities	Illustrative Quotes
Emotional dimension	Pleasure and relaxation	Happiness/joy (n=45), relaxation (n=4), surprise/novelty (n=7)	Aesthetic appreciation, play, physical activity, aimless exploration	"There's not much fun in the neighborhood, so I prefer going to farther places to play." "I feel a sense of happiness when running on the playground—a feeling of relaxation and release."
	Sense of escape	Tranquility (n=2), sense of privacy (n=1)	Walking, creative activities, social interaction	"I enjoy taking walks and sketching in small parks. They're relatively quiet." "A space where you can be alone, just one or two people, undisturbed—that kind of space."
	Self-awareness	Sense of reward (n=2), familiarity (n=1), sense of achievement/self-efficacy (n=6)	Sports, competition, manual labor, caring for plants and	"During harvest season, digging sweet potatoes in rural fields makes me feel very happy."

Social dimension	Sense of connection and care	Parent-child/social connection (n=34), neighborliness/harmonious social atmosphere (n=11), collective sense of honor (n=4)	Parent–child interaction, social engagement, prosocial behavior	"There are lots of adults and children in the neighborhood—it feels lively." "I saw a family of three feeding pigeons together; they got along so harmoniously. It made me feel their happiness." "The sense of team honor also brings me happiness."
	Cultural and social identity	Sense of prosperity (n=3), vibrant everyday life (n=1), cultural resonance (n=11)	Labor, aesthetic appreciation, cultural experiences, consumer experiences	"In the fields, you can see people working. That simplicity makes me feel happy." "I saw many intangible cultural heritage items." "There were many water lilies and lotuses... blooming so lushly and beautifully—it made me happy and proud of them." "I really like being here; it

A total of 14 codes related to children's descriptions of happiness were generated, which were synthesized into five overarching themes.

The emotional dimension emerged as the most frequently mentioned and easily perceived aspect of happiness among children. Three subthemes were identified within this dimension: pleasure and relaxation, a sense of escape, and self-awareness. Pleasure and relaxation encompassed feelings of joy, calmness, and surprise, often triggered by activities such as aesthetic appreciation, play, sports, or aimless exploration across diverse outdoor settings. The sense of escape included feelings of tranquility and privacy, typically arising from walking, creative engagement, or social interaction in more secluded outdoor environments. Self-awareness encompassed feelings of accomplishment, familiarity, and self-efficacy, which were mainly derived from sports and competitive activities in open fields or from caring for plants and animals in green spaces.

The social dimension of happiness was reflected in two major themes: connection and care, and cultural and social identity. Outdoor spaces facilitated interactions among children, as well as between children and others, fostering a sense of mutual care and a harmonious social atmosphere. While this social connectivity might appear contradictory to the desire for solitude expressed by some children, it highlights the diverse and sometimes paradoxical needs underlying children's happiness. Although parental companionship was the most frequently mentioned relational factor, shared activities with friends, classmates, or other peers—especially experiences involving cooperation and collective pride—also played an important role. Some children further demonstrated social empathy, deriving happiness from observing or caring about others' well-being.

In addition, children's happiness was shaped by cultural and sensory experiences in outdoor environments. The presence of aesthetic, cultural, or consumption-related stimuli evoked feelings of vibrancy and liveliness. Cultural attributes of places supported children's awareness of local heritage and urban identity, generating a sense of cultural resonance. In contrast, some children found meaning and emotional comfort in rural labor scenes, which represented a counterpoint to urban prosperity and reflected alternative forms of cultural belonging.

Interestingly, although physical health is often considered a core aspect of well-being, few children mentioned it directly. While several children described activities such as running or playing ball games—commonly associated with health benefits—they mostly emphasized the positive emotional responses elicited by these activities, such as relaxation or a sense of achievement. One child noted feeling physically stronger after reaching a sports goal, but even in such cases, the primary source of happiness appeared to be the competitive experience itself.

Overall, the emotional and social dimensions emerged as the most significant contributors to children's happiness in outdoor environments. Emotional experiences often involved immediate, surface-level responses to ongoing activities, whereas social happiness was shaped by more layered and indirect processes. These included interpersonal connections, empathic perception of others, and resonance with community and cultural settings. Compared to immediate emotional reactions, these deeper sources of happiness often involved symbolic meaning-making and the construction of personal significance.

4 Discussion

4.1 Interpretation of Findings

This study explored how experiences within individual outdoor places support children's subjective well-being. The findings suggest that this support is not solely dependent on the type of outdoor setting but is also closely linked to the specific experiences occurring within it. Ultimately, these experiences contribute to different dimensions of well-being.

Unlike many previous studies that focus broadly on green space quantity or accessibility, this research highlights the distinct ways in which various types of outdoor environments contribute to children's well-being. First, children's sources of well-being were found to be highly individualized, significantly shaped by household activity radii and daily mobility patterns. The most frequently mentioned spaces included outdoor spaces in daily life, outdoor spaces within other urban blue and green infrastructure, Outdoor recreational spaces with comprehensive facilities, and outdoor spaces in hometowns or those that evoke memories. Second, it is important to note that well-being was not always tied to the spatial category of a place. Instead, it was often evoked by environmental details, symbolic natural elements, specific individuals, or meaningful events. These findings call for deeper inquiry into whether well-being is primarily driven by the spatial attributes of places, by non-spatial elements, or by an interaction between the two.

Children's well-being in outdoor spaces emerged as a multidimensional construct, with emotional experience at its core, supported by social connection and embodied participation. These dimensions interacted in complex ways, with specific activities and place types jointly shaping children's well-being trajectories. This aligns with prior research (Ajayi & Amole, 2022; Korpela et al., 2014), yet our findings further reveal that well-being experiences are not limited to surface-level pleasure but involve layered processes of cognitive and emotional integration. Moreover, the impact pathways and complexity of different well-being dimensions may vary considerably.

4.2 Policy Implications

This study provides important implications for the development of child-friendly urban spaces. First, everyday outdoor environments constitute the most fundamental and essential type of space in supporting children's well-being. Urban planning should prioritize the provision of accessible outdoor spaces within children's daily activity radius—such as school playgrounds and sports fields, neighborhood green areas, school routes, and multi-functional urban parks—particularly in spatially deprived communities. At the same time, opportunities for children and their families to engage with other types of outdoor environments, including urban blue–green infrastructure, well-equipped recreational venues, and places associated with memories or rural origins, should be encouraged to foster meaningful experiences of well-being.

Second, emotional well-being—characterized by feelings of pleasure and relaxation—and social well-being—characterized by a sense of connection and care—emerged as two key experiential dimensions commonly shared across outdoor environments. However, these experiences also reflect considerable individual differences. Therefore, urban space design should avoid single-function approaches and instead promote diverse and multifunctional environments that accommodate varied forms of engagement.

In addition, our findings highlight a notable gap between children's and adults' interpretations of well-being-supportive spaces. Children's participation in spatial governance should thus be expanded. Future urban design and management should actively listen to children's voices by establishing inclusive mechanisms such as children's councils, participatory design initiatives, and collaborative workshops. Moreover, children's outdoor experiences are shaped not only by spatial features but also by familial and community support, as well as the broader social atmosphere. Urban policy should concurrently enhance shared family and community play platforms and foster a social environment that supports children's experiences of happiness in outdoor spaces.

4.3 Limitations and Future Research

Despite the rich first-hand data collected through participatory workshops with children, this study has several limitations. First, the sample was primarily drawn from a single community in Guangzhou, China. The limited sample size and relatively homogeneous socioeconomic and residential backgrounds may have resulted in similar patterns of outdoor place use and perceptions of well-being. Future research should expand the geographic and demographic scope to enhance the generalizability of the findings.

Second, although the study included children with a wide age range, it did not explicitly differentiate place-based preferences and well-being

experiences across age groups. Future investigations should consider age-specific analyses to better understand variations in spatial needs and well-being construction across developmental stages.

Finally, although this study adopted multimodal, child-centered participatory strategies, some children may have encountered challenges in expressing their experiences due to limitations in communication skills or the interview setting. Future studies could incorporate a wider array of child-friendly expression tools—such as mapping, spatial modeling, or visual-based play—to more effectively capture children's nuanced emotional experiences.

5. Conclusion

This study, grounded in participatory workshops with children, explored how different types of urban outdoor spaces and specific place-based experiences support children's subjective well-being. The findings revealed that children's well-being is shaped through a multidimensional integration process—primarily driven by emotional experiences, complemented by social connections, and sustained through physical engagement. Diverse types of outdoor spaces contributed to well-being by accommodating a range of activities and emotional needs.

We recommend that policymakers prioritize the provision of accessible everyday outdoor spaces for children and promote environments that combine functional, emotional, and cultural qualities. Future research should broaden the diversity of samples and expression tools to deepen understanding of the mechanisms through which outdoor experiences enhance children's well-being, thereby advancing child-friendly urban planning.

Children's well-being is deeply embedded in their daily life routines and experiences in outdoor spaces. We call for children's spatial rights and well-being needs to be placed at the core of urban governance—an essential step toward building genuinely child-friendly cities.

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PARTICIPATORY LANDSCAPE GOVERNANCE IN THE AKAMAS PENINSULA: A BOTTOM-UP APPROACH THROUGH THE TOPIO PROJECT

TOPIC: With Society: Participatory approaches and governance strategies.

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Abstract

The increasing intricacy of managing protected landscapes demands innovative methodologies that fuse scientific evidence, digital innovation, and grassroots participation to reconcile ecological integrity with social and economic aspirations. The Akamas Peninsula in Cyprus, designated under Natura 2000 for its ecological and cultural significance, represents a pressing case study in balancing conservation and local development. This paper presents a robust participatory framework developed within the EU-funded TOPIO project (Towards a Democratic Landscape Observation through Geoinformatics and Public Participation). TOPIO brings together nine institutions across Europe, including research centers, universities, SMEs, and NGOs, to design inclusive and transferable methodologies for landscape governance. Our participatory process integrates Public Participation GIS (PPGIS), Earth Observation (EO), citizen science, and structured stakeholder engagement to produce actionable, community-validated insights [1]. A mixed-methods approach was adopted, combining quantitative data from structured Likert-scale surveys with qualitative data from open-ended interviews and participatory mapping sessions. This was piloted in February 2025 in the "Akamas in Action" workshop, attended by 120 local participants from diverse backgrounds including residents, farmers, local business owners, environmental activists, and municipal authorities.

Printed topographic maps (1:25,000 scale) were used for on-site annotations of areas perceived as valuable, threatened, or in need of restoration. Questionnaires assessed landscape values (aesthetic, natural, cultural, economic), perceived changes over the past two decades, and priorities for restoration. Facilitated small group discussions allowed participants to explain their choices and voice concerns, all of which were transcribed and thematically coded. The EO component involved analysis of Sentinel-2 satellite data from 2015 to 2024 to detect land use and land cover (LULC) changes and validate participant observations.

Quantitative responses revealed strong aesthetic and natural values (mean 4.6/5 and 4.7/5, respectively), with cultural and heritage values also prominent (4.2/5 and 4.1/5). Economic and tourism values were rated lower (3.2/5 and 3.5/5), though over 80% of participants affirmed a deep personal or communal bond to the landscape. Perceived degradation over the past two decades averaged 3.8/5, highlighting wildfires, habitat fragmentation, and terrace abandonment. EO-derived LULC change detection confirmed a 12% decline in forest cover and a 9% increase in built-up areas, offering strong triangulation between observed and perceived changes.

Cluster analysis of survey data identified three stakeholder typologies: (1) Conservation Guardians (45%) prioritizing ecology and heritage, (2) Development Pragmatists (30%) focused on sustainable tourism and

livelihoods, and (3) Balanced Stewards (25%) advocating integrative solutions. These findings suggest the necessity of tailored governance structures, such as shared stewardship councils, buffer-zone mechanisms, and cross-sector advisory boards.
A digital extension of the process is currently underway via the TOPIO online participatory platform, which aims to democratize access to planning tools, facilitate geospatial data contributions, and support longitudinal monitoring. With strong participant interest (mean 4.3/5), the platform is expected to become a central node for continuous community engagement and data-driven policy design.
This paper argues that the integration of community knowledge, geoinformatics, and participatory planning offers a replicable model for other Mediterranean and Natura 2000 contexts. Recommendations include institutional support for hybrid participatory systems, investment in digital literacy, and multi-stakeholder mechanisms for ongoing co-management. Through the Akamas pilot, the TOPIO project demonstrates the transformative potential of combining traditional values with modern tools to achieve truly inclusive landscape governance.

1.Introduction

In recent decades, the governance of protected landscapes has undergone a paradigm shift, increasingly moving away from rigid, top-down conservation models towards more inclusive, participatory frameworks. This evolution reflects growing awareness among policymakers, researchers, and civil society that landscape management must not only preserve ecological integrity but also acknowledge and integrate the values, needs, and knowledge of local communities. The European Landscape Convention (ELC), adopted by the Council of Europe in 2000, encapsulates this shift by defining landscapes as "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors." This definition underscores the role of public perception and local narratives in shaping both landscape identity and management strategies. Participatory governance is no longer viewed as supplementary but as foundational to the success and legitimacy of landscape policies, particularly in regions where ecological protection intersects with socio-economic tensions.

The Akamas Peninsula in northwestern Cyprus offers a compelling case for participatory landscape governance. Encompassing rich biodiversity, endemic flora and fauna, ancient terraced agricultural systems, and coastal ecosystems, Akamas is a designated Natura 2000 site of high ecological and cultural significance. However, this region has long been a site of contestation, caught between conservation imperatives and pressures for tourism-driven development. Local residents, many of whom maintain ancestral ties to the land, have expressed concern about top-down policies that overlook their lived experiences, economic realities, and cultural heritage. Meanwhile, environmental organizations have decried unregulated development, habitat degradation, and insufficient enforcement of protection measures. This clash of interests has made Akamas not only a conservation priority but also a testing ground for democratic governance models that aim to harmonize competing values through dialogue, data, and co-management.

The EU-funded TOPIO project (Towards a Democratic Landscape Observation through Geoinformatics and Public Participation) responds directly to this need for innovative and inclusive governance frameworks. Bringing together a consortium of nine partners—including universities, SMEs, NGOs, and research centers—TOPIO is premised on the belief that sustainable landscape governance must be co-produced by experts and communities alike. At its core, the project employs a mixed-methods approach that blends geospatial technologies, such as Public Participation GIS (PPGIS) and Earth Observation (EO), with citizen science, structured surveys, and deliberative workshops. This methodological integration facilitates multi-scalar insight into how people perceive, value, and interact with their landscapes, while also providing robust, spatially explicit data to inform planning and policy [2].

The Akamas Peninsula was selected as a pilot site for the implementation of the TOPIO methodology, allowing researchers to test participatory strategies in a real-world context marked by ecological sensitivity and socio-political complexity. In February 2025, the project hosted a participatory workshop titled "Akamas in Action," which brought together 120 stakeholders from diverse backgrounds: local residents, farmers, small business owners, municipal authorities, conservation advocates, and youth groups. Through interactive mapping, structured questionnaires, and moderated group discussions, participants shared their knowledge and concerns, identified landscape values and threats, and proposed restoration priorities. This face-to-face engagement was complemented by EO-derived

baseline data, including satellite-based land cover change analysis, which helped contextualize stakeholder perceptions within broader environmental trends.

The choice to combine analog and digital tools, printed maps and stickers with satellite imagery and geospatial databases, reflects a deliberate strategy to ensure accessibility and inclusiveness. While the academic discourse increasingly champions digital twins, virtual reality, and artificial intelligence as the future of landscape monitoring, many communities lack the infrastructure, training, or trust required to engage with these tools meaningfully. TOPIO's approach prioritizes usability and co-ownership, acknowledging that technology should enhance rather than substitute human interaction [3] and local expertise. In this sense, the role of landscape architects, facilitators, and community mediators becomes central. These actors serve as bridges between scientific knowledge and vernacular insight, enabling co-design processes that are not only participatory in form but also impactful in outcome.

The Akamas pilot is not only a response to local governance gaps but also a contribution to broader regional and global agendas. By aligning its methodology with the principles of the ELC, the UN Sustainable Development Goals (SDGs), the EU Green Deal, and conventions like Faro and Aarhus, TOPIO aims to position participatory landscape governance as a cornerstone of sustainable territorial development. In doing so, the project transcends traditional conservationist paradigms and opens the door to governance models that are adaptive, evidence-based, and rooted in collective stewardship.

This paper seeks to document and critically assess the outcomes of the Akamas pilot, using it as a lens to examine the opportunities and challenges of participatory governance in protected Mediterranean landscapes. Specifically, it addresses the following research questions: (1) How do local stakeholders perceive landscape values and changes over time? (2) What restoration priorities emerge from participatory tools such as PPGIS and surveys? (3) How can digital platforms extend participation beyond in-person workshops and contribute to ongoing governance? By exploring these questions, the study aims to offer both empirical insights and methodological recommendations for researchers, practitioners, and policymakers working at the intersection of environmental planning, civic engagement, and geospatial innovation.

2. Materials and Methods

The methodological framework employed in the Akamas pilot of the TOPIO project was designed to capture both objective environmental transformations and subjective human experiences across the landscape. This dual orientation toward ecological data and community knowledge reflects the project's central aim: to co-produce actionable insights through the convergence of geospatial technologies and participatory processes. As such, the methodology was grounded in a mixed-methods design, integrating qualitative and quantitative approaches with Earth Observation (EO) and Public Participation GIS (PPGIS). This integration was further supported by structured stakeholder engagement activities, digital tools for data visualization and sharing, and a participatory design ethos that emphasized inclusivity and co-ownership of the process.

The study area, the Akamas Peninsula in western Cyprus, was selected as a pilot due to its ecological richness, socio-political complexity, and long-standing contestations over land use. The region is characterized by diverse landscapes including coastal ecosystems, gorges, maquis shrubland, and traditional agricultural terraces. At the same time, it faces significant pressures from tourism infrastructure, land speculation, and habitat degradation. These conditions made Akamas an ideal context in which to test participatory governance models capable of addressing conflicting values and long-term sustainability.

The research process was divided into three main phases: (1) preparatory data collection and mapping; (2) community engagement through participatory workshops; and (3) post-workshop analysis and triangulation. The first phase involved gathering and analyzing baseline environmental data using EO technologies. High-resolution Sentinel-2 satellite imagery was analyzed to detect land use and land cover (LULC) changes over a nine-year period (2015–2024). This analysis focused on identifying trends such as deforestation, agricultural abandonment, urban sprawl, and coastal erosion. Using supervised classification and change detection algorithms, the research team was able to quantify changes in vegetation cover, built-up area expansion, and fragmentation of natural habitats. These findings provided a spatially explicit backdrop for community-level discussions and ensured that participant perceptions could be grounded in empirical environmental data.

In parallel with the EO analysis, a participatory mapping base was developed using topographic maps at a 1:25,000 scale. These maps were printed and laminated for in-situ use, allowing participants

to annotate them directly with stickers, markers, and handwritten notes. Key thematic layers, such as Natura 2000 boundaries, road networks, and hydrography, were overlaid to enhance spatial literacy and facilitate meaningful dialogue. The design of the participatory materials drew on cartographic clarity and cognitive accessibility, with legend symbology co-developed through preliminary focus group discussions with local informants.

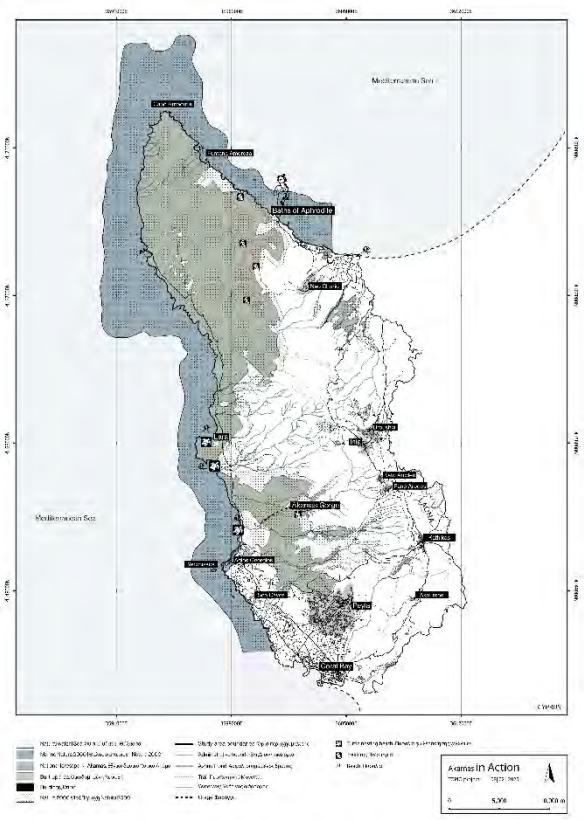


Figure 1. Printed 1:25,000 topographic base map used during participatory mapping sessions in the *"Akamas in Action" workshop (February 2025).*

The core engagement activity took place in February 2025 under the title "Akamas in Action," a participatory workshop held in the village of Kathikas. A total of 120 individuals attended, representing a diverse cross-section of the local population: permanent residents, landowners, farmers, tour operators, environmental NGOs, municipal council members, educators, and youth groups. Participants were divided into smaller groups (10–15 people) facilitated by trained moderators with backgrounds in landscape architecture, environmental planning, and social sciences. Each group rotated through three thematic stations: participatory mapping, structured surveys, and open dialogue.

At the participatory mapping station, individuals and groups marked areas of personal or collective importance using symbols that represented different landscape values, such as aesthetic, ecological, cultural, or economic. They also identified zones perceived as degraded or at risk, along with areas in need of restoration. This process was supported by prompts and guiding questions designed to elicit not only spatial knowledge but also emotional and historical associations with the landscape. These annotated maps were later digitized and analyzed using GIS software to identify spatial patterns and value clusters [4].



Figure 2. Participants annotated areas of value, perceived threats, and restoration priorities using color-coded stickers. *"Akamas in Action" workshop (February 2025)*

In the structured survey station, participants completed questionnaires consisting of Likert-scale and open-ended items. Quantitative items assessed perceptions of landscape quality, value hierarchies (from aesthetic to economic), perceived environmental change over time, and willingness to participate in restoration activities or co-management initiatives. Open-ended responses invited reflection on personal connections to the land, observations of specific transformations (e.g., erosion, fire damage, construction), and expectations for the future. Survey design was informed by established frameworks in landscape perception studies and was pilot tested for clarity and cultural relevance in a local context prior to implementation.

The final station involved small group dialogue, where participants were encouraged to voice their concerns, debate priorities, and envision alternative futures. These sessions were audio-recorded (with consent), transcribed, and coded thematically using qualitative analysis software (NVivo). Codes were developed inductively to capture emergent themes and then refined through axial coding to identify

patterns across groups. This process helped surface underlying tensions, for example, between conservation interests and livelihood concerns—as well as areas of consensus, such as support for wildfire prevention and terraced agriculture restoration.

Following the workshop, all data types, satellite imagery, annotated maps, survey responses, and qualitative transcripts, were integrated through a process of triangulation. This allowed for the validation of stakeholder perceptions against environmental trends and the cross-referencing of spatial and narrative data. For instance, EO-detected deforestation zones were compared with participant-identified areas of degradation, revealing a high degree of convergence in over 80% of cases. Similarly, areas valued for their natural beauty were often co-located with heritage features such as old mills or traditional paths, reinforcing the notion that landscape values are multi-dimensional and place specific.

Finally, the participatory process was extended into digital space through the TOPIO online platform, which offers an interactive map interface, data upload tools for community contributions, and forums for asynchronous dialogue. While not a central focus of the February 2025 engagement, this digital layer aims to institutionalize participation by enabling continuous involvement beyond the confines of in-person events. It also facilitates transparency, data accessibility, and feedback loops between planners, scientists, and citizens.

Through this multi-layered methodology, the Akamas pilot provides a replicable model for participatory landscape governance that is sensitive to both the biophysical realities and the socio-cultural complexities of protected areas. The integration of geospatial analysis, community mapping, and deliberative engagement forms the empirical and epistemological backbone of the study, ensuring both rigor and relevance [5].

3. Results

The participatory governance process piloted in the Akamas Peninsula yielded rich quantitative and qualitative data, revealing a complex landscape of perceptions, values, and priorities across the diverse spectrum of local stakeholders. The outcomes underscore the relevance of inclusive, spatially explicit tools in identifying community needs and enabling informed decision-making.

A total of 120 participants took part in the "Akamas in Action" workshop, encompassing residents, landowners, farmers, small business operators, conservationists, and municipal representatives. Structured questionnaires, participatory mapping, and semi-structured interviews collectively contributed to a multifaceted understanding of how the Akamas landscape is valued, perceived, and contested.

Quantitative analysis of the Likert-scale responses revealed that participants placed the highest value on the aesthetic and natural dimensions of the Akamas landscape. The aesthetic quality of the region received a mean score of 4.6 out of 5, while ecological and biodiversity value was rated at 4.7, indicating near-universal appreciation of the area's visual beauty and environmental importance. Cultural and heritage elements were also rated highly, with average scores of 4.2 and 4.1 respectively, pointing to the significance of historical structures, traditional practices, and place-based identity. In contrast, economic value and tourism potential received relatively moderate evaluations, scoring 3.2 and 3.5 respectively. These results suggest a degree of ambivalence or concern about overdevelopment, despite an acknowledgment of tourism as a potential driver of local economies.

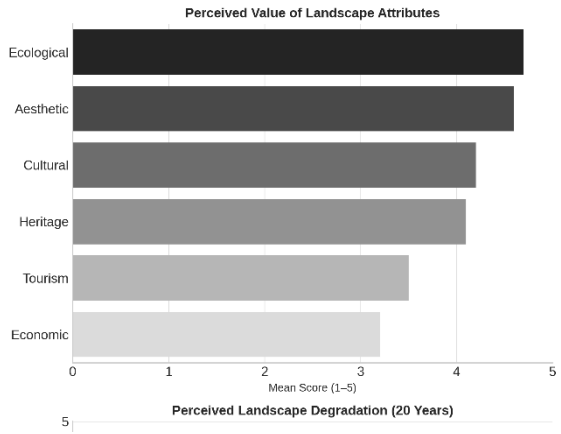


Figure 3. Mean Scores of Perceived Landscape Values in the Akamas Peninsula Based on Participant Survey Responses. *"Akamas in Action" workshop (February 2025)*

One of the most striking findings was the perceived degradation of the landscape over the past two decades, with an average score of 3.8 indicating moderate to high concern. Qualitative data from interviews and group discussions elaborated on this, with frequent references to uncontrolled construction, loss of terraced agricultural land, increased frequency and severity of wildfires, and diminished access to traditional footpaths. These narratives were validated by the remote sensing analysis, which used Sentinel-2 satellite data from 2015 to 2024. The EO component confirmed a 12%

decline in forest cover and a 9% increase in built-up land, particularly in the buffer zones around local settlements [6]. Areas identified by participants as degraded or under threat—such as specific valleys and forest edges—showed strong spatial alignment with LULC change detected through EO, indicating that local perceptions were not only valid but also geographically precise.

Participatory mapping sessions further reinforced this alignment. Using 1:25,000 printed topographic maps, participants marked zones they considered valuable, vulnerable, or in need of restoration. These hand-drawn annotations were digitized and overlaid with EO outputs to create an integrated geodatabase of community-validated spatial concerns. Most frequently cited areas of value included coastal viewpoints, dry stone terraces, and riverine habitats, while threats were concentrated near expanding tourist routes and peri-urban sprawl.

Cluster analysis of stakeholder responses revealed three distinct typologies. The largest group (45%), labeled "Conservation Guardians," consistently emphasized ecological preservation, landscape aesthetics, and cultural heritage, showing minimal support for further development. The second group (30%), termed "Development Pragmatists," prioritized sustainable tourism and agricultural viability, often highlighting the need for infrastructure upgrades and controlled investment. The third group (25%), called "Balanced Stewards," advocated for integrative strategies that harmonize conservation with regulated development and community welfare. These typologies help to explain divergences in opinion during the workshop and point to the need for nuanced governance frameworks that respect plural values and negotiate trade-offs [7].

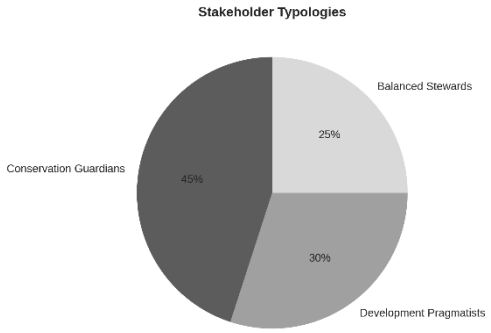


Figure 4. Distribution of Stakeholder Typologies Identified through Cluster Analysis. *"Akamas in Action" workshop (February 2025)*

Finally, participants expressed a strong desire to remain involved in future landscape decision-making. More than 70% indicated they would actively use the forthcoming TOPIO digital platform to contribute data, monitor changes, or engage in collaborative planning. The mean score for digital engagement interest was 4.3 out of 5, suggesting that community-driven monitoring can be sustained through hybrid physical-digital participatory systems.

Overall, the results confirm the Akamas Peninsula as a highly valued yet contested landscape where participatory tools can bridge scientific data with local priorities. By triangulating survey insights, mapped knowledge, and EO validation, the process not only documented community sentiment but also created a foundation for transparent, evidence-based landscape governance.

4. Discussion

The findings from the participatory governance process in the Akamas Peninsula offer critical insights into how local communities perceive, value, and interact with their landscape, and how such perceptions can be integrated into more democratic, adaptive forms of spatial governance. The high ratings for aesthetic, ecological, and cultural values confirm previous research on Mediterranean landscapes that emphasize the coexistence of natural and cultural capital as defining features of identity and belonging [8]. The relatively lower emphasis on economic and tourism values, despite their acknowledged importance, signals a collective wariness toward development trajectories that risk compromising ecological integrity or traditional practices.

These findings resonate with international literature on landscape governance, which highlights the importance of plural value systems and the challenge of managing competing interests (Brown & Raymond, 2007). In the case of Akamas, the identification of three stakeholder typologies, Conservation Guardians, Development Pragmatists, and Balanced Stewards, suggests the presence of underlying value-based cleavages that, if unacknowledged, may lead to conflict or planning fatigue. However, by making these typologies visible through a structured participatory process, the project enabled a space for dialogue that recognized divergence without attempting to erase it. Such pluralistic approaches are essential in protected landscapes, where monolithic planning often fails to capture local nuance or generate legitimacy.

The strong correlation between perceived and EO-detected landscape degradation highlights the epistemic validity of local knowledge and supports calls for integrating citizen observations with scientific monitoring. Rather than treating

perception as anecdotal or subjective, the triangulation of community-generated data with remote sensing reinforces the scientific robustness of participatory methods. In this way, the TOPIO approach contributes to the co-production of knowledge, empowering communities as active contributors to environmental understanding rather than passive informants.

A key innovation of the TOPIO project lies in its hybrid methodology: combining analog tools (printed maps, in-person workshops) with digital extensions (GIS databases, EO analytics, and an online participatory platform). This aligns with emerging trends in landscape planning that advocate for blended systems of engagement to ensure inclusivity across digital divides and foster long-term involvement. The high willingness of participants to engage with the digital platform also points to a shift in local digital literacy [9] and suggests that future governance structures should integrate both face-to-face deliberation and online participation mechanisms.

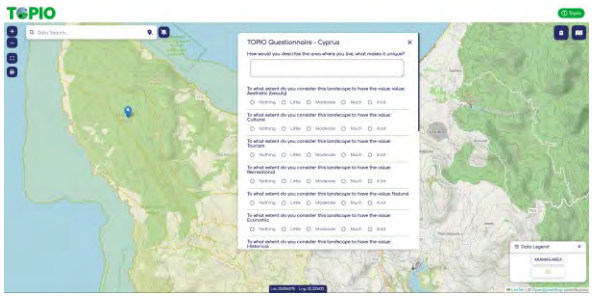


Figure 6. Draft image of the TOPIO online platform showcasing the Akamas', Cyprus, case study questionnaire. Presented at the *"Akamas in Action" workshop (February 2025)*

Nevertheless, the process was not without limitations. While the workshop achieved high levels of diversity in participation, certain groups, particularly seasonal workers and youth, were underrepresented. Moreover, tensions between stakeholder groups surfaced in discussions around land ownership and tourism infrastructure, revealing the need for institutional mediation mechanisms. These limitations do not undermine the process but rather emphasize the importance of continued iteration, feedback, and adaptation.

Ultimately, the Akamas case illustrates how participatory landscape governance can transition from consultative exercises to co-decision-making platforms. By embedding geospatial tools within a culturally sensitive participatory framework, the TOPIO methodology holds promise not only for Cyprus but for other contested or fragile landscapes seeking to harmonize conservation with community aspirations. The challenge ahead lies in institutionalizing these practices and ensuring they are sustained beyond the lifespan of pilot projects.

5. Conclusion

The Akamas Peninsula pilot, developed under the EU-funded TOPIO project, demonstrates the transformative potential of participatory landscape governance when rooted in scientific rigor, digital innovation, and inclusive engagement. Situated within a Natura 2000 site under considerable ecological pressure and socio-political complexity, the pilot operationalized a framework that combined Public Participation GIS, Earth Observation data, and stakeholder-based knowledge production. This enabled the alignment of local perspectives with geospatial evidence, creating a shared basis for decision-making.

A key lesson from the Akamas experience is that landscape planning must move beyond technocratic or top-down models and actively integrate community memory, values, and priorities into environmental management. The findings revealed strong emotional and cultural ties to the landscape among residents, as well as widespread concerns regarding degradation due to fires, fragmentation, and unregulated development. When cross-validated with remote sensing data showing a measurable decline in forest cover and urban sprawl, these perceptions gained further legitimacy. This underscores the critical value of hybrid evidence systems, where qualitative and quantitative data are treated with equal epistemic weight.

From a policy standpoint, the project calls for the formal institutionalization of participatory mechanisms within landscape governance regimes. One clear recommendation is the establishment of permanent multi-stakeholder councils,including residents, scientists, civil servants, and NGOs, that can co-design and oversee the implementation of management plans. Such councils should be granted consultative or even deliberative authority within the governance structure of Natura 2000 sites. Moreover, planning legislation must be updated to mandate the integration of community-generated spatial knowledge in land-use decision-making and strategic environmental assessments.

On the digital front, the TOPIO platform, currently under development, offers a promising avenue for scaling engagement.



Figure 6. Draft image of the TOPIO online platform showcasing the land use map presentation. Presented at the *"Akamas in Action" workshop (February 2025)*

To maximize its impact, we recommend the following: (1) ensure open access to validated spatial datasets through user-friendly interfaces; (2) incorporate interactive mapping, 3D modelling, and participatory scenario tools to support transparent decision-making; and (3) embed longitudinal feedback mechanisms, such as comment logs and update notifications, so users remain engaged throughout the policy cycle. Training modules in digital literacy and platform use should also be deployed in collaboration with local schools, municipalities, and NGOs to build capacity and ownership.

The Akamas case also confirms the adaptability of the TOPIO methodology beyond Cyprus. Its modular structure, combining EO analysis, field workshops, stakeholder segmentation, and digital participation designed for replication. However, successful transfer requires tailoring to local socio-political contexts, particularly in areas with different governance cultures or technological baselines. We recommend initiating future pilots with pre-assessment diagnostics to understand stakeholder networks, power dynamics, and local attitudes toward participation. Partnerships with regional universities and civic tech organizations can further localize the model while maintaining methodological consistency.

In conclusion, the Akamas participatory governance model offers a replicable, evidence-based, and socially responsive approach to managing contested landscapes. Its legacy lies not just in its outputs, maps, surveys, or digital tools, but in its process: one that recognizes communities as co-authors of landscape futures. By embedding such models into environmental policy, digital infrastructure, and cross-regional collaborations [10], we can cultivate more democratic, resilient, and ecologically just landscapes across Europe and beyond.

Acknowledgments

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Short papers

TOPIC 2
Guiding territories by changing the design of regional projects: tools for intervention at different scales, for multifonctional landscapes

THINKING ON NEXT GENERATIONS: NATURE-BASED SOLUTIONS IN PUBLIC SCHOOLS TO CLIMATE CHANGE MITIGATION

TOPIC: Urban habitat rewilding: from sp. choices to infrastructure models

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Keywords: Schoolyard naturalization; Nature-based Solution; Nature education; Climate adaptation

Abstract

In 2022, the Fundación de Patrimonio Natural de Castilla y León launched a competition for the renaturalisation of school playgrounds. Our studio, with a team of four landscape designers, was selected to work on thirteen schools in the provinces of Burgos and Soria, on the Castilian plateau, and we have completed the work this year.

Our public-school playgrounds in Spain are typically paved with concrete, devoid of a single tree or plant.

The general objectives of this project are to increase adaptation and resilience to climate change through the application of nature-based solutions in public schools through the implementation of the following general actions.

- Reducing the outdoor heat island effect - increasing shade, reducing solar radiation, natural temperature regulation, and heat absorption of materials.
- Improving and/or increasing the permeability of the ground, treating built surfaces (pavements), and replacing them with permeable pavements or green areas.
-. Irrigation water management and increased drainage capacity by improving surface run-off.
- Enhancement of vegetation and other local biodiversity, with particular emphasis on local agro-food varieties, pollinators, and insectivorous birds.

In this way, this ambitious project aimed to address the main consequences of climate change, which have a particular impact on one of the most vulnerable groups in the population - children - through education and awareness-raising initiatives in the new playgrounds.

The budget for each school was limited, but the objectives were met with a dose of imagination and creativity. Using the landscape as inspiration, and working closely with schoolteachers, pupils, and parents, we have designed and built new schoolyards where pupils can interact with and enjoy nature.

Perhaps the best tool in these times of climate emergency and uncertainty is to raise awareness and educate from these new nature classrooms. Because to know is love. and to care.

1.**Introduction and objectives**

1.1 Introduction

The pandemic situation experienced in 2020-2022 has had a significant impact on the school population, raising the need to develop educational activities outside the classroom with greater use of outdoor spaces. This necessity has been addressed by the evident fact that outdoor areas in educational facilities are especially susceptible to the impacts of climate emergency. This is because most of these spaces are constructed from concrete and lack a substantial presence of trees, resulting in the formation of what is known as "heat islands". These heat islands serve to exacerbate the effects of elevated temperatures, thereby diminishing the resilience of these environments to the challenges posed by climate change.

The Spanish National Climate Change Adaptation Plan 2021-2030 states that our country, due to its geographical location and socioeconomic characteristics, faces significant risks, with actions focused on adapting to climate change. The term "climate change adaptation" refers to a comprehensive set of strategies designed to prevent or mitigate the potential impacts of climate change, while also promoting enhanced preparedness for recovery in the event of damage.

On the other hand, the European Biodiversity Strategy emphasizes the importance of enhancing urban and public green spaces through the implementation of green infrastructure, nature-based solutions, and tree-planting initiatives. These measures have the potential to significantly benefit educational institutions by promoting biodiversity, enhancing health, and resilience.

The Castilla y León Natural Heritage Foundation, financed by the European Regional Development Fund (FEDER) to promote the renaturalisation of schoolyards in the eight provinces. This initiative aligns with the FEDER REACT-EU's priority axis 20, which focuses on "Promoting recovery from the crisis in the context of the COVID-19 pandemic and its social consequences, and preparing for a green, digital and resilient recovery of the economy." A total of 65 schoolyards has undergone a process of renaturalisation in the whole territory.

Our studio, with a team of four landscape designers, was selected to work on thirteen schools in the provinces of Burgos and Soria, on the Castilian plateau, and we completed the projects in 2023 the projects and in 2024 the works.



Figure 1. CEIP Virgen de Olmacedo-

1.2 Objectives

The overarching aim of these projects was to enhance adaptation and resilience to climate change by implementing nature-based solutions in primary and secondary public schools. This was achieved through the execution of the following general actions:

- Mitigation of the heat island effect in outdoor areas. The benefits of increased tree shade include a reduction in solar radiation, natural temperature regulation, and heat absorption by materials. The use of native trees and green spaces is to be encouraged.

-The project will result in an improvement and/or increase in soil permeability. The treatment of built surfaces (pavements) involves the replacement of these with permeable pavements or green areas.

- Optimized irrigation water management and enhanced drainage capacity through improved surface runoff and the creation of rain gardens.

The project will enhance vegetation and local biodiversity, with particular emphasis on local agrifood varieties and the promotion of pollinators and insectivorous birds.



Figure 1. .CEIP Los Vadillos

As previously mentioned, the primary objective of this project is to address one of the most significant consequences of climate change in Castile and León and, more broadly, in Mediterranean countries. Specifically, the project aims to mitigate the vulnerability of urban areas to rising temperatures, with a particular focus on the most vulnerable segment of the population: children. Indeed, when the ambient temperature is 38°C, concrete pavements can reach temperatures more than 60°C. At a child's height, the temperature can be approximately 50°C, which poses a significant threat to their health.

At the same time, the measures are intended to contribute to improving biodiversity and air quality. Moreover, as the works are to be conducted on an educational site, they will be designed to integrate with the curricular and extra-curricular educational

requirements of the Centre's educational community.

2.-Methodology

During the project development process, special attention has been paid to involving the educational community at each centre, facilitating the co-creation of the solutions to be implemented, as well as their final approval and subsequent use, enjoyment, and maintenance. The adaptation of the proposals to the specific needs of each centre has involved a series of iterations of the design and definition process with the project's coordinating and driving teams, led by the Castilla y León Natural Heritage Foundation, with the participation and support of the drafting team, SCIA S.L.

The SCIA drafting team analysed the proposals prepared by each educational center, indicating their specific needs for renaturalisation and educational integration. This proposal, which served as a guide for the rejection or inclusion of each school based on various selection criteria, set out the requirements for renaturalising each school's playground. However, it did not take into account any budgetary or technical limitations; it only considered the needs or wishes of each centre, such as the heat waves experienced in the playground, puddles that made it impossible to play, and the need for more habitable spaces for school activities. The opinion of the entire educational community was considered in this process, thus initiating a participatory process in which the preferences of teaching staff, parents, and children regarding their play spaces, mobility limitations, and contact with nature were considered. These requirements were included in surveys, the results of which were made available to the drafting team and incorporated into their design proposals.

One unique feature of this project is that many of these educational centers are owned by the local councils of each municipality. We have also been in contact with them to find out their preferences, as they are involved in the future maintenance of these spaces.

After the initial project analysis phase, during which we familiarized ourselves with the unique features of each site, we visited each school with the Natural Heritage of Castile and León team, the Soria Department of Education officials, the project managers at each school and, in some cases, local government officials.

These site visits provided new information about the needs of each location, expanding the possibilities for intervention and creating a dynamic among all the agents involved that allowed for the unification of everyone's tastes and needs. Thus, after touring the school playgrounds and seeing first-hand how each space is used, the children's play preferences, the waiting areas for parents, the teachers' needs, etc., the starting point was slightly modified and, after a subsequent meeting, the spaces and requirements were rethought. For example:



Figure 3. CEIP Principe de España,

- As criteria for use, different categories of spaces were established: activity spaces, quiet spaces and intermediate or semi-activity spaces, which would contain the different possibilities for intervention according to the needs of each centre.

- As for technical criteria, some of the spaces initially proposed by each educational center were in more favorable areas, seeking better exposure to the sun or spaces more protected from the wind.

- As for economic criteria, an initial assessment of the budget available for each centre was carried out, which limited the possibilities for intervention.

Once all the necessary information had been gathered, the design team began creating the first sketches for the site design. These were compiled into a preliminary project that included a descriptive report with a landscape analysis of the site, plans with nature-based solutions, and the corresponding budget. However, the preliminary budget for most of the schools far exceeded the initial budgetary resources available. While not all the proposals can be implemented immediately, this document serves as a master plan, allowing actions to be added over time.

To bring it into line with what is actually possible, the projects have been subdivided into specific areas that can be financed. The document is being

sent to the technical agents responsible for the schools, the town councils for primary schools and the Regional Ministry of Education for secondary schools.

Once all issues raised by these agents had been resolved and incorporated into the projects, a meeting was held with heads of educational centers, heads of the Regional Ministry of Education in Soria, and heads of the development team to present the projects. This made it possible to establish priorities based on economic criteria and, finally, to designate the areas of intervention on which this project is based.

Finally, the executive project for the selected areas will be developed and delivered at the end of 2022.

In 2023, the work will be put out to tender. As they are school premises and to avoid noise problems, they will begin during the school holidays, i.e. in mid-June, July and August, with planting and snow taking place in October.



Figure 4. CEIP CRA Raimundo de Miguel

The works will be put out to tender so that a single construction company will carry out the work in each province: a block of five schools in Soria and eight schools in Burgos.

3-Project criteria

The following criteria were considered when drafting this project, with a particular focus on ecology, landscape and sustainability:

-. Criteria for the promotion of biodiversity:
Introducing new plant species to courtyards increases their biodiversity. However, selecting the right plants ensures this promotion is optimal for the site by establishing synergies between plant and animal communities. This can be achieved by selecting species that attract pollinators or edible fruits, or by incorporating equipment that encourages animal communities to settle, such as insect hotels, nesting boxes or bird baths.

-. Sustainability criteria:
In this type of project, which requires the removal and demolition of large areas of paving, it is necessary to consider minimizing waste through reuse. Where possible, demolition waste has been incorporated into the project as technical flooring or drainage material. This reduces waste management costs and the associated problems, as well as greenhouse gas emissions from transport to the recycling plant. In addition to being one of the project requirements set by the development team, every effort has been made to implement this measure wherever possible.
The project includes environmentally friendly and safe materials and products, and wherever possible, locally sourced materials to reduce the carbon footprint of their acquisition and use. Some recycled elements have also been incorporated to raise awareness of the importance of the circular economy in construction processes.

-. Economic criteria:
The proposal complies with the previously allocated budget as far as possible, promoting interventions that substantially improve the quality of the space and provide greater climatic comfort.
The new facilities and equipment proposed in the project are durable and easy to maintain. This document includes a maintenance plan with a schedule of mandatory periodic checks and inspections.

The proposed irrigation system includes programming and automation elements that allow for scheduling and comprehensive management. Wherever possible, drip irrigation has been chosen as it is much more efficient than sprinkler irrigation and saves water. In addition, an appendix 'Irrigation Requirements' contains calculations that can be used as a guide for maintaining the different plantations.

4-Execution of the works and Results

For each school and a budget of 40.000 €, on average, 300–500 m² of concrete has been removed and recycled in the drainage system or as a base for topographical modifications. Around 15–20 trees, 100 shrubs, and 500-1000 aromatic and perennial species have been planted.

The main actions carried out are listed below:

• Biodiversity.
- Mainly native or adapted species, ruling out exotic species.

- Prioritizing the selection of fruit-bearing trees and shrubs for reasons of biodiversity, carbon sequestration, climate resilience, and food education for schoolchildren.
- Planting species that attract pollinators.
- Selection of broad-canopy species to create shaded areas.
- Creating vegetation corridors to promote biodiversity
- Creation of areas for insects, ponds, bird nests, butterfly nests…,

. • Topography:
-. Create a topography that is not uniform in height.
- Avoid the negative effects of surface runoff.

• Facilities
- Create School orchards that are integrated into food education programs with local varieties.
- Create outdoor rest areas with shade. In general, "agoras" have been designed for 25–50 children.
- Willow huts built with the children

• Drainage:
- Improve soil permeability to reduce heating due to solar gain; for example, replace paving with green areas.
- Improve the drainage system to promote the slow infiltration of torrential waters.
- Create rain gardens to infiltrate runoff water.

• Irrigation
- Improve water irrigation management



Figure 5. CEIP Los Vadillos

5-Conclusion

The playgrounds built have been very well received by the children, who have quickly made them their own. And so renaturalisation takes on its full meaning.

Perhaps the best tool in these times of climate emergency and uncertainty is to raise awareness and educate from these new nature classrooms. Because to know is love. and to care

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Landscape plans: the strengths and weaknesses of a landscape approach

Topic 2: Guiding territories

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Keywords: landscape plan, transition, mediation, landscape approach, regional project

Abstract: This paper looks at the 'landscape plan' tool from two angles: the European framework which has led to the emergence and subsequent strengthening of the implementation of this approach in France, and the approach of the landscape architect as designer or mediator. These two positions produce different effects in the documents produced and influence their translation into planning terms. Two local examples are set out in this presentation: that of the city of Nantes, which uses landscape plans on a neighbourhood scale, and that of the Pays du vignoble nantais, an inter-municipal area on the outskirts of Nantes.

Introduction

Landscape plans are one of the tools proposed by France's Ministry of Energy Transition to take landscape into account in public policy. These tools also include landscape atlases, which are used to develop knowledge of the territory by defining landscape units on a departmental and regional scale, and photographic landscape observatories, which track the evolution of a landscape by regularly taking photographs from the same angle. All of these tools, which range from knowledge to action, remain poorly known to local residents, local authority employees and elected representatives [1]. Against this backdrop, the desire for greater appropriation of landscape approaches is emerging, and an incentive policy has been put in place by the French Ministry of Ecological Transition to encourage development players to embark on the landscape plan approach. This policy consists of offering funding for territories through a call for projects. Landscape plans are therefore the subject of our doctoral research in geography. The thesis seeks to understand how a landscape approach, in the context of the implementation of landscape plans, enables the construction of a territorial project. The methodology employed consists of semi-structured interviews with elected representatives, local authority officials and landscape professionals. The qualitative approach of this research continues with the analysis of technical documents, including the landscape plans themselves. This paper addresses one aspect of the doctoral research in progress, seeking to demonstrate how the landscape plan approach, in the European context, influences the role of the landscape architect and the effects on planning.

I - Landscape plans: a French approach within a European framework

Exchanges of practice between European countries first enabled the landscape plan tool to be disseminated, and then ratification of the European Landscape Convention provided France with a solid conceptual basis for reappropriating landscape plans.

II - An approach imported from the Netherlands

Landscape planning is an approach carried out on a large landscape scale [2], and first appeared in France in the middle of the 20th century. It was landscape architect Jacques Sgard who experimented with it for the first time in France, in 1955 at Lamalou-les-Bains, in response to a commission from one of his

professors, urban planner Théodore Leveau of the Ministry of Urban Reconstruction (MRU). The landscaper's method was organized around what was already at work in the Netherlands, where Sgard had completed his end-of-study internship. The European framework then acted as a space for the dissemination of methods between the Netherlands, with its long-standing practice of planning [3], and France, where the legacy of largely urbanized and cultivated areas combined with the challenges of the "trente glorieuses" (thirty glorious years). At the time, landscape was little considered in public policy, and the tools for protecting and enhancing landscapes were the initiative of various ministries and the DATAR (interministerial directorate for regional planning and action). The creation of national parks in 1960 and regional nature parks in 1967 were the first steps towards taking landscape into account on a regional scale, often from an environmental perspective.

It wasn't until the early 1970s that Robert Poujade created the Ministry of the Environment. In his book "Le Ministère de l'Impossible", Poujade retraced the history of the creation of the Ministry, entitling chapter 9 "Le paysage cet inconnu" ("Landscape, the unknown"), in which he testifies to the difficulty of taking this element into account in public policy [4].

12 - A methodology framed by texts and guides from the French Ministry of the Environment

Although the Lamalou les bains landscape plan was initiated by the Ministry of Urban Reconstruction (MRU), it wasn't until the early 1990s that the French government, through the Ministries of Public Works [5] and the Environment, sought to institutionalize the approach. In 1995, two years after the law on landscape, a circular laid the foundations for an institutional framework for this tool. The circular was drafted on the basis of feedback from several experimental landscape plans. The landscape plan for the Vallée de la Plaine (Meurthe-et-Moselle department, France), for example, was an important milestone, as it led to a series of proposals for action. At the time, the task was a complex one: landscape architects had little experience of the grand paysage, and mediation was not yet at the heart of the approach.

In 2001, landscape architect Bertrand Folléa produced a guide to the plans for charters and contracts [6], taking up the method announced since the 1990s: an approach organized around three stages: a shared diagnosis, the aim of which is to enable the landscape architect to acquire in-depth knowledge of the territory, but also to create a common culture with the other players, the definition of issues corresponding to landscape quality objectives, and an action plan to implement the landscape plan.

13 - Relaunched following the European Landscape Convention

The European scale once again plays a major role following the long birth of landscape plans. In the late 1990s, Jean-François Séguin, Head of the Landscape Office at the French Ministry of the Environment, was one of the drafters of the European Landscape Convention (ELC) [7]. He explains that landscape plans are not mentioned in the ELC (just as they are not mentioned in the landscape law), yet the spirit of the approach seems to appear in the definitions. According to Jean-François Seguin, "Landscape plans are included in this convention in a somewhat roundabout way, since they correspond very exactly to the first article of the convention, which is the one on definitions, where under the objective of landscape quality we find a definition that is exactly that of landscape plans" (interview, August 2024). France signed the Convention in 2006, and in 2013 the Bureau des Paysages relaunched the landscape plan policy by proposing a call for projects to finance part of the cost of producing landscape plans. The aim is in part to experiment with new landscape plans in order to define the landscape quality objectives that will be included in the "law for the reconquest of biodiversity, nature and landscapes". This call for projects is still running, and has enabled almost 200 winners to implement the approach.

French landscape plans were born of exchanges of experience on a European scale, and have

contributed to the development of landscape plan policy in France. The various texts structuring the spirit of this tool: the landscape law (and the associated circular) and the European Landscape Convention are therefore two guides that nourish the landscape plan policy, but they also present various ways for the landscape designer to appropriate this tool.

2 - The landscape designer at the heart of the territorial project

The landscape designer is at the heart of a landscape plan. While the recruitment of a landscape architect from outside the region seems to be the best way of offering a fresh perspective on the landscape and its challenges, the response to calls for tender for the project is often made in the form of a consortium that also includes architects, graphic designers or energy specialists, depending on the themes addressed in the plan.

21 - The landscape gardener as man of the art

In the first landscape plans, the landscape gardener, identified as an expert, surveys the territory, meets with a few local players or scholars and uses his or her perception to construct what ends up as a landscape plan. This was the method used in the early 1990s for the Plaine valley landscape plan. He provides a view of the territory and proposes actions, acting as a "man of the art". The Landscape Act reinforces this vision by establishing a profession, its identity and its expertise. This position of expert seems to contradict the vision of a landscape that is accessible to all. At the seminar marking the 30th anniversary of the Landscape Act, organized by the French Ministry of Ecological Transition in June 2023, Anne Fortier-Kriegel, who drafted Minister Ségolène Royal's presentation speech to the French National Assembly in 1993, explains, "If landscape is defined as perceived, this means that it is not a profession with a culture, training and practice, but on the contrary, that we can now appeal to everyone's tastes and colors" [8].

22 - The landscape gardener as mediator

In contrast to the expert landscape gardener, the landscape gardener takes on the role of landscape mediator, gathering the perceptions of local residents and stakeholders, and synthesizing the elements of the landscape and the views of those who use it. This vision corresponds to the definition of landscape quality objectives (LQO) mentioned in the European Landscape Convention: "the formulation by the competent public authorities, for a given landscape, of the aspirations of the population with regard to the landscape characteristics of their living environment". As we have seen, in the minds of the convention's drafters, the definition of a landscape plan was thus confused with that of landscape quality objectives.

The challenges of participation, as defined in the Aarhus Convention [9], are always difficult to implement. Mobilizing residents in sufficient numbers and in a representative manner is a real challenge for public authorities, and in this context, too little participation calls into question the value of landscape quality objectives and the role of the landscape designer. It is in this context that, for the 2025 edition of the call for landscape plan projects, the Ministry has included a methodological sheet focusing on participation as the first appendix. It describes the added value of participation by setting out four points: strengthening the landscape plan, facilitating acceptance of the landscape plan's content, democratizing decision-making and fostering social ties. The French Ministry of Ecological Transition is therefore following in the footsteps of the European Landscape Convention, by positioning the landscape plan as a tool for territorial planning, both in terms of the approach it mobilizes and the document it produces.

23 - A dual interpretation of the landscape architect's role the landscape architect as a focal point

Thus defined, the two postures of the landscape architect have an impact on the form of the document produced and the approach adopted. In order to overcome these two visions of the profession, calls for tender for the production of landscape plans seek to

associate different skills by requesting groupings. Depending on the issues at stake, the landscape plan is then produced by a consortium comprising a landscape design office, at the heart of the approach, with which may be associated, depending on the context, a participatory design office specializing in themes such as energy or biodiversity, as well as graphic designers. In this way, the landscape architect becomes the project's orchestra conductor, while retaining his or her own identity.

3 - How to act on landscape through planning, the Pays de la Loire example

In this final section, we'll look at how these two approaches can be applied in practice, using two local examples.

31 - Nantes landscape plans, a local approach

The city of Nantes has adopted a particular approach to landscape planning. In this metropolis, landscape plans are piloted by the central city, and the originality of the landscape plans is that they cover the scale of a district, and the term "heritage" is added to that of landscape plan to form "landscape and heritage plans" (PPP). The city has carried out 12 landscape plans, the latest of which is currently being finalized. The choice was made to retain only those districts that are not subject to strong heritage protection (the historic city center) and that are not concerned by large-scale rehabilitation, such as the large housing estates built in the 1960s and 1970s. The last of the landscape plans concerns a district to the north of Nantes, between the Erdre and Gesvres valleys. The landscape and heritage plan process, which began in September 2024, involved seven workshops. The final workshop, to be held in the near future, will be the fruit of dialogue between the various departments, and will provide a response to the proposals made by residents as to what can and cannot be achieved, depending on financial and technical considerations.

The district-based approach allows for close contact with local residents, with the landscape architect acting as an interface between citizens and the local authority. The proposals that emerge from this process enable specific aspects of the territory to be addressed, such as tree alignments along the boulevards, pedestrian continuities and certain built heritage to be preserved. Piloted by the city of Nantes, the plan is then transcribed into the metropolitan local urban plan.

For the local authority, the landscape plan is a means of developing citizen dialogue, but it can also be a means of revealing disagreements between the institution and the citizen. Several issues emerged during the Jonelière landscape plan workshops, the two main ones being a housing project and the removal of parking spaces. In the Jonelière district, the landscape plan became a catalyst for residents' demands, and led to the emergence of a number of phenomena: awareness of the projects; contacts between residents, enabling them to exchange views; and the questioning of officials and elected representatives. For the municipality, far from being a window onto an approach that would enable the development of the area through consultation, the plan became an indicator of opposition to the urban project on two main points: urban densification and the elimination of car parking.

Landscape planning on the scale of a town, or even a district, therefore reveals the position of landscape designers as mediators between residents, elected representatives and technical services. Getting residents to talk about what they know about their living environment is an opportunity to open up a dialogue.

32 - Le plan de paysage du vignoble nantais, an inter-municipal strategy

To highlight the diversity of landscape plan forms, we propose to take a look at a second landscape plan. Located on the outskirts of Nantes, the Pays du Vignoble Nantais is the winner of the 2022 call for projects. One of the objectives is to anticipate landscape changes in the face of evolving agricultural practices: the decrease in the area occupied by vines and the increase in the area occupied by market gardening. Unlike the previous example, which focused on a part of the municipal area, the Nantes vineyard landscape plan covers a vast

territory: two inter-municipalities sharing the same Schéma de Cohérence Territoriale (SCoT). The primary aim is to link the landscape plan and the Schéma de Cohérence Territoriale (Territorial Coherence Scheme). Although it seemed logical for the plan to be implemented upstream of the SCoT, in order to feed it with landscape quality objectives, the SCoT was initiated upstream of the plan. The plan is therefore more appropriate as a landscape translation of the SCoT's strategy, and will feed into the inter-municipal local urban plans of the two communities that make it up, should they adopt the plan.

The Jonelière landscape plan concerns around 3,700 inhabitants (population in 2020), compared with around 101,000 (population in 2017) for the SCoT du vignoble. In the Pays du Vignoble Nantais, the consultation workshop for phase 3 (definition of the action plan) was attended by 23 inhabitants and 6 elected representatives, which does not seem very representative of the total population. In Nantes, on the other hand, some forty residents attended the feedback workshop for elected representatives.

In the case of the Nantes vineyard landscape plan, the landscape designer's role is more that of an expert, and even if he calls on local residents to help construct the landscape plan, the low level of representativeness of the population (in terms of numbers and diversity) means that he needs to bring his own expertise to bear on the future of the landscapes. This expertise was reinforced by the work carried out by landscape design students from the Institut Agro d'Angers last winter. Using the landscape plan as a starting point, their work consisted in proposing scenarios for the evolution of the landscape according to various cursors.

Conclusion

The French landscape plan is a tool strongly influenced by the European context. Firstly, the experience of the Netherlands led to the development of the French version of this tool, and secondly, the European Landscape Convention led to its evolution from a document built by the landscape designer in the 1990s to a document co-constructed with the population since the early 2010s. This dual positioning is still reflected today in the documents produced, as the scales of appropriation of the tool lead us to apprehend the approach in a different way: the proximity to the landscape architect in landscape plans at commune level enables the realization of actions resulting from consultation at street or neighborhood level, while at a higher level it will be more the major orientations capable of orienting planning documents that will emerge. Of course, between the two examples we have discussed, a multitude of approaches exist, mixing the two ways of producing a landscape plan.

For the 2025 call for projects, the French Ministry of Ecological Transition has appended a fact sheet to the application file, emphasizing the importance of consultation. The rules of the call for projects also explain that "the communal approach thus becomes the exception in this 2025 edition of the call for projects", The Ministry's twofold desire to develop consultation and make the implementation of plans on a communal scale the exception may seem contradictory, and the still experimental nature of the approach may make it possible to develop original modes of consultation on an inter-communal scale, as in the case of the Pays-de-la-Loire region's Sarthe Valley, where a citizens' charter on wind power was drawn up with a representative panel of local residents.

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EAST LEEDS ORBITAL ROUTE – A GUIDING LANDSCAPE FOR THE CITY OF LEEDS

TOPIC: Guiding territories by changing the design of regional projects: tools for intervention at different scales, for multifunctional landscapes

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Keywords: Landscape-led approach, Infrastructure, Nature, Active Travel, Community

Abstract

The East Leeds Orbital Route (ELOR) is a pioneering project which was conceived as a multi modal transport corridor 'driven' by nature, with people's wellbeing at its heart. Set within an abundance of attractive and useable green space, it is a guiding landscape for the City of Leeds and represents an innovative re-imagining of the transport corridor with green, blue infrastructure principles underpinning the design, reflected in its 75% Landscape to 25% road space ratio.

Spanning 7 kilometres, the route marks the eastern boundary of the city. The overarching vision was a road corridor set within a country park, integrating infrastructure with nature, that also fosters active travel and ecological enhancement. This balance offers a guiding framework for a city's growth, setting a high benchmark for future developments at the urban edge.

The landscape-focused approach positions green spaces, Pocket parks and play on the way, with amenity placed at the heart of the design, ensuring that the needs of the environment and community are prioritised. Pedestrians, cyclists, and equestrian users are all carefully considered with shared, informal routes interwoven alongside more formal commuter paths, connecting local communities and encouraging sustainable transport choices.

An essential feature of the project was engagement with local communities and the co-design process embedded within it. This collaborative approach ensured that the infrastructure serves not only as a means of movement but also as a vital space for recreation and social interaction. Central to this is the creation of a family of iconic bridges that encourage east west permeability across the scheme.

Environmental considerations were paramount, with particular attention given to stormwater management. The landscape incorporates water-sensitive design techniques, including drainage systems to slow the flow of water and retain it on site. This approach reduces the risk of flooding and enhances nature and human interaction. The project also strengthens and expands ecological networks, promoting biodiversity and community health. The provision of generous and varied green space helps improve air quality, encourages physical activity, and promotes the well-being of local residents. The scheme encompasses 12 hectares of wildflower meadows, 4.5km of native hedgerows, 2 water bodies and over 35,000 trees.

The heritage aspect also further enriches its design, responding thoughtfully to its historical context. The presence of a Scheduled Ancient Monument within the route's path has been celebrated, respected, and creatively incorporated into the design through storytelling and bold planting choices.

The East Leeds Orbital Route is a guiding landscape setting the stage for the future development of East Leeds. It integrates thoughtful design principles that prioritise the needs of the environment and the community, offering a model for sustainable, holistic urban development. Weaving together landscape design, transportation, ecological networks, heritage, and community engagement, ELOR delivers a vision of urban expansion that is functional but also meaningful and transformative. The project has been recognised with a number of awards and was selected by the UK Landscape Institute as a masterclass project for innovative infrastructure.

1. Introduction

ELOR is a major infrastructure initiative designed to support the sustainable growth of Leeds. As the largest city in West Yorkshire - England, Leeds faces increasing pressure to accommodate housing, improve transport connectivity, and enhance environmental resilience. ELOR responds to these challenges by creating a 7.5km dual carriageway that links the A6120 Ring Road at Red Hall to the A58 at Thorpe Park, forming a critical component of the East Leeds Extension (ELE).

This Short Paper examines ELOR through the lens of Landscape Architecture, highlighting how the project exemplifies a guiding landscape strategy that shapes urban form, supports biodiversity, and fosters community identity.

2. Context and Vision

2.1 Strategic Importance

ELOR is a key infrastructure project that underpins the East Leeds Extension (ELE) - one of the most ambitious residential growth initiatives in the United Kingdom. Strategically designed to unlock land for over 5,000 new homes, ELOR plays a pivotal role in shaping the future of Leeds by enabling sustainable urban expansion, alleviating traffic congestion, and improving access to employment hubs and the city centre.

However, ELOR's significance extends far beyond its function as a transport corridor. It was conceived as a landscape-led green artery, weaving together ecological networks, recreational spaces, and urban development. This integrated approach places nature at the heart of infrastructure, ensuring that growth is not only efficient but also enriching for people and the environment.

As Tracy Brabin, Mayor of West Yorkshire stated:

"This project is vital for the regeneration of East Leeds and will help bring housing and industry to a part of our region that really needs it… it's a great example of how we are investing in our communities to improve cycle safety, reduce traffic congestion, and promote healthier leisure opportunities that improve people's wellbeing."



Figure 1. ELOR Landscape Masterplan

2.2 A precursor to National Policy Goals

ELOR is not only a regional milestone but also a forward-thinking exemplar of national policy in action. It anticipates and delivers on several key Government ambitions, including:

- **Nature-Rich, Beautiful Places** – through extensive habitat creation and landscape enhancement.
- **Active and Healthy Places** – by promoting walking, cycling, equestrian routes and outdoor recreation.
- **Thriving and Prosperous Communities** – by unlocking housing and economic opportunities.
- **Resilient and Climate-Positive Places** – through sustainable drainage, carbon-conscious design, and climate-adaptive planting.

2.3 The Role of Landscape Architecture

Landscape Architects have been instrumental in realising Leeds City Council's vision of a road that feels more like a journey through a country park than a conventional highway. Their work has shaped every aspect of the scheme - from the alignment of the route to the character of its green spaces.

Key achievements include:

- **12 hectares of new wildflower meadows**, designed to support pollinators and seasonal interest.
- **Extensive amenity grasslands** for informal recreation and visual continuity.

- **Over 35,000 trees** planted to create woodland corridors, buffer zones, screening and microclimates.
- **Generous waterbodies** supplied by SuDS (Sustainable Drainage Systems), which serve both ecological and aesthetic functions.



- **Figure 2.** Wildflower Meadows envelope the route

2.4 A Connected and Inclusive Landscape

ELOR is more than a road - it is a linear parkland that invites people to move, play, and connect with nature. The route hosts:

- **Four pocket parks** with 'play on the way' features, encouraging intergenerational activity.
- **Two outdoor gyms** and **three trim trails**, promoting health and wellbeing.
- **Multi-use paths** for walking, cycling, and equestrian use, integrated into the wider green infrastructure network.

These spaces are not only recreational but also educational and ecological, offering opportunities for learning, discovery, and stewardship.

2.5 Ecological Connectivity and Water Sensitive Design

The scheme has been carefully designed to enhance biodiversity and hydrological resilience. Key features include:

- **Three ecological ponds** and numerous swales that provide SuDS functionality while creating valuable wetland habitats.
- **Viewing platforms** that allow people to engage with nature and observe wildlife in a low-impact, informal manner.
- **4.5 km of hedgerows** protected, restored, or newly planted to support habitat continuity and landscape character.
- **2.5 hectares of native woodland and shrub planting**, reinforcing the ecological fabric of the area.

These interventions ensure that the corridor functions as a living system, supporting species movement, water management, and climate adaptation.

2.6 Infrastructure as Landmark

The route is punctuated by a family of five striking corten steel bridges, each designed as a sculptural landmark. These bridges are not only functional - providing crucial east-west pedestrian and cycle links - but also symbolic, wrapped in wildflower blankets that echo the surrounding landscape. They serve as gateways, wayfinding elements, and visual anchors within the broader green network.



Figure 3. Iconic Corten Bridges by Knights Architecture

2.7 Landscape-Led Planning

From the outset, the project adopted a landscape-led approach. This methodology prioritises the natural and cultural context of the site and connecting people to nature, ensuring that infrastructure is embedded within the landscape rather than imposed upon it. The vision was to create a route that is not only functional but also beautiful, biodiverse, and meaningful to local communities both existing those that are planned.

This project showcases how Landscape Architects can join up the dots to create healthy accessible spaces for human wellbeing, with climate and nature positive goals, all wrapped into beautiful places that reflect the parent landscape. Or as Rob O'Brien, PM, LCC stated…

"ELOR … is a project like no other where people, place, nature and active travel were at the heart of the design."

3. Design Principles

3.1 Integration with the Landscape

The design of ELOR is rooted in the existing topography, hydrology, and vegetation patterns of East Leeds. The route follows natural contours, minimising cut-and-fill operations and preserving mature trees and hedgerows where possible. This approach reduces environmental impact and enhances visual continuity and connectivity.

3.2 Green Infrastructure Framework

A comprehensive green infrastructure framework underpins the project. Key components include:

- Linear woodlands and hedgerows to provide habitat connectivity.
- SuDS (Sustainable Drainage Systems) integrated into roadside verges and swales.
- Wildflower meadows to support pollinators and reduce maintenance.
- Multi-use paths for walking, cycling, and equestrian use, promoting active travel.



Figure 4. Official Opening of the Equestrian Routes



Figure 5. Leisure Route

3.3 Character Areas

The route is divided into distinct character areas, each reflecting local landscape typologies. These include:

- Red Hall Agricultural Plateau – open farmland with long views.
- Skelton Ridge – elevated terrain with woodland edges.
- Whinmoor Fields – transitional space between urban and rural.
- Manston Meadows – low-lying land with wetland features.

Each area is treated with bespoke planting palettes, materials, and landform interventions to reinforce identity and sense of place along the route.

4. Community and Cultural Integration

4.1 Public Engagement

Community consultation played a central role in shaping the landscape strategy. Workshops, exhibitions, and digital platforms enabled residents to contribute ideas and express concerns. Feedback influenced the alignment of paths, the design of play areas, and the selection of planting schemes.

5. Heritage and Identity

5.1 Local History

As the East Leeds Orbital Route (ELOR) traverses the landscape, it intersects with a site of profound historical and cultural significance: the Scheduled

Monument of Barnbow, the former First World War National Filling Factory. This site holds both local and national importance, being the first of its kind in the United Kingdom and a powerful symbol of the wartime contributions made by women.

Established in 1915, the Barnbow factory was a cornerstone of the British war effort, producing munitions on an industrial scale. At its peak, the facility employed over 16,000 workers, 93% of whom were women. These women, known locally as the "Barnbow Lasses," undertook perilous work filling shells with explosives. The chemical exposure caused their skin to turn a distinctive yellow hue, a visible and haunting reminder of the risks they faced daily. Despite the dangers, their dedication and resilience became emblematic of the home front's contribution to the war.

The ELOR scheme recognises and honours this legacy through a sensitive and symbolic landscape intervention. Within the boundaries of the Scheduled Monument, the landscape design adopts a bold and evocative planting strategy that pays tribute to the Barnbow Lasses. A carefully curated palette of yellow-flowering and yellow-stemmed species has been selected to create a year-round visual narrative that echoes the yellowing effect experienced by the women.

In spring, the central reservation bursts into life with a dense carpet of yellow-flowering bulbs - symbolising renewal and remembrance. As the seasons progress, the landscape transitions into the golden hues of summer perennials and grasses, maintaining the chromatic theme. In autumn, an avenue of Ginkgo biloba trees - chosen for their striking yellow foliage and resilience lines the route, creating a dramatic and contemplative experience. Finally, in winter, the yellow stems of Cornus sericea 'Flaviramea' (yellow dogwood) provide structure and colour, ensuring the tribute remains visible even in the dormant months.

This evolving tapestry of yellow serves not only as a visual landmark but also as a living memorial. It invites reflection on the personal stories, sacrifices, and strength of the women who worked at Barnbow.

By integrating this commemorative gesture into the ELOR scheme, the project demonstrates how infrastructure can be a vessel for memory, identity, and education. The landscape becomes a medium through which the past is honoured and made present.



Figure 6. Memorial to the Barnbow Lasses in Manston Park, Cross Gates

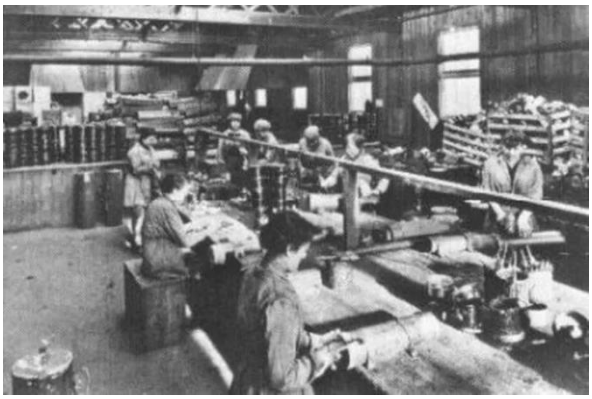


Figure 7. Barnbow Munitions Factory *Leeds Library and Information Services*

6. Sustainability and Climate Resilience

ELOR exemplifies a comprehensive approach to sustainable infrastructure, embedding environmental responsibility, climate adaptation, and community wellbeing into every aspect of its design and delivery. The project's primary sustainable contribution lies in its commitment to reducing reliance on motorised transport by promoting active travel and integrating nature-based solutions.

6.1 Encouraging Active Travel

At the heart of ELOR's sustainability strategy is the creation of a comprehensive, accessible, and attractive network of non-motorised transport routes. These include paths for walking, cycling, and equestrian use, designed to be safe, legible, and enjoyable for users of all ages and abilities. The routes are not only functional but also experiential - woven into the rural landscape and enhanced with features such as:

- 'Play on the way' installations, encouraging children and families to engage with the environment.
- Outdoor exercise units and trim trails, promoting physical activity and wellbeing.
- Connections to wider footpath and bridle-way networks, enabling seamless move-ment across East Leeds.

This integrated approach demonstrates how infrastructure can support behavioral change by making sustainable travel the most appealing option for short journeys.

"I am really impressed with the connectivity this new active travel route provides and how it will bring new and future communities in the east of Leeds together. The pocket parks… will function as great rest spots for families and give them the opportunity to learn about nature whilst living in a city."

Alistair Brownlee, Active Travel Ambassador, Leeds City Council - double Olympic champion



Figure 8. Active Travel Routes



Figure 9. Play On The Way



Figure 10. Outdoor Gyms

6.2 Material Reuse and Landscape Integration

In line with circular economy principles, the project retained and reused excavated material on-site. This material was strategically shaped to form noise and visual attenuation bunds, reducing the impact of the road on adjacent communities and enhancing the visual integration of the route into the surrounding landscape. These bunds also serve as ecological features, supporting planting and habitat creation.

6.3 Climate Resilience Through Design

ELOR has been designed with future climate scenarios in mind. The landscape strategy incorporates adaptive planting schemes that respond to both drought and flood conditions:
Drought-tolerant species have been selected for general planting areas, ensuring long-term viability under warmer, drier conditions.
Inundation-tolerant species are used in SuDS (Sustainable Drainage Systems) zones, where temporary waterlogging is expected.
The SuDS network is fully integrated into the landscape, comprising swales, attenuation basins, and ecological ponds. These features manage surface water runoff, reduce flood risk, and improve water quality, while also providing habitat and visual interest.
Robust materials and thoughtful site-level design ensure that footpaths and cycleways remain dry and usable, even during heavy rainfall. This enhances the reliability and attractiveness of active travel routes year-round.

6.4 Ecological Collaboration and Habitat Connectivity

Working in close collaboration with ecologists and the local Nature Conservation Officer, the ELOR team has delivered a landscape that enhances

biodiversity and ecological connectivity. Key interventions include:

- Linking existing and new woodlands to create continuous habitat corridors.

- Specifying biodiverse seed mixes for wildflower meadows, supporting pollinators and invertebrates.

- Establishing mixed native hedgerows and shrub layers, providing food and shelter for birds and small mammals.

- Creating wetland habitats within SuDS features, supporting amphibians and aquatic species.

- These measures not only mitigate the ecological impact of the road but actively contribute to the restoration and enhancement of the local environment.

6.5 Improving Quality of Life and Environmental Health

The ELOR scheme is forecast to deliver measurable improvements in air quality across the East Leeds Extension by reducing congestion and encouraging modal shift to active travel. The integration of water-sensitive urban design improves stormwater management and contributes to healthier urban hydrology.

By embedding green infrastructure into the core of the project, ELOR enhances the quality of life for residents and visitors alike - providing cleaner air, accessible green space, and opportunities for recreation and connection with nature.

6.6 Alignment with Global Sustainability Goals

The project aligns with several of the United Nations Sustainable Development Goals (SDGs), demonstrating its contribution to global sustainability efforts. In particular, ELOR supports:

- Goal 3: Good Health and Well-Being – through active travel, outdoor recreation, and improved air quality.
- Goal 8: Decent Work and Economic Growth – by unlocking land for housing and employment.
- Goal 9: Industry, Innovation and Infrastructure – through resilient, future-ready design.
- Goal 11: Sustainable Cities and Communities – by integrating green infrastructure and inclusive mobility.
- Goal 13: Climate Action – through adaptive planting, SuDS, and carbon-conscious construction practices7. Monitoring and Management

7. Outcome and Legacy

7.1 Transformational Impact

ELOR has redefined the relationship between infrastructure and landscape in Leeds. It demonstrates that roads can be more than transport corridors—they can be ecological lifelines, community assets, and cultural landmarks.

7.2 A Model for Future Growth

The project sets a precedent for future development in Leeds and beyond. It shows how Landscape Architecture can guide urban expansion in a way that is sustainable, inclusive, and inspiring.

8. Conclusion

ELOR exemplifies the transformative potential of landscape-led infrastructure in shaping sustainable urban futures. By embedding ecological thinking, community values, and design excellence into every phase - from strategic planning and stakeholder engagement to detailed design and implementation - ELOR has established more than just a transport corridor, it has created a guiding landscape framework for the city of Leeds.

This project demonstrates how infrastructure can transcend its utilitarian function to become a catalyst for environmental enhancements, social cohesion, and local identity. The integration of green infrastructure, biodiversity corridors, and active travel networks ensures that mobility is not

achieved at the expense of ecological integrity or community well-being. Instead, ELOR fosters a symbiotic relationship between movement and place, where roads coexist with habitats, and connectivity enhances rather than fragments the landscape.

As Leeds continues to evolve in response to population growth, climate change, and economic transformation, the ELOR model offers a replicable blueprint for future development. It underscores the importance of interdisciplinary collaboration, long-term visioning, and adaptive design in delivering infrastructure that is resilient, inclusive, and contextually grounded. In doing so, it redefines the role of infrastructure as a dynamic and responsive element of the urban fabric - one that supports not only mobility, but also the health, identity, and sustainability of the communities it serves.

SYSTEMATIC MULTI-SCALE ANALYSIS OF CULTURAL LANDSCAPE DYNAMICS IN YELLOW RIVER MOUTH ESTUARY NATIONAL PARK, CHINA

TOPIC: Guiding territories by changing the design of regional projects: tools for intervention at different scales, for multifunctional landscapes

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Abstract
Conventional conservation strategies have predominantly emphasized ecological values, often neglecting the role of cultural landscapes. This study introduces a customized multi-scale Landscape Character Assessment (LCA) framework to systematically identify, evaluate, and manage cultural landscapes in the Yellow River Mouth National Park. Through spatial overlay analysis, remote sensing interpretation, expert visual assessment, descriptive coding, and hierarchical mapping, five primary local-scale landscape units were delineated: coastal fisheries and salt fields, dynamic estuarine wetlands, historical agricultural plains, petroleum extraction zones, and peri-urban agricultural lands. These results inform targeted conservation efforts, ecological restoration, and sustainable landscape governance.

1. Introduction

1.1 Background and Research Purpose

Landscapes continuously evolve through the interaction of natural processes and human activity. Identifying and assessing these characteristics is essential to understanding ecological succession and supporting sustainable development. Advances in geospatial technology and the implementation of the European Landscape Convention have positioned Landscape Character Assessment (LCA) as a foundational method for landscape planning, ecological protection, and cultural heritage research [1–3]. LCA facilitates classification of areas with shared natural and cultural features across multiple spatial scales, improving spatial cognition, value evaluation, and strategic planning.
Situated at the terminus of the Yellow River Basin, the Yellow River Estuary is a highly dynamic delta with evolving landforms, abundant biodiversity, and a long history of human influence. The

establishment of the Yellow River Mouth National Park in 2022 reflects renewed efforts toward regional conservation, emphasizing the need to systematically identify and manage cultural landscapes [6,7].

This research proposes a multi-scale framework combining GIS analysis, remote sensing data, and field surveys to classify and interpret cultural landscape units within the park. The goal is to provide a scientific foundation for heritage preservation, landscape restoration, and participatory governance.

1.2 Research Status

Global trends in landscape research have shifted from static, descriptive models to dynamic, multi-scale approaches that recognize temporal evolution, human-nature interactions, and the need for adaptive governance. Emphasis has moved toward frameworks that integrate socio-ecological systems, enabling planners to respond to landscape change, cultural resilience, and environmental pressures. Countries such as the United Kingdom, the Netherlands, and Italy have taken the lead in developing national and regional landscape typologies that inform spatial planning, biodiversity protection, and rural revitalization [2,4]. These typologies support policy formation, heritage evaluation, and the designation of protected landscapes.

Tools like LANMAP and CORINE Land Cover provide the technological basis for transboundary landscape assessment and monitoring, offering harmonized geospatial datasets that support comparative analysis and scenario modeling across Europe [5]. The maturity of these systems has significantly enhanced landscape research in the EU, allowing decision-makers to bridge local and continental spatial scales while promoting the integration of natural and cultural heritage values.
In contrast, the application of LCA in China remains in a formative stage. Most studies focus on ecological or visual factors at a single scale, with insufficient integration of multi-layered human, cultural, and spatial data. Particularly in ecologically fragile and socioeconomically complex environments such as river deltas, these limitations hinder robust assessment and sustainable management. Furthermore, expert-led approaches often lack transparency and standardization, leading to reduced reproducibility and limited scalability in policymaking and planning practices [10].

To address these gaps, this study introduces a hierarchical, geospatially informed LCA framework that combines topographic, land use, ecological, and human activity data across three nested spatial levels: regional, municipal, and site-specific. The construction of Landscape Description Units (LDUs) enables the transition from loosely defined geographic zones to analytically structured landscape spaces. This spatial logic provides a foundation for more precise classification, facilitates decision support, and advances the broader goal of integrated cultural landscape governance.

2. Materials and Methods

To ensure a comprehensive understanding of the cultural landscape structure in the Yellow River Mouth National Park, this study adopted an integrated methodological approach based on multi-scale analysis, spatial technology, and empirical field validation. The research design draws on established practices in landscape ecology and planning while tailoring the framework to the region's geomorphological, ecological, and cultural complexities.

2.1 Study Area and Scale Design

The study area covers 3,522.91 km² within Dongying City, Shandong Province, encompassing Kenli District, Hekou District, and Lijin County. These areas exhibit diverse geomorphological features and land use systems, shaped by both natural processes and prolonged human activity. To accommodate the heterogeneity of landscape features and allow for layered classification, a three-tiered spatial framework was employed:

Regional scale: Centered on the Yellow River Delta High-Efficiency Ecological Economic Zone (~26,500 km²), this level provides a macro view of ecological systems, sediment dynamics, and broad anthropogenic influences.

Municipal scale: This intermediate scale refines landscape analysis within Dongying's jurisdiction. It reflects how administrative boundaries interact with natural features, and aids in identifying dominant land use patterns and cultural typologies specific to local governance and economic function.

Site scale: Detailed spatial and structural investigations were conducted using sample blocks sized 10 km × 10 km and 2 km × 2 km. These samples represent a range of landscape configurations and enable in-depth analysis of micro-patterns, human interventions, and morphological units at the field level.

2.2 Analytical Methods

To capture the complexity and variability of the cultural landscape, the study integrated four core methodological steps:

Spatial overlay analysis: Using ArcGIS, multiple data layers—such as topography, hydrology, vegetation cover, infrastructure, and historical land use—were superimposed to produce a composite spatial model. This served as the initial base for regional zoning and typological inference.

Remote sensing interpretation: Landsat-8 imagery was processed using ENVI software to detect land use dynamics, landscape boundaries, and spectral features. This stage helped refine zoning outputs and distinguish landscape types with higher spatial accuracy.

Landscape type naming and coding: The typological system was informed by Historic Landscape Characterisation (HLC) and LANMAP frameworks, customized to integrate local geomorphic conditions, land utilization patterns, and heritage attributes [3,4]. Each landscape type was assigned a code and descriptor, forming the basis for LCT (Landscape Character Type) development.

Cross-scale mapping: To ensure logical continuity between different spatial levels, the landscape was decomposed into three structural layers: base layer (natural and physical forms), cultural layer (land use and heritage functions), and network layer (roads, canals, and interaction corridors). This hierarchical mapping improved interpretability and cross-level coherence.

2.3 Element Classification and Data Sources

Classified data were tabulated and organized into distinct categories across the three spatial scales (shown in Table 1), with corresponding data sources and processing techniques outlined in Table 2.

Table 1. Classification of landscape feature identification elements at different scales

Element Category	Regional Scale	Urban Scale	Site Scale	
Primary Identification Factors	Landform and Topography			
	Soil			
	Land Use			
			Salt Field Landscape	
			Oil Field Landscape	
			Fishing Landscape	
			Farmland Landscape	
Auxiliary Correction Factors	Terrain Undulation			
	Vegetation Cover			
	Hydrology			
	Geology		Stratum	River Channel
	Climate			Wetland
	Population			Alluvial Deposit
	Spatial Distribution of Villages and Towns			Vegetation
	Settlement Style		Cultural Landscape Layer	Salt Field Landscape
	Industrial Structure			
	Natural Resources			Oil Field Landscape
Descriptive Elements	Aesthetic Perception	Integrity		Fishing Landscape
		Cohesiveness		
		Pattern		
		Scale		Farmland Landscape
		Diversity		
	Perception	Color	Network Layer	
		Sense of Safety		
		Degree of Stimulation		Road Network
		Naturalness		
		Level of Noise		

Table 2. Data sources and processing methods

Identification Element	Data Source	Data Name and Processing Method
Landform and Topography	Geospatial Data Cloud	ASTER GDEM 30M Digital Elevation Model (DEM)
Terrain Undulation	Geospatial Data Cloud	ASTER GDEM 30M; analyzed using ArcGIS spatial analysis tools to extract elevation variation
Soil	Institute of Soil Science, Chinese Academy of Sciences	1:100,000 Soil Database
Vegetation Cover	Aerospace Information Research Institute, CAS	Global 30m Vegetation Classification Product (2020)
Hydrology	World Wide Fund for Nature (WWF) & University of Kassel	Global Lakes and Wetlands Database (GLWD)
Road Network	Open Street Map	Global Road Network Data
Land Use	Institute of Geographic Sciences and Natural Resources Research, CAS; National Environmental Information Center, MEE	2020 Multi-period Land Use/Land Cover Remote Sensing Monitoring Database
Geology	China Geological Survey; Geological Survey of Shandong Province	1:250,000 Geological Structure and Distribution Database
Climate	China Meteorological Administration	Climate Zoning Map of China based on data from 1951–1970 and 1978
Biological Resources	Shandong Provincial Forestry Bureau; Biodiversity Committee of Chinese Academy of Sciences	National Park Planning Data (2021–2035); Global Biodiversity Information Facility (GBIF)
Population	Nanjing Medical University Population & Health Geoscience Center; The Seventh National Census	WorldPop 2020 Global Gridded Population Dataset; Seventh National Population Census Data
Village and Town Spatial Distribution	National Bureau of Statistics; Baidu Map	2023 Urban-Rural Classification and Code Dataset; WGS_1984-adjusted coordinate dataset
Industrial Structure	Shandong Academy of Natural Resources and Rural Planning; Shandong Academy of Agricultural Planning	National Park Planning Data (2021–2035)
Settlement Style	Institute of Traditional Chinese Architecture	Ancient Villages in Shandong (Textual and Visual Records)
Cultural Landscape (Salt Field, Oil Field, Fishery, Agricultural)	Geospatial Data Cloud; National Geographic Resource Platform (Tianditu, Shandong)	Landsat-8 OLI-TIRS Remote Sensing Imagery; cultural landscape interpretation using ENVI and human visual analysis

Landscape elements were defined at each spatial scale based on key thematic variables:

Regional level: Focused on macro-ecological indicators including terrain, soil types, climate

conditions, hydrography, and settlement distribution patterns.

Municipal level: Added socio-economic and historical dimensions, capturing administrative zoning, land use intensification, cultural heritage distribution, and the industrial footprint of the petroleum sector.

Site level: Field investigations provided detailed documentation of land surface features, vegetation texture, infrastructure form, and visible cultural markers, enabling ground-truth validation of satellite and GIS outputs.

Primary data sources included:
Landsat-8 satellite imagery and ENVI classification outputs.
Official land use and development planning documents.
National and provincial geospatial databases.
On-site surveys and photographic records collected during fieldwork campaigns in 2022 and 2023 [6,7].

2.4 Construction of the Multi-Scale Framework

The multi-scale LCA framework was constructed through a structured three-step process:

Desk-based analysis: Initial LDUs (Landscape Description Units) were delineated using overlay analysis and attribute weighting in GIS. These units acted as modular spatial blocks capturing landscape composition and function.

Field validation: On-the-ground investigations were used to adjust boundaries, verify visual character attributes, and select representative LCTs at the site level. Local interviews and photographic surveys supported qualitative refinement.

Typology construction: Based on the verified LDUs, landscape units were classified into standardized LCTs. Each type was characterized by a code, description, dominant features, and cross-referenced with remote sensing and municipal data. This allowed the development of a consistent, scalable typological system aligned with regional planning needs.

This methodological framework ensured robustness, replicability, and spatial alignment across levels, while addressing the challenges of classifying hybrid and transitional cultural landscapes (shown in Figure 1 for workflow)

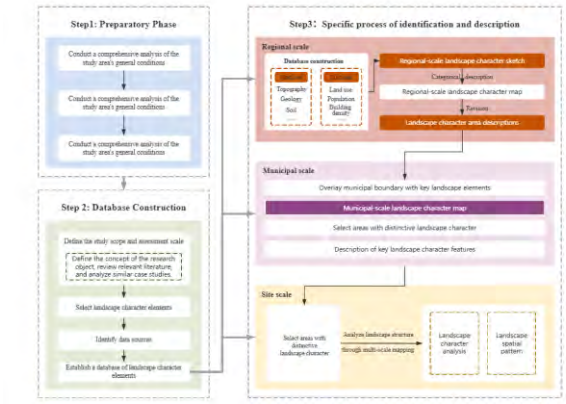


Figure 1. Workflow of the Multi-Scale Cultural Landscape Feature Recognition System

Table 3. Classification and Spatial Distribution of Cultural Landscape Types at the Regional Scale

Primary Landscape Character Area	Secondary Landscape Character Types	Area (km^2)	Proportion (%)
Urban-Industrial Landscape	AaIn31, AaIn32, AaSa51, AaSa53, BbSa51, BbSa53, CcSa53	2252.5	8.50
Village-Agricultural Landscape	AaAn52, BbAn52	2178.3	8.22
River and Wetland Landscape	AaSh41, AaSh42, AaSa43, AaSh45, AaSh46, AaRi99, BbSh43, BbSh46	4886.6	18.44
Plain Agricultural Landscape	AaLu11, AaLu12, AbIn33, AaFe61, AaFe63, AaFe64, AaFe65,	16952.05	63.97

Low Hill and Forest Landscape	AaFe66, AaFe67, BaLu12, BbIn32, BbIn33, BcFe66 AcSl21, AcSl22, AcSl23, AcSl24, BdLu21, BbLu22, BbLu23, BbLu24, BbIn31, CdSl22, CbSl22, CdSl23, CdIn31, CdIn32, CdIn33	230.55	0.87

3. Results

The analytical outcomes from the multi-scale framework illustrate the distinct yet interrelated characteristics of the cultural landscape in the Yellow River Mouth National Park. Through successive refinement across regional, municipal, and site levels, this study identifies typological patterns, structural relationships, and spatial signatures that collectively inform a comprehensive understanding of landscape character.

3.1 Regional Scale

At the regional level, spatial clustering and overlay analysis produced a classification of eleven major landscape types (shown in Figure 2). These include expansive coastal mudflats, dynamic estuarine wetlands, alluvial agricultural plains, saline-alkali zones, industrial complexes, and transportation corridors. Each type reflects underlying geomorphological processes, historical land formation, and broad-scale anthropogenic interventions. Their corresponding areas and proportions are summarized in Table 3.

The coastal mudflats and estuarine wetlands are shaped by fluvial sediment deposition and tidal influences, supporting biodiversity and functioning as ecological buffers. Agricultural plains exhibit structured irrigation systems and long-term settlement patterns, while industrial zones—particularly related to petrochemical infrastructure—indicate concentrated economic activity and environmental transformation.

These typologies form the foundational layer of the LCA system, offering a macro perspective for interpreting transitions and contextualizing finer-scale landscape variation. Their classification enables strategic zoning for ecological protection, land use planning, and cultural heritage inventorying.

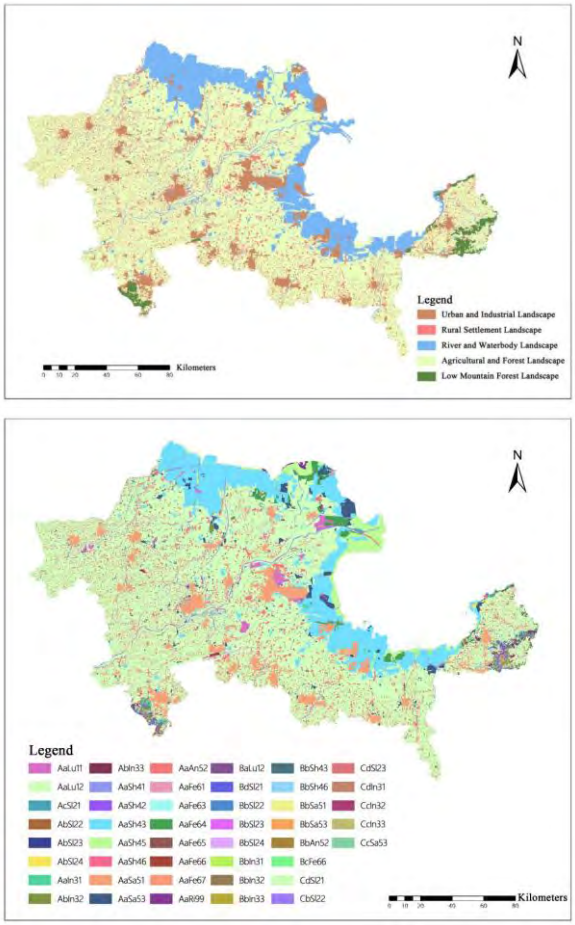


Figure 2. Landscape types at regional scale

3.2 Municipal Scale

At the municipal level, landscape types were refined through remote sensing interpretation and expert visual analysis. A total of fifteen discrete landscape units were identified and grouped into five overarching categories (shown in Figure 3 and Figure 4): resource extraction zones (e.g., oilfields), coastal salt production areas, aquaculture basins, modern agricultural zones, and mixed urban-rural transition areas. The interpretation samples and criteria are listed in Table 4.

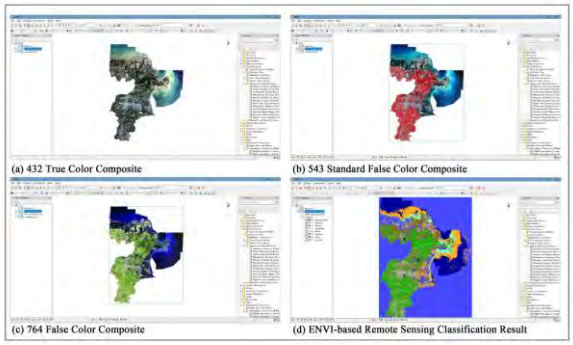


Figure 3. Interpretation process at city scale

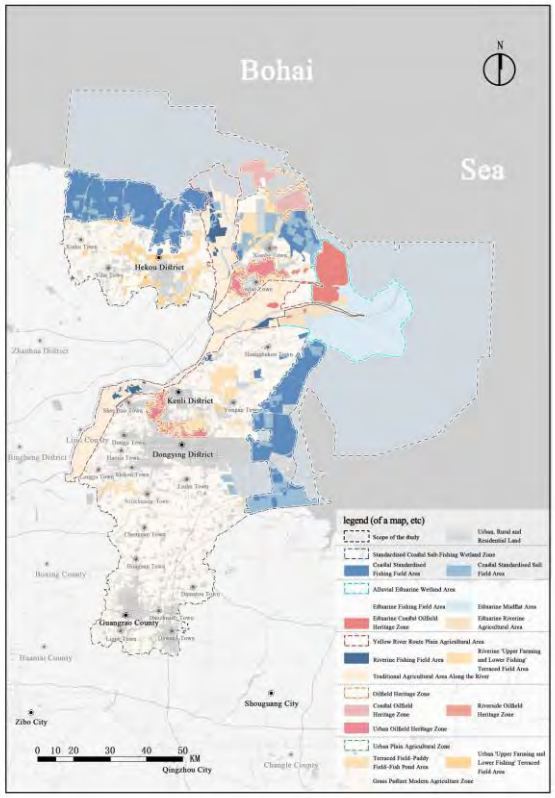
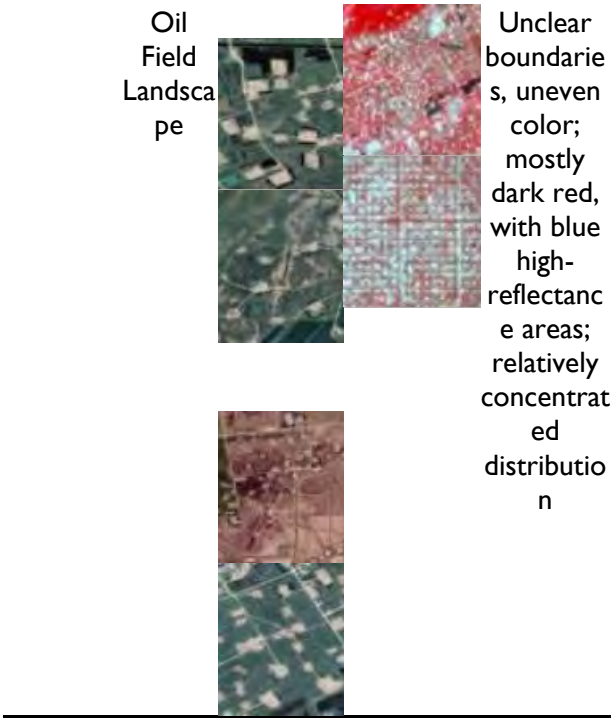


Figure 4. Distribution of cultural landscapes in the city

Table 4. Interpretation samples and the basis of interpretation

Cultural Landscape Type	Feature Element Expression	Landscape Interpretation Sample	Identification Criteria
Agricultural Cultural Landscape	Fishery Landscape		Clear boundaries, uniform color, appearing dark blue; distributed in coastal wetland areas
	Terrace Landscape		Clear boundaries, alternating bright red and dark red; strip-shaped layout; often near built-up areas with concentrated distribution
Industrial Cultural Landscape	Salt Field Landscape		Uneven tone, with highlighted areas; large patch grid layout; mostly along coast



Spatial patterns were analyzed using ArcGIS, with overlays identifying morphological clusters and dominant land use configurations. For example, the salt fields near Kenli display a rectilinear matrix of evaporation ponds and feeder canals, while aquaculture zones show a more organic spatial structure, adapting to microtopography and tidal flows.

Oil extraction zones are distinguished by their infrastructural density, including road networks, derrick fields, and processing facilities, forming visually and functionally distinct units. In contrast, peri-urban agricultural landscapes exhibit fragmentation due to encroaching urban development, reflecting tensions between conservation, production, and expansion.

Validation was conducted through field inspections and photographic documentation, ensuring consistency between remotely sensed classification and on-the-ground conditions. The municipal-level typology thus bridges macroecological structure and micro-scale heterogeneity.

3.3 Site Scale

The site-level analysis provided the most detailed resolution of landscape character. By applying nested spatial analysis to sample areas of 10 km × 10 km and 2 km × 2 km, micro-patterns of land use, built form, and ecological structure were uncovered (shown in Figure 5).

Fishery-dominated sites revealed complex mosaics of rectangular ponds, intersecting canals, access roads, and adjacent rural settlements. These features highlight intricate relationships between livelihood practices, water management, and settlement morphology. Field verification captured not only spatial configuration but also material textures, such as levees, sluice gates, and aquaculture infrastructure.

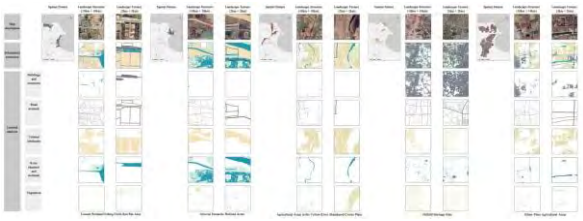


Figure 5. Mapping of landscapes at site scale

In oilfield areas, high spatial density of mechanical structures—pumpjacks, derricks, pipelines—form industrial landscape units with clearly demarcated zones of operation. The visual and structural uniformity of these areas contrasts with more fragmented agricultural zones nearby.

Urban-fringe sites revealed transitional morphologies, characterized by patchy farmland, sporadic housing construction, and road extensions. These landscapes are undergoing rapid change and demonstrate the need for adaptive management policies grounded in real-time monitoring and community participation.

Across all samples, the inherited structure from larger-scale classifications was evident, confirming the continuity and hierarchical layering of the LDU and LCT systems. These findings validate the methodological logic of the framework and provide a detailed basis for future planning, conservation prioritization, and policy implementation.

4. Discussion

The results of this study illustrate a coherent, hierarchical spatial logic underpinning the cultural landscapes of the Yellow River Mouth National Park. The findings confirm that distinct processes dominate at different spatial scales: regional patterns are largely shaped by natural forces such as geomorphological evolution, sedimentation, and

hydrological systems; municipal structures are defined by land use systems, infrastructure development, and industrial zoning; and site-scale features emerge from fine-grained interactions between ecological conditions and human practices.

This layered approach enhances analytical clarity by connecting observable surface patterns with underlying ecological and cultural processes. Unlike traditional LCA methods that rely heavily on expert judgment and static land cover datasets, the multi-scale framework in this study integrates real-time geospatial data, field observations, and cross-scale typologies, thereby increasing reproducibility and accuracy [8,9].

The use of Landscape Description Units (LDUs) and Landscape Character Types (LCTs) provides a systematic way to classify and interpret complex, dynamic landscapes. Particularly in a deltaic environment, where frequent ecological changes and socio-economic transformations occur, a static, one-size-fits-all approach is insufficient. By applying cross-scale mapping that includes base, cultural, and network layers, this study offers a more holistic, responsive understanding of spatial structure.

Moreover, the identification of transitional zones—such as peri-urban agricultural belts and aquaculture-urban interface areas—highlights the need for flexible, forward-looking governance strategies. These zones are most vulnerable to policy shifts, climate variability, and development pressure. Their dynamic nature makes them key targets for conservation buffers, pilot restoration projects, and participatory planning mechanisms.

This study also demonstrates the practical utility of the framework for stakeholders including park managers, urban planners, conservationists, and local governments. By translating spatial analysis into decision-ready typologies, the framework supports scenario modeling, zoning policy, environmental monitoring, and public engagement.

However, several limitations remain. While the current framework captures static and short-term spatial dynamics, it does not fully integrate historical landscape evolution or social memory. The absence of longitudinal data and community-based knowledge restricts interpretive depth. Additionally, while field validation was robust, incorporating participatory mapping and stakeholder narratives would enhance context sensitivity and governance alignment.

5. Conclusion

This research presents a robust, scalable multi-scale Landscape Character Assessment framework for identifying, classifying, and managing cultural landscapes in the Yellow River Mouth National Park. The integration of GIS-based spatial analysis, remote sensing imagery, and empirical field surveys has resulted in a structured system of LDUs and LCTs that accurately reflect the complex interaction between natural processes and human activity.

The framework facilitates precise typological classification across regional, municipal, and site levels, providing a replicable model for deltaic and transitional environments. It supports a move toward spatially explicit, value-driven planning approaches that incorporate ecological resilience, cultural significance, and socio-economic development.

Future research should aim to enhance the temporal dimension of the framework by incorporating historical land use maps, remote sensing time series, and oral histories. The addition of geo-simulation tools could also allow for predictive modeling of land use change, while participatory GIS methods could promote local engagement and policy relevance.

In conclusion, the proposed LCA framework contributes to global efforts in cultural landscape governance by offering a systematic, adaptable methodology suited to dynamic and multi-functional environments. It provides critical support for integrated conservation, sustainable landscape management, and heritage-informed planning aligned with international best practices.

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LIF-T LANDSCAPE IN FOCUS – TOOLS FOR SMALL MUNICIPALITIES FOR SUSTAINABLE LANDSCAPE

TOPIC: Guiding territories by changing the design of regional projects: tools for intervention at different scales, for multifunctional landscapes

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Keywords: landscape, rural areas, capacity building, best practice, climate change

Abstract

Small and medium-sized municipalities across Europe face unprecedented challenges in environmental and landscape management, typically lacking dedicated environmental specialists and landscape architects available to larger urban centres. Municipal leaders in communities with populations up to 5,000 inhabitants experience significant knowledge gaps that impact their territorial responsibility as critical custodians of cultural heritage and ecological health. The LiF-T (Landscape in Focus - Tools for Small Municipalities for Sustainable Landscape) project represents an EU-funded international collaboration among landscape architects from the Czech Republic, Finland, Germany, and Slovakia, designed to address this expertise deficit through developing comprehensive resources that translate landscape-related best practices into implementable actions suited to small municipalities' specific constraints and capacities.

The project employed a systematic dual-output approach: developing 20 inspirational case studies (5 from each partner country) demonstrating successful landscape management practices and creating a comprehensive implementation guide following a "10 x 10 = 100" concept with 100 practical recommendations organized into 10 thematic chapters. Case study development utilized rigorous selection criteria emphasizing long-term sustainability, strategic landscape planning approaches, meaningful community involvement, architectural quality, and demonstrable health benefits. Each partner country created comprehensive databases, conducted site surveys, and performed stakeholder interviews with municipal officials and community representatives. The implementation guide involved collaborative content creation across partner organizations, with each contributing specialized expertise while maintaining consistency through shared editorial frameworks.

Analysis of the completed case studies reveals remarkable diversity in sustainable landscape management approaches. Water management and climate adaptation emerge as the most prevalent challenges, with virtually every case study addressing flooding, drought, or stormwater retention through nature-based solutions rather than purely technical approaches. Community engagement represents a universal success factor, though implementation varies significantly across cultural contexts, from democratically elected Children's Parliaments to volunteer-driven restoration associations. Multi-functional design approaches dominate successful solutions, reflecting resource constraints and integrated thinking that achieves greater impact through comprehensive interventions addressing multiple needs simultaneously.

The project successfully demonstrates that small municipalities possess significant potential for innovative landscape management when provided with appropriate resources and support. Key conclusions indicate that nature-based solutions prove more effective and sustainable than technical approaches, resource limitations can drive innovation when coupled with strategic planning and community engagement, and successful landscape management requires context-specific solutions respecting local conditions while addressing shared challenges. The comprehensive framework developed—combining inspirational case studies, practical guidance, and accessible digital tools—positions small municipalities to implement sustainable landscape practices that enhance both local resilience and broader environmental objectives. This approach serves as a model for supporting environmental governance in resource-constrained contexts while respecting local autonomy and cultural distinctiveness, suggesting that investing in small municipality capacity building yields disproportionate returns in landscape stewardship and environmental protection.

1. Introduction

Small and medium-sized municipalities across Europe face unprecedented challenges in environmental and landscape management, often lacking the specialized expertise and resources available to larger urban centres. Municipal leaders in communities with populations up to 5,000 inhabitants typically operate without dedicated environmental specialists or landscape architects, creating significant knowledge gaps that impact their entire territorial responsibility. These municipalities serve as critical custodians of cultural heritage and play a vital role in maintaining landscape character and ecological health yet face distinct challenges in implementing sustainable and climate-resilient practices.

The LiF-T (Landscape in Focus - Tools for Small Municipalities for Sustainable Landscape) project represents an EU-funded international collaboration among landscape architects from the Czech Republic, Finland, Germany, and Slovakia. This initiative addresses the expertise deficit experienced by small municipalities through developing comprehensive resources that translate landscape-related best practices into implementable actions suited to their specific constraints and capacities.

The project's approach encompasses two main outputs: a collection of 20 inspirational case studies (5 from each partner country) demonstrating successful landscape management practices, and a comprehensive brochure-style step-by-step implementation guide following a "10 x 10 = 100" concept with 100 practical recommendations organized into 10 thematic chapters. This dual strategy recognizes that small municipalities, while often more connected to the open landscape than larger cities, frequently lack understanding of landscape values and contemporary challenges, leading to inadequate approaches in municipal planning and decision-making.

This paper focuses primarily on the systematic development and documentation of both completed outputs, showcasing exemplary landscape management practices across diverse European contexts. The case studies and implementation guide reveal remarkable diversity in approaches to sustainable landscape management while highlighting shared challenges, particularly water management and climate adaptation. With both outputs completed and the web platform structure established, content integration is currently underway to provide a comprehensive framework for supporting small municipalities in implementing sustainable landscape practices, with comprehensive piloting of the platform beginning in August 2025.

2. Materials and Methods

2.1. Project Framework and Partnership Structure

The LiF-T (Landscape in Focus - Tools for Small Municipalities for Sustainable Landscape) project represents an EU-funded international collaboration coordinated by ČAKA Czech Association for Landscape Architecture. The five-partner consortium spans four European countries and includes ČAKA as the lead partner alongside IEPS Institute of European Professional Studies (Czech Republic), SPU Slovak University of Agriculture Nitra (Slovakia), bdla Federation of German Landscape Architects Regional Chapter Saxony (Germany), and MARK Finnish Association of Landscape Architects (Finland). This partnership structure combines academic expertise, professional landscape architecture knowledge, and practical municipal support experience. The project specifically targets small and medium-sized municipalities with populations up to 5,000 inhabitants, acknowledging their critical role as landscape custodians despite facing significant resource constraints and limited access to specialized environmental expertise. The initiative addresses the knowledge gap experienced by municipal leaders who typically lack dedicated environmental specialists or landscape architects on their teams, unlike their counterparts in larger cities. The project's dual-output approach focuses on developing two main resources: a collection of 20 inspirational case studies (5 from each partner country) demonstrating successful landscape management practices, and a comprehensive step-by-step brochure featuring 100 practical recommendations organized into 10 thematic chapters covering topics from strategic planning to funding opportunities. The case study collection and brochure content development have both been completed, with both resources designed for multi-language accessibility through a dedicated web platform.

2.2. Case Study Development Strategy

The project employed a systematic methodology for developing the case study collection, building on collaborative expertise across partner countries and rigorous selection criteria. The case study development process began with extensive literature review and stakeholder consultation, including partnerships with municipal associations, professional organizations, and academic institutions in each country. A standardized template was developed to ensure consistency across all 20 case studies while allowing for local adaptation and cultural context. The selection criteria emphasized five key principles: long-term sustainability of implemented

solutions, conceptual approaches to strategic landscape planning, meaningful community involvement and stakeholder engagement, architectural quality in rural design, and demonstrable health and well-being benefits for residents. Each partner country created a comprehensive database of potential municipalities, conducted site surveys, and performed stakeholder interviews with municipal officials, project managers, and community representatives. The final case studies were structured to include project mottos, detailed annotations, implementation descriptions, and outcome assessments, with content adapted for multi-language web presentation featuring structured text, keywords, and search functionality. This methodology ensured that the selected examples represent diverse yet comparable approaches to sustainable landscape management, providing transferable insights while respecting regional specificities and governance frameworks across Czech Republic, Finland, Germany, and Slovakia.

2.3. Implementation Guide Development

The project's second major output involved developing a comprehensive brochure designed to provide practical guidance for small municipalities seeking to implement landscape-focused sustainable development strategies. The brochure follows a "10 x 10 = 100" concept, featuring ten thematic chapters with ten practical recommendations each, totalling 100 actionable solutions addressing key landscape management challenges. The thematic chapters cover critical areas including strategic planning and development, environmental challenges and climate adaptation, aesthetics and authenticity, land use and economic management, public space reimagining, partnership building, population dynamics, funding opportunities, long-term care and maintenance, and landscape architecture integration. Each chapter combines introductory awareness-building content with specific interventions scaled to municipal capacity, relevant case study examples, and cross-cutting matrices showing interconnections between different challenges. The brochure development process involved collaborative content creation across partner countries, with each organization contributing expertise in specific thematic areas while maintaining consistency through shared editorial frameworks. The content was designed for accessibility to both municipal representatives and general public audiences, avoiding technical jargon while maintaining professional rigor. The brochure structure enables flexible usage - readers can either follow the complete sequence or focus on chapters most relevant to their immediate needs. Integration with the web platform allows for multi-language accessibility, search functionality through keywords and topics, and dynamic linking to related case studies, ensuring the brochure serves as both standalone guidance and gateway to broader project resources.

3. Results and Discussion

3.1. Completed Case Studies Analysis

The collection of 20 case studies across Czech Republic (5), Germany (5), Finland (5), and Slovakia (5) reveals a rich diversity of approaches to sustainable landscape management in small municipalities, representing a broad spectrum of community scales from very small rural villages to medium-sized municipalities. The analysis demonstrates both shared challenges and remarkably diverse solution pathways across different European contexts.

Water management and climate adaptation emerges as the most prevalent and urgent challenge, with virtually every case study addressing flooding, drought, stormwater retention, or water system restoration through nature-based solutions rather than purely technical approaches. Sophisticated examples include Kirchbach's restoration of twelve interconnected ponds creating a functioning ecosystem, Židlochovice's 13-hectare flood park combining protection with recreation, Keuruu's comprehensive catchment restoration addressing brownification and extreme weather events, and Vlčany's integration of rain gardens with underground water reservoirs. These interventions demonstrate evolution from reactive flood protection toward proactive water retention and reuse strategies that provide multiple ecosystem services.



Figure 1. Kirchbach, pond restoration (photo: Steffi Schüppel)



Figure 2. Keuruu, water system restoration (photo: Elina Nystedt)

Community engagement and participatory planning represents a universal success factor, though implementation approaches vary significantly. Heinsdorfergrund's democratically elected Children's Parliament exemplifies innovative governance structures, while Nadějkov's volunteer-driven landscape restoration through two civic associations demonstrates grassroots environmental stewardship. Neratov's integration of social services with community development shows how vulnerable populations can become active contributors to landscape management. The contrast between top-down municipal leadership (Mšeno's mayor-driven transformation) and bottom-up citizen initiatives (Zálesie's civic association projects) illustrates diverse pathways to community mobilization.



Figure 3. Heinsdorfergrund, activities of the Children's Parliament (photo: Sylvia Staudte)



Figure 4. Neratov, cultural heritage preservation (photo: Ben Skála)

Heritage preservation integrated with contemporary adaptation characterizes many interventions, revealing sophisticated approaches to balancing cultural continuity with modern needs. Kirchbach's conscious decision against settlement expansion while enhancing ecological value preserves the Waldhufendorf structure, while Kostelní Lhota's church restoration combines monument conservation with community space creation. Radefeld's 800-meter village green preservation demonstrates how historical landscapes can accommodate contemporary recreational needs through careful planning and community engagement.

Multi-functional design approaches dominate successful solutions, reflecting resource constraints and integrated thinking. Vlčany's park squares simultaneously address stormwater management, cultural heritage presentation, and community gathering needs. Heinsdorfergrund's school grounds function as educational laboratory, ecological habitat, and community recreation space. Erlbach-Kirchberg's village square transformation combines water management, children's play areas, and parking solutions in a single intervention. This pattern suggests that rural municipalities achieve greater impact through integrated solutions rather than single-purpose projects.

Innovative adaptive reuse and material strategies appear frequently, demonstrating creative approaches to limited resources. Moravské Lieskové's granary transformation into an environmental education center, Mosel's baroque manor house conversion to tourism facility, and Neratov's comprehensive village restoration all exemplify how historical structures can accommodate new functions while preserving cultural value. Tradi-

tional building techniques and local materials feature prominently, from Brdárka's mudbrick house restoration to Zálesie's wooden promenade design harmonizing with natural settings.



Figure 5. Zidlochovice flood park (photo: municipality archive)



Figure 6. Vlcany, multifunctional square design (photo: Attila Toth)

Economic sustainability strategies reveal remarkable diversity and innovation. Tourism development approaches range from Taipalsaari's sustainable nature trail design to Koštelní Lhota's award-winning comprehensive village improvement attracting new residents. Social enterprises like Neratov's sheltered workshops demonstrate how landscape restoration can integrate with social services. Agricultural innovations include Krásne Sady Mlynica's permaculture-based ecovillage development and Brdárka's cherry orchard restoration supporting sustainable food production.



Figure 7. Taipalsaari, sustainable nature trail design (photo: goSaimaa)



Figure 8. Brdarka, conceptual planting and tree care (photo: Vladimir Baran)

Educational integration and knowledge transfer patterns emerge across multiple case studies, suggesting growing recognition of landscape projects' pedagogical potential. Heinsdorfergrund's school-centered approach, Moravské Lieskové's demonstration garden, Hausjärvi's ecosystem hotel concept, and Finland's accessible trail development all incorporate learning components that enhance project sustainability and community engagement.

Governance and leadership diversity spans from charismatic individual leaders (Kostelní Lhota's mayor, Neratov's priest-founder) to institutional partnerships (Keuruu's multi-stakeholder water management) and entirely volunteer-driven initiatives (Nadějkov's landscape restoration associations). This variety suggests that successful landscape management can emerge from different governance configurations when aligned with local context and community capacity.

Multi-level governance and regional connectivity demonstrates how local landscape projects can simultaneously address community needs while contributing to broader environmental and policy objectives. Keuruu's catchment restoration exemplifies true cross-scale coordination, with three municipalities collaborating on water management that addresses local flooding while contributing to national water quality goals and EU environmental directives. Several projects leverage multi-level funding and partnerships, such as Vlčany's water retention measures supported by EU structural funds, or Neratov's restoration combining local community efforts with national heritage programs and international pilgrimage networks. The achievement of national and international recognition by projects like Kostelní Lhota's European Village Renewal Award or Kirchbach's Entente Florale success demonstrates how exemplary local landscape management can inspire policy development and knowledge transfer across broader networks. Additionally, projects addressing transboundary challenges—such as climate adaptation, biodiversity conservation, and cultural heritage preservation—show how small municipality initiatives contribute to larger-scale environmental resilience while maintaining their distinctly local character and community ownership.

This comprehensive analysis reveals that successful landscape management in small municipalities requires context-specific solutions respecting local conditions, cultural values, and community capacity while addressing shared challenges of climate adaptation, demographic change, and sustainable development. The diversity of approaches provides a rich repository of transferable strategies and innovative solutions for municipalities facing similar challenges across Europe.

3.2. Implementation Guide

The comprehensive brochure has been successfully completed, representing a significant milestone in the project's knowledge transfer objectives, with content development finalized across all ten thematic chapters. The collaborative content development process successfully engaged all four partner organizations, with each contributing specialized expertise while maintaining consistency through shared editorial frameworks and standardized templates. The "10 x 10 = 100" structure has proven effective in organizing complex landscape management topics into accessible, actionable guidance, with chapters ranging from fundamental strategic planning and environmental challenges to specialized topics like funding strategies and long-term maintenance approaches. Each chapter integrates multiple knowledge sources, combining theoretical foundations with practical interventions, relevant case study examples, and cross-cutting matrices that illustrate interconnections between different landscape challenges. The content successfully balances professional rigor with accessibility, avoiding technical jargon while maintaining substantive guidance for municipal decision-makers and community leaders. The brochure's flexible structure allows users to either follow sequential guidance or focus on immediate priority areas according to their specific needs and circumstances. The integration strategy with the web platform has been finalized, ensuring multi-language accessibility, search functionality through keywords and topics, and dynamic linking between brochure content and related case studies. Quality assurance processes involving cross-partner review and expert consultation have strengthened content validity and practical applicability. This comprehensive resource positions the project to deliver substantial value to small municipalities seeking practical guidance for sustainable landscape management, with the brochure serving as both standalone reference material and gateway to broader project resources.

3.3. Preliminary Insights and Lessons Learned

The case study development process has revealed several important insights about sustainable landscape management approaches across European contexts. Cross-cultural variations in governance and implementation emerged as a significant factor, with German municipalities demonstrating strong institutional frameworks for heritage preservation and systematic planning, Finnish projects showcasing innovative approaches to accessibility and nature-based tourism, Czech examples highlighting community-driven restoration initiatives, and Slovak cases emphasizing creative funding strategies and adaptive reuse of agricultural infrastructure. Methodological challenges in case study selection highlighted the complexity of defining "small municipalities" across different administrative systems, leading to the adoption of flexible population criteria (up to 5,000 inhabitants, in some cases even more) while prioritizing demonstration of replicable good practices over strict demographic parameters. The universality of water-related challenges across all partner countries suggests climate adaptation should be central to any landscape management framework, while the diversity of community engagement strategies indicates that successful participation requires careful adaptation to local cul-

tural contexts and existing social structures. Resource mobilization patterns vary significantly, with some municipalities leveraging EU programs effectively while others depend on local partnerships and volunteer contributions, suggesting the need for diverse funding guidance. The importance of individual leadership emerges consistently, whether through mayors, community activists, or institutional champions, indicating that sustainable landscape management often requires dedicated advocates who can maintain long-term vision and coordinate complex partnerships. These preliminary findings suggest that while challenges are shared across European rural contexts, successful solutions require careful attention to local governance cultures, resource availability, and community capacity.

3.4. Platform Development and Accessibility

The project's digital platform structure has been established, with content integration currently underway and self-assessment tools in development. The development strategy emphasizes comprehensive accessibility and multi-language functionality to ensure broad usability across diverse European municipal contexts. Multi-language implementation involves complete translation of all 20 case studies and brochure content into Czech, Finnish, German, and Slovak, enabling local stakeholders to engage with materials in their native languages while maintaining consistency in structure and messaging. Search and navigation functionality has been designed to incorporate sophisticated keyword and topic-based systems, allowing users to locate relevant case studies and guidance based on specific challenges, approaches, or municipal characteristics. The platform architecture supports dynamic cross-referencing between case studies and brochure chapters, enabling users to move seamlessly between theoretical guidance and practical examples. User interface design prioritizes intuitive navigation for non-expert users, including municipal officials with limited technical expertise, while maintaining professional presentation standards appropriate for policy and planning contexts. Content structuring utilizes standardized templates and consistent formatting to ensure comparable information across all case studies, with clear headings, comprehensive keyword tagging, and visual documentation supporting accessibility for diverse learning preferences. A self-assessment tool is being developed to help municipalities evaluate their current landscape management approaches and identify priority areas for improvement, providing personalized guidance pathways through the available resources. Technical accessibility features address varying levels of digital literacy among target users through straightforward navigation, responsive design for different devices, and downloadable resources for offline use. The platform serves as the central hub for all project outputs, supporting both immediate practical application and ongoing knowledge exchange among participating municipalities and stakeholders across the partner countries.

4.0 Conclusions

The LiF-T project has successfully developed a comprehensive framework for supporting sustainable landscape management in small municipalities across Europe, addressing critical knowledge gaps that have historically limited environmental governance in resource-constrained communities. Through the systematic analysis of 20 diverse case studies and the development of practical implementation guidance, this research demonstrates both the urgent need for specialized support and the remarkable potential for innovative landscape solutions in small municipal contexts.

The case study analysis reveals that successful landscape management in small municipalities is characterized by several key principles that transcend national boundaries while respecting local cultural and governance contexts. Water management and climate adaptation emerge as universal challenges requiring immediate attention, with nature-based solutions proving more effective and sustainable than purely technical approaches. The evolution from reactive flood protection toward proactive water retention strategies that provide multiple ecosystem services represents a fundamental shift in thinking that small municipalities can implement despite limited resources.

Community engagement emerges as the critical success factor, though its implementation varies significantly across cultural contexts. The diversity of approaches—from democratically elected Children's Parliaments to volunteer-driven restoration associations—demonstrates that meaningful participation requires careful adaptation to existing social structures and local governance cultures. The contrast between top-down municipal leadership and bottom-up citizen initiatives illustrates that successful landscape management can emerge from different governance configurations when aligned with community capacity and local context.

Multi-functional design approaches dominate successful solutions, reflecting both resource constraints and sophisticated integrated thinking. Small municipalities achieve greater impact through com-

prehensive interventions that simultaneously address water management, cultural heritage preservation, community gathering needs, and economic development. This pattern suggests that resource limitations can actually drive innovation when coupled with strategic planning and community engagement.

The project's methodological approach, combining detailed case study documentation with practical implementation guidance, proves effective in translating complex landscape management concepts into accessible, actionable resources. The "10 x 10 = 100" structure successfully organizes diverse landscape challenges into manageable guidance that respects varying levels of expertise and resource availability among municipal officials. The digital platform's multi-language functionality and dynamic cross-referencing capabilities ensure broad accessibility while maintaining professional standards appropriate for policy and planning contexts.

Cross-cultural analysis reveals distinct patterns in governance and implementation approaches that reflect broader European diversity while highlighting shared challenges. German institutional frameworks for heritage preservation, Finnish accessibility innovations, Czech community-driven initiatives, and Slovak creative funding strategies collectively demonstrate the value of collaborative knowledge exchange across national boundaries. This diversity provides a rich repository of transferable strategies that municipalities can adapt to their specific circumstances.

The project's innovation lies not only in bridging expertise gaps but in demonstrating how small municipalities can contribute to broader environmental resilience while maintaining distinctive local character and community ownership. Examples of multi-level governance coordination show how local landscape projects can simultaneously address immediate community needs while contributing to national water quality goals and EU environmental directives. This scaling effect multiplies the impact of local initiatives and demonstrates the strategic importance of supporting small municipality landscape management.

Several implications emerge for policy development and professional practice. First, sustainable landscape management in small municipalities requires flexible support frameworks that accommodate diverse governance cultures and resource availability rather than standardized solutions. Second, the universality of water-related challenges suggests that climate adaptation should be central to any landscape management framework, with nature-based solutions prioritized over technical approaches. Third, the critical importance of individual leadership indicates that capacity building should focus on developing local champions who can maintain long-term vision and coordinate complex partnerships.

Future research should explore the long-term sustainability of implemented solutions and their replication potential across different European contexts. The project's digital platform provides an infrastructure for ongoing knowledge exchange and monitoring that could support longitudinal studies of landscape management effectiveness. Additionally, the self-assessment tools being developed offer opportunities for comparative analysis of municipal capacity building and decision-making processes.

The LiF-T project ultimately demonstrates that small municipalities, despite structural constraints, possess significant potential for innovative landscape management when provided with appropriate resources and support. The comprehensive framework developed through this research—combining inspirational case studies, practical guidance, and accessible digital tools—positions small municipalities to implement sustainable landscape practices that enhance both local resilience and broader environmental objectives. This approach serves as a model for supporting environmental governance in resource-constrained contexts while respecting local autonomy and cultural distinctiveness.

The success of this initiative suggests that investing in small municipality capacity building yields disproportionate returns in terms of landscape stewardship and environmental protection. As climate change intensifies pressure on rural communities, the tools and approaches developed through the LiF-T project provide essential resources for building resilience while maintaining the distinctive character and community ownership that characterize Europe's diverse small municipality landscape.

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RESILIENCE RESTORATION AND SYMBIOSIS OF POST-INDUSTRIAL VULNERABLE ECOSYSTEMS IN SALT LAKES VIA THE PHILOSOPHY OF MINIMAL INTERVENTION

TOPIC: Guiding territories by changing the design of regional projects: tools for intervention at different scales, for multifunctional landscapes

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Abstract
The salt lake is the end of the lake's life cycle, but the beginning of lithium batteries. The prosperity of new energy vehicles promotes the development of brine lithium ore, which is more environmentally friendly than the ore method, but it still needs a large area of salt pan and a large amount of fresh water consumption,This is causing an unpredictable ecological crisis to the extreme environment, resulting in the cost of clean energy being transferred to the development site[1].

Rich lithium salt lake distributed in arid high altitude inflow basin, such as desert or plateau, rely on limited fresh water resources and seasonal supply, a few species can adapt to the extreme environment, the food chain is usually not more than three nutritional level (such as: salt -algae brine -birds), excessive exploitation or climate change (such as precipitation) easy to cause water level, salinity, cause ecological collapse and extremely difficult to recover. For example, the Atacama Salt Lake, the world's largest lithium resource lake, has dropped by 30 meters due to mining, and the food chain at the top of the flamingos has collapsed. The ecological impact of Zabye Salt Lake, located in the third pole of the world, is temporarily controllable, but in the early stage The factories and salt pans that produce lithium carbonate occupy the area of meadows and salt lakes, squeezing the grazing area of herdsmen and the lake living space of halophilic bacteria and algae. The salinity of the lake and soil rises dramatically, threatening the characteristic plateau plants and the organisms in the lake[2].

In this regard, landscape designers practice the concept of minimum intervention, dividing the area in the north of the North Lake to carry out large-scale cultivation of "halophilic microorganisms", and use spring water and river supply to support the aquaculture industry chain[3]. At the same time, the industrial relics are reverse utilized to recycle the salt fields around the North Lake as the gradient salinity pool to maintain the optimal survival salinity of halophilic microbial communities ($g \cdot L^{-1}$)[4]; recycle the illegally excavated soil to build the isolation barrier. In the transformation of the territory, solar thermal power stations for new technology will replace cow dung to provide heat source for herdsmen. "cow dung" may be used as economic fertilizer for soil improvement and train local herdsmen to participate in the collection and construction. According to the landscape design, the herdsmen should participate in the multi-industry economy, reshape the herdsmen's belief in the land and lake water, and form a positive feedback cycle of "economic incentive-resource protection-cultural identity". Participate in brine insect breeding, become part of historical memory; participate in soil improvement and ecological zone construction, consolidate the belief of water god; act as a guide, excavate and connect potential scenic spots and set up restricted areas to protect fragile landscapes. Landscape may be able to transform industrial violence into a resilience

carrier of eco-social-cultural symbiosis through multi-scale tools, providing a restoration paradigm for other salt lakes around the world.

Text

1. Introduction

Salt lakes mark the end of a lake's life cycle but the beginning of lithium-ion battery production. Currently, the development of salt lakes is facing an ecological paradox amid the global energy transition. Lithium-ion batteries power electric vehicles to achieve zero emissions of carbon dioxide, nitrogen oxides, and particulate matter, and are widely regarded as a green and clean energy source. However, the costs of raw material extraction are being shifted to extreme regions—80% of the world's lithium-rich salt lakes are located in arid, high-altitude, inland basins (such as the Qinghai-Tibet Plateau and the Andes Mountains). These regions' ecological fragility and water scarcity create natural constraints. Taking the Zabuye Salt Lake in Tibet as an example, its “Solar Pond” process achieves zero-carbon lithium extraction (at a cost as low as 15,000–20,000 yuan per ton), but it has triggered secondary crises such as water level decline, salt imbalance, and the collapse of unique halophilic biological chains. This study proposes a minimal intervention regeneration framework, integrating industrial heritage resource utilization, ecological chain integration, and cultural capital conversion to establish the first “socio-ecological” symbiotic paradigm for high-altitude salt lakes, providing a replicable pathway for over 80 potential lithium-development salt lakes on the Qinghai-Tibet Plateau.

1.1. Global Lithium Market Growth

The proliferation of new energy vehicles has driven a surge in lithium demand, exacerbating ecological pressures on salt lakes. According to Statista, global demand for lithium is projected to reach 2.4 million metric tons of lithium carbonate equivalent by 2030, double the forecast for 2025. Due to the rapid development of new energy electric vehicles and mobile energy storage devices, lithium has become a strategically important asset prioritized by nations worldwide, with lithium geological resource exploration emerging as a focal point [5].

1.2. Global Lithium Mineral Distribution and Resource Endowment

Currently, industrial-scale lithium extraction primarily occurs in salt lake-type and hard rock-type lithium deposits, with salt lake-type extraction being the most energy-efficient and cost-effective method[5]. China's lithium resources in salt lake brine are estimated at approximately 5.87 million tons (calculated as lithium oxide), far exceeding solid lithium ore reserves, ranking third globally, primarily distributed in provinces such as Qinghai and Tibet[1] (see Figure 1). Currently, China's lithium production still primarily relies on hard rock lithium mines; however, compared to brine-based lithium extraction, this mining process consumes more resources and energy and has drawbacks in terms of resource utilization, environmental impact, and economic viability. Therefore, conducting research, exploration, and investment in salt lake brine-type lithium deposits on a global scale holds significant practical and strategic importance[6].

2.The Multiple Challenges of the Zabuye Salt Lake

The Zabuye Salt Lake in Tibet has a lake surface elevation of 4,421 meters, an area of 259 square kilometers, and a lithium concentration in the brine as high as 632 ppm, making it the world's highest-altitude and lowest magnesium-to-lithium ratio high-quality carbonate-type salt lake [6]. It is currently the only salt lake in the world where the “Solar Pond process” is used on an industrial scale. The Zabuye Salt Lake has a unique shape, being a north-south oriented structural lake. A northeast-trending hidden fault runs through the lake's central region, creating an ancient calcareous lake island over 20 meters high and sand and gravel deposits that divide Zabuye into southern and northern lakes [4] (see Figure 1). Extremely halophilic bacteria and algae are widely distributed in the northern lake's brine layer, giving the water a light reddish-brown color, making it one of the must-visit spots for tourists traveling westward into Tibet. However, the “white gold fever” for lithium is now surpassing the boundaries of ecological and industrial balance. The costs of clean energy are being shifted to remote development

sites, bringing unpredictable ecological crises, with the local mountains, waters, herders, wildlife, and ecosystems bearing the costs of this “green future.”

2.1.The technological advantages and ecological fragility of the Zabuye Salt Lake

The “solar pond” process essentially leverages the abundant solar energy (annual sunshine hours of 3,651) and low temperatures (annual average temperature of 2.19°C) of the site, along with the characteristic that the solubility of lithium carbonate in water significantly decreases with rising temperatures. This enables the concentration and separation of lithium in the high-temperature zone (＞60°C) at the bottom of artificially constructed solar ponds.

However, these high-quality salt lakes located in regions with high solar radiation, such as the South American Lithium Triangle mining area, the North American Southwest mining area, and the Qinghai-Tibet Plateau salt lake mining area, often simultaneously exhibit characteristics such as aridity, low temperatures, oxygen deficiency, and permafrost, and rely on limited freshwater resources and seasonal replenishment. Taking Zabuye as an example, the solar pond is divided into three layers. The top layer requires the evaporation of a large amount of freshwater to maintain dynamic equilibrium and the long-term extraction of brine to obtain lithium products from the bottom layer. This may lead to groundwater seepage replenishing the salt lake, “Reverse seepage” means that freshwater or slightly saline water originally available for use by the surrounding areas is “sucked” into the salt lake to fill the deficit caused by industrial extraction, leading to a shortage of the most critical freshwater resources upon which the local ecosystem and herders depend for survival.

2.2.Solar pond Encroaching on the Living Space of Wild Animals and Salt Lake Organisms

Current development activities in the Zabuye Salt Lake have already caused explicit harm to local herders and the ecosystem. In June 2022, the Central Ecological and Environmental Protection Inspection Report pointed out: Development companies violated the Mineral Resources Law by illegally extracting 1.784 million cubic meters of soil around the salt lake; they also illegally constructed 1,200 hectares of salt fields and crystallization pools within the lake management area. These projects not only block the natural exchange of lake water but also cut off the traditional migration routes of herders during the dry season; Construction activities, including noise and land encroachment, directly disturbed wildlife such as Tibetan antelopes and black-necked cranes, and damaged high-altitude vegetation with soil and water conservation functions, such as cushion-like point-ground moss and Qinghai-Tibet moss.

Beyond illegal operations, even compliant lithium extraction processes harbor ecological risks: Continuous freshwater extraction disrupts regional water-salt balance, causing surrounding land salinity to surge sharply. This change first causes the death of salt-tolerant vegetation, then destroys the habitats of water birds and ungulates, ultimately triggering a collapse in biodiversity. Herders who rely on wetlands for grazing face the depletion of pasture resources—grassland degradation and water source salinization directly threaten the foundation of their livelihoods. Meanwhile, in the North Lake brine area, which is rich in extreme halophilic bacteria and algae (such as Artemia salina), their activity is now difficult to detect, with traces only visible in lake bottom and shoreline sediments. They may have already begun to disappear due to the drastic changes in salinity, along with the pink hue of Zabuye Lake's water [4].

Particularly concerning is that the Qinghai-Tibet Plateau, as the “Third Pole of the World,” has an inherently fragile ecosystem. Ecological restoration in high-altitude, arid environments may require centuries or an unpredictable amount of time, and the unique cushion vegetation of the region is nearly irreversibly damaged once destroyed. Development activities are transforming short-term economic gains into permanent ecological liabilities.

3. Minimal Intervention Framework: Resource-Driven Regeneration for Socio-Ecological Resiliencee

Post-industrial ecological restoration in extreme habitats faces the significant challenge of fragile ecosystems being susceptible to secondary disturbances. To effectively avoid potential damage caused by the introduction of external materials, landscape designers must adhere to the

core principle of minimal intervention. This requires the restoration process to deeply align with the site's natural succession dynamics and systematically identify and transform the potential value of existing “materials” on the site—including natural limiting factors, industrial waste, and illegal structures—viewing them as usable resources rather than obstacles. This strategy aims to significantly reduce the ecological risks and overall costs of restoration projects. Based on this, the ultimate goal of restoration is to reconstruct a dynamic framework integrating “resource circulation-economic vitality-cultural identity,” thereby fostering a salt lake ecosystem with self-organizing evolutionary capabilities. This system effectively buffers the boundary tensions between industrial zones and ecologically sensitive areas. Building a socio-ecological system where herders participate in benefit distribution, alleviating the environmental and social costs imposed on local herder communities by traditional industrialization models, thereby deeply exploring sustainable pathways for salt lake industrial heritage and life systems to achieve resilient coexistence.

3.1. Timely reconstruction and preliminary zoning planning

Before proceeding with resource recovery and zoning restoration, it is essential to address the existing damage and restore basic services for residents' daily needs.

Prioritize addressing the urgent need for herders to access water during the dry season by clearing the sand dunes in the central part of the salt lake to restore access routes for water collection. Subsequently, to facilitate industrial activities and restoration efforts, reinforce the lake shores and repair sections of the shoreline that have collapsed due to construction or tourist activities. Subsequently, survey geological research resources of historical and tourist value in the surrounding area, and preliminarily protect and isolate sites such as historically significant ancient lake shorelines along the shore, orange-colored salt lake biogenic rock deposits, and foraminifera fossil sites. Some of these will be designated as scenic spots within the tourist zone. Subsequently, preliminarily confirm the locations of abandoned resources and their future relocation sites, and mark the travertine islands within the salt lake to facilitate future construction for targeted soil filling and dam construction.

3.1.1. Tourism Zone Standards and Protection of Vulnerable Scenic Spots

Designate distinctive tourism zones, optimize the layout of scenic viewing areas, and categorize landscapes into scenic types such as “sunset viewing points” and “wildlife observation zones,” potential industrial scenic spots such as “ancient lake shorelines,” “paleontological fossil zones,” and “best viewing points for crystallization pools,” and restricted zones such as vulnerable geological research resources. Integrate attractions and standardize tourism facilities, design signage with routes and access times, and collaborate with the government to provide guide positions for herders, responsible for introducing landscapes to visitors, noting precautions, and regulating visitor behavior to prevent trampling of restricted zones and damage to fragile landscapes.

3.1.2. Possibility Analysis and Design of Microbial Restoration Zones

The halophilic algae living in the salt lake are primarily Chlamydomonas and Dunaliella salina. The latter accumulates extremely high levels of beta-carotene internally under extreme environmental conditions, making it an economically valuable algae species. Their “air carbon fixation” is an important source of carbonate and other substances in salt lakes, and their internal pigments help absorb sunlight to increase brine temperature, giving the northern lake water a light gray-red color with tourist appeal. Restoring their habitats ensures the long-term development of lithium extraction industries and tourism, while also enabling the development of related aquaculture economies to generate multi-dimensional benefits.

Survey analysis confirms that the northern part of the North Lake region has moderate salinity, making it ideal for the restoration of halophilic bacteria and algae. The surface brine has a specific gravity of 1.268–1.275 and a salinity of 300–360 $g \cdot L^{-1}$, with extensive development of extreme red halophilic bacteria and algae. The salt lake is replenished by a large amount of glacial meltwater through rivers and deep-circulating upwellings. Additionally, in the North Lake brine area rich in

salt-loving bacteria and algae, numerous rare travertine island groups have been discovered. These islands exhibit stable cold springs and gas emissions along their fissures, indicating that the North Lake is replenished with a significant amount of CO_2 and other nutrients, as well as freshwater. These islands are composed of over 500 white travertine cones, distributed in a NEE-NE direction within the lake. The island group extends along its length and connects with the Cenozoic volcanic rock area to the east [4].

The suitable brine salinity, the original microbial habitat, and the freshwater and nutrient supply from both external and internal sources provide significant potential for establishing a restoration zone. By leveraging the calcite deposits within North Lake, creatively selecting certain NEE-NE oriented islands as boundaries, and designating their NW-facing sides as microbial cultivation zones, this area will receive freshwater replenishment from western rivers and well-developed springs in the surrounding region, supporting large-scale microbial cultivation.

3.2 Resource Recycling: Industrial Heritage Regeneration and Ecological Chain Integration

3.2.1 Recycling Industrial and Ecological Resources

See table 1 for examples of converting industrial waste and salt field liabilities into resilient carriers to reduce engineering costs, as well as transforming herders' daily heating materials into resilient carriers.

① Part of the salt fields in North Lake are being retrofitted into gradient freshwater storage pools to collect rainwater during the rainy season and surrounding spring water, serving as a water storage facility for rainwater grading and salinity buffering in the wetland restoration area. Once the pool water salinity drops to the suitable range for brine shrimp (50–150 $g \cdot L^{-1}$), introduce domesticated brine shrimp (Artemia tibetiana) from Tibetan highland salt lakes (e.g., Qixiangcuo Salt Lake) into the gradient pools to promote herders' development of sustainable aquaculture economies.

② Recover illegally excavated industrial debris and construct ecological isolation embankments around the calcareous island group to inhibit the exchange between the restoration area and the high-salinity water body of North Lake, ensuring the stability of salinity in the halophilic algae and bacteria restoration area (target range: 200–300 $g \cdot L^{-1}$). This algal-bacterial community also serves as a salinity indicator, enabling dynamic salinity monitoring through microscopic observation and biomass quantification analysis. In the future, salt algae residue enriched with β-carotene will be converted into soil fertilizer and supplementary feed for livestock.

③ Purchase cow manure from herders and compress it into ecological building materials for reinforcing embankments and shorelines; Simultaneously leverage its high nutrient content (total nitrogen 0.38%, humus 14.9%). After composting, mix it with salt-tolerant grass seeds (e.g., Tibetan sagebrush Artemisia wellbyi, Chinese flat-spike grass Blysmus sinocompressus) and apply to saline-alkali areas to accelerate soil structure improvement and grassland ecological restoration.

3.2.2. Wind-Driven Embankment: Feather Infill for Cost-Efficiency

Preliminary analysis of the dominant wind direction, internal water movement, and island locations in Zabuye Lake indicates suitability for simulating the Dutch “soft sand beach” sand engine scheme, thereby accelerating embankment evolution and reducing labor costs and mechanical disturbance.

The Zabuye region experiences prolonged and intense winds. According to statistics from 1991 to 2000, the annual average wind speed is 4.5 $m \cdot s^{-1}$, with maximum annual wind speeds ranging from 14 to 35 $m \cdot s^{-1}$, and the most frequent wind directions are WSW and SSW. During the rainy season from August to October, the predominant wind direction is SSW, while in other months it is WSW (see Figure 2) [3]. These wind directions accelerate water evaporation on the northeastern shore, so the dykes on the northeastern side of the salt-tolerant algae and bacteria restoration area require additional reinforcement to prevent salt diffusion into the restoration zone.

Construction should be carried out during calm months (e.g., September to December), with the fill soil shaped into an open feather-like structure that interlocks. The fill soil should be distributed along the fissures in the direction of the calcareous

island's extension in the restoration area, with a SW-N orientation, and the ends connected to the northern shore, isolating the northwest corner of North Lake as the restoration area[7]. To prevent soil from being directly blown away, SW-oriented soil filling is placed in the southern gaps of the islands, while N-oriented soil filling is placed in the western gaps. Different directions of filling are applied to different segments of the island chain, allowing the soil to naturally diffuse into the target structure under wind direction (see Figure 3).

This design will transform perceptions of natural risks, leverage wind's influence on construction, and ensure long-term dike protection objectives. The dike's evolutionary process will also be witnessed by new herders, who will participate in shaping the collective historical memory.

3.3. Allocating Responsibilities and Benefits: Establishing a Dual-Track Economic Model for Research and Community Development

In accordance with the principles of resilient development, a dual-track economic model centered on researchers and supported by herders has been established to ensure the sustainable development of industrial and ecological restoration efforts.

① Technical Monitoring Team: Led by scholars and equipped with advanced technology, this team trains herders to become technical workers responsible for preliminary construction, soil improvement, grassland restoration, and water quality testing in restoration areas. As ecological compensation, the company is responsible for providing equipment and basic wages, and a portion of annual profits is injected into the team to maintain its basic operations and prevent the exploitation of herders' labor value. Meanwhile, the government implements ecological performance-linked policies, such as granting corresponding tax incentives to the company when water quality and grassland restoration areas in the restoration zone reach different proportions.

② Herder Cooperatives: Fully operated by herders, retaining 100% of profits, responsible for tourism services, cow dung procurement, and salt algae e-commerce, providing herders with diverse job opportunities and additional income sources.

Activities such as shoreline reinforcement, restoration zone construction, breeding, and guiding will serve as tangible carriers of faith. Through participation, herders can deepen their understanding of the land and lake, reshape their faith in the land and lake, co-create history, and enhance their sense of community pride. These processes increase ecological conservation awareness among both enterprises and residents, forming a positive feedback loop of “economic incentives-resource protection-cultural identity.”

4. Summary

To restore ecological damage caused by industrial activities in extreme environments, landscapes should adhere to the principle of minimal intervention. Through multi-scale tools, industrial violence can be transformed into resilient carriers of ecological-social-cultural symbiosis, providing a restoration model for other salt lakes worldwide.

①Designate tourist zones, restoration zones, and geological protection zones outside industrial areas. Identify sites for microbial restoration zones based on site salinity and freshwater supply conditions.

② Reorganize local resources: reconfigure industrial relics (salt fields) into gradient salinity pools; convert illegally dumped soil into isolation embankments; use cattle dung as building material bricks.

③ Utilize natural resources such as strong winds: design feather-shaped interconnected embankment structures based on the dominant wind direction (WSW-SSW) to accelerate natural embankment formation, reducing time and labor costs.

④ Engage residents in a dual-track circular economy model by establishing an ecological restoration team and a herders' cooperative. Ensure that corporate profits are invested in the restoration team to rebuild the local ecosystem, and distribute the benefits of the lithium industry to herders based on labor contributions. Ensure that herders have 100% control over cooperative benefits, driving annual per capita income growth while restoring faith in the salt lake.

This framework can be adapted to global high-evaporation-type salt lakes (Atacama Salt Lake),

low-biological-type salt lakes (Uyuni Salt Lake), and tourism-driven salt lakes.

Guidelines

1. Figures (3-5) and Tables (3-5)

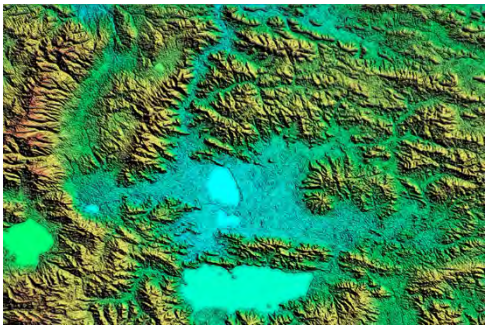


Figure 1. Satellite Image of Zabuye Salt Lake.

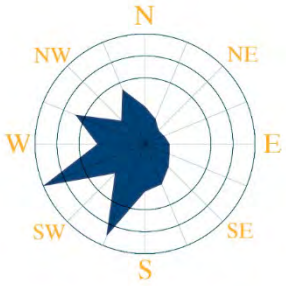


Figure 2. Wind Rose Diagram of Zabuye Salt Lake.

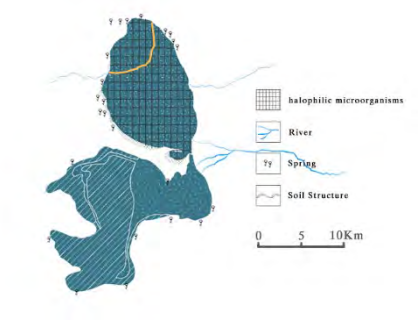


Figure 3. The location of the dam in Zabuye Salt Lake.

Table 1. Write your table caption here.

2. Equations

All equations must be centred and numbered flush right, using Arabic numbers in brackets. Variables must be italicised and clearly defined in the text.

The following equation (Eq. 1) is an example:

$$E_1 = E_f V_f + E_m (1 - V_f).$$

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Acknowledgments

Due to my own limitations, the article lacks quantifiable data in economic and engineering aspects, such as the annual profit ratio invested by enterprises into cooperatives and the implementation model of the sand engine. Additionally, due to the extreme conditions of the region, I was unable to conduct on-site investigations into the erosion of local herders' beliefs regarding lake water and mountains, hence this section has been omitted from the article. Regarding the restoration of the Zabuye Salt Lake, my approach is as pragmatic as possible, though its effectiveness remains uncertain. Therefore, I only hope that this paper may inspire even one practitioner to turn a bolder vision into reality, thereby fulfilling its purpose.
Special thanks to:
Yu Zhang for the inspiration regarding the cost of lithium mining, Jiaying Yan for suggestions on the research framework, and Fang for the review and encouragement.

References

The accuracy of the references in the paper is under the full responsibility of the Author/Authors of the paper. All publications cited in the text should be referred to by a number in square brackets, [1,2,3].

The full reference **(maximum 10 references)** should be given in a list at the end of the paper according in the following format / ISO690 / International standart for bibliographic elements :

[1] 孟广寿, 2008. 矿石提锂与盐湖卤水提锂将并存发展. 世界有色金属, (2), pp.67-69.\

[2] 李昱昀, 狄晓亮 and 高洁, 2005. 国内外盐湖卤水锂资源及开发现状. 海湖盐与化工, 34(5), pp.31-35.

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THE THIRD LANDSCAPE- EXPLORING THE SEAM BETWEEN METROPOLIS AND MOTORWAY

TOPIC: Guiding territories by changing the design of regional projects: tools for intervention at different scales, for multifunctional landscapes

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Abstract
The following abstract deals with how to approach landscapes in the urban fringe and what role, among other things, green open spaces get when densification takes place in these territories.
Two municipalities have been studied, situated in growing metropolitan regions, in different parts of Sweden with different landscape characteristics. The projects have a common vision- that that future districts should ensure livability and sufficient access to recreation, with areas that can also contribute to biological diversity and climate adaptation in terms of stormwater management. Yet, the current areas in Sundbyberg and Burlöv are characterized by large and dominant infrastructure systems. This consists mainly of motorways, which cause both noise and pollution.

The transport infrastructure prompts physical and mental boundaries that reinforce the feeling of an urban fringe and raises questions about what qualities can exist in the area and what kind of opportunities there are for place-making. The study is based on two overarching problems. The first concerns place-making, and addresses issues linked to the complex nature of urban boundaries in particular. This is largely about our perception of past landscapes and existing qualities, which in turn can create an ambiguity in terms of identity, cultural anchoring and future predictability. These issues become particularly pressing for areas sandwiched between large-scale infrastructures, where previously undeveloped land has become an urban waiting room.

The second question deals with the possibility of green outdoor environments in a dense urban landscape. This complexity is not unique to developing periurban areas but is a universal problem when densification is progress. At the same time, the metropolitan fringe present special conditions where the open green space can function as a steppingstone between the inner city and the surrounding countryside, where, for example, natural and cultivated land exists. The study starts off from the presumption that biodiversity is already on the agenda but that the recreational values need more attention. A conclusion from our study is that this zone of territorial transformation “The Third Landscape” is a resource for creating a seam between the city and the highway. A place where more activities and affordances could take place if there was a fruitful collaboration between the Swedish Transport Administration, the municipalities and the inhabitants. Conclusions suggest that the European Landscape Convention could be activated on different scales and planning phases and thereby provide for continuous collaboration and development of ecosystem-services.

Further the study and the undertaken partnership project recommends that the border-zones could be designed with nature-based solutions in general and with nature like plantings in particular, providing noise mitigation, recreation, water retention and biodiversity.

1 Introduction

The study was made as a partnership between two municipalities of Burlöv and Sundbyberg, researchers at the Swedish University of Agricultural Sciences and the national authorities for Transport and The Built Environment. The project started as a question to the University, if we could help to compile knowledge about the landscape of the urban fringe next to the motorway. These zones had an unclear identity and were expected to provide open green spaces in the ongoing municipal zoning plans. Yet at the same time, they were buffer-zones from the highway, where regulations for the road side were not helpful in achieving a municipal vision of a border zone for recreational activities. The starting point for the participating stakeholders was to gain knowledge and identify aspects that could serve several purposes. The primary concern of the researchers was to select and compile research that would be relevant for the stakeholders. They also facilitated the partnership process and produced a report which translated was named; There is a town here! - possibilities for public green space, place and identity in a dense urban fringe.

1.1 Method

During a period of two years the project group convened through online meetings and site visits. The process was designed to understand preconditions, identify research questions, outline the challenges of the stakeholders and compile knowledge on relevant topics. The output from the project was described in a report of thematic descriptions and guiding conclusions for further development and maintenance. (Deak Sjöman, Wade 2024)
Participants included Landscape Architects and Urban planners from the municipalities of Burlöv and Sundbyberg. The Swedish Transport Administration was represented through a Landscape Architect, a Transport Planner, a specialist on Ecology and Environment and a specialist on Nature management. The Swedish authority of the Built environment participated through a Landscape Architect. Finally researchers from the Swedish University of Agricultural Sciences were involved with different areas of expertise including Nature-based solutions, urban forestry, soundscape design and sensory masking, governance of green spaces and landscape-adaptation of transport infrastructure.
The partnership project was designed with a series of workshops as follows.
Ws 1 Define and understand preconditions for the Case-study areas and the stakeholders.
Ws 2 Identify challenges and constraints in the Case- study areas. After this step two main topics were identified to compile relevant research: 1, Place making and identity in an urban fringe and; 2, Open green spaces in a dense edge. A draft was shared with the participants before the next workshop.
Ws 3 Compilation of research was discussed and a conclusion was to look further into a typology of natural plantings. These could serve several purposes and could be studied in real life.
Ws 4 Site visits to three sites where the participants experienced different levels of noise, different landscaping and different densities of planting in nature like plantings. The visited sites included the case area in Burlöv, a large noise berm (> 10 meters high and 200 meters long) and finally the forested and dynamically designed areas of the Landscape laboratory in SLU, Alnarp, next to the railway. The laboratory is described in the book Woods go Urban 2023, edited by Busse Nielsen, A. Diedrich, L et al.
The project was concluded in a report also giving guidance on how to work with identified aspects on site-specific, local/ municipal and regional level.

1.2 Research question

How can a zone instated to separate landscapes develop and be designed to accommodate several assets that provides ecosystem services? And what questions need to be addressed in research to overcome the obstacles of general practice?

1.3 Deliminations

The scope of the partnership project was broad within the two topics of 1,Place making and identity in an urban fringe and 2, Open green spaces in a dense edge, ending in a specific result of nature-like plantings being able to provide ecosystem services. This was primarily adressing the first research question about design. In this paper however, we are focusing on the latter part of the research question: What questions need to be addressed in research to overcome the obstacles of general practice?

Looking at the project as a whole, including the partnership process and the compiled research, we have found it interesting to frame this paper through the European Landscape convention.

2 A study of the seam between motorway and metropolis

The two sites share similar preconditions in that they are located in small municipalities in the expanding metropolises of Stockholm and Malmö-Copenhagen. They are both planning new residential districts next to an existing motorway and have claims on the urban fringe for recreational purposes. This is however, a different agenda than the Highway maintenance at the Swedish Transport Administration, who is responsible for upholding the transport. The following sections in this chapter layout the challenges of the case studies and contextualizes them in relation to relevant research.

2.1The sites and their challenges

The Case studies demonstrate a conflict of interest in land-use. In the undertaken project, two workshops were held with stakeholders in 2021 to 1, understand the preconditions and 2, discuss challenges and delimit issues to be explored in the compilation of research. (Deak Sjöman, Wade 2024, p 43-45)

From the discussions the following challenges and considerations were identified;

> Urban development acknowledges the need for open green space within the masterplan yet both municipalities saw potential in also incorporating the border to the motorway to design it to provide for a *more informal green space*.

> *A longitudinal perspective* (i.e. recurring over a longer period of time) is necessary to opt for multi-functionality and flexibility to prevailing needs over time.

> Large and dominant infrastructure characterizes the landscape through noise annoyance and the sharp boundary it creates to the surroundings. There should be a possibility to mitigate the visual barrier effect with sight lines and earth modeling to announce the "place", define its identity and to *visually connect the two the landscapes of the town and the road.* se figure 1.



Figure 1 The urban periphery in Sundbyberg and Burlöv where the municipalities expected to design the areas to provide recreation.Photo H. Blanck

> In the context of land scarcity, there should be a common aim for the stakeholders to provide for the *creation and maintenance of ecosystem-services*. what plans or existing cooperation can be

used or developed to provide this possibility in the future?
> Considering the characteristics of these zones, what affordances are reasonable to offer the citizens? Is a noisy area close a motorway good enough for recreation and what *design would support both biodiversity and recreational values and provide a safe place*?

2.2 Understanding the Third Landscape

The Third Landscape as mentioned by Clement 2003, is an impediment between landscapes full of purpose. Certain conditions apply in these linear zones next to a highway. The presence of movement causes pollution from noise, light and particles from cars. These transitional landscapes are located on the urban fringe. They create a new ecological network yet their potential for recreation seems under estimated.

2.2.1 Sense of place in the urban fringe

The edge of the city is an elusive space.
Why are peri-urban areas so hard to define? These areas have appeared between growing cities, large roads and agricultural land, se figure 2. We may perceive them as complex, containing the promises of something new and the end of what we know. They are areas that may be described as a ”phase” rather than a “place” (Qviström 2007). These patches and lines, following the roads, are they a quantity of undecided spaces, devoid of function and lacking a name? (Clement 2003) Because of its vague nature, its unclear function we may tend to mirror these spaces to comfortable definitions, the city or countryside. But from the perspective of the pastoral rural we may be disappointed or confused by the urban fringe. A perception truer to its identity, would be to acknowledge these peripheral zones as being “rich, contradictory and dynamic landscapes” (Qviström, Saltzman 2006). Places where spontaneous activities such as gardening, cross biking exist next to industrial estates. Some activities are ongoing, like the constant flow of vehicles on the motorway. Others are temporary like occasional recreational visitors or a pop-up business. This may in turn lead to socially fragmented landscapes since different users exist within the same territory, often with conflicting interest. (Allen, 2003). This is the case with the partnering municipalities in this study. (Deak Sjöman, Wade 2024)

2.2.2 The European Landscape Convention

The European landscape convention (ELC) defines that a landscape is as perceived by people and a result of natural and artificial elements and actions. Perhaps the mundane qualities are overlooked in the visionary planning yet are meaningful to the inhabitants. (COE Council of Europe, 2000) To democratize landscape, planning suggest collaboration of different stakeholders, but the Conventions gives little guidance how this could be organized. (Jones, Stenseke 2011). Our study shows that the ELC works different ways for the authorities at different levels.
The Swedish legislation requires public consultation in different stages of the planning process, but the ELC is not explicitly referred to, when motivating public involvement. The municipalities in Sweden are solely responsible for landuse planning and manage the process of making zoning plans. They accommodate the public perspective through public participation in the planning process. Public consultation is also incorporated in the day-to-day enhancement or restoration of public open space. The main objectives of the zoning plan, such as housing, schools, roads and parks are presented as elements to be consulted about in the plan. However, the buffer zones are mostly the concern of municipal officers, who in our Case-studies are the ones to argue for the recreational and biodiversity potential of the zones along the highway. A reason for wanting to use these zones for recreation in the Case studies is scarcity of public open space in new zoning plans. In Sundbyberg the ecological potential in the new development was also highlighted when the municipality made an ecosystem-service assessment.

The Swedish Transport administration is responsible for planning, constructing and upholding the stately roads and railways. The Authority employ specialists like Ecologists, Landscape Architects and Cultural Heritage experts beside a large number of technical- and maintenance staff. The Transport Administration has incorporated the ELC in guidelines for Landscape adaptation and uses the methodology of Integrated Landscape Character Assessment (Noborn et al.2017) to include the multitude of aspect from different stakeholders and disciplines. The latter is applied during planning and design phases. However, when a highway has entered the governance phase, there is little if none interaction with other stakeholders. From discussions during the workshops and interviews with the participants in the study it was highlighted that aspects concerning biodiversity is adressed during all phases but beside the function of transport, social aspects are left when entering the governance phase. (Deak Sjöman, Wade 2024, p 48-49)



Figure 2 The Case study area in Sundbyberg, Ursvik showing the transitional landscape from 1959 to 2020. Aerial photoes Sundbybergs stad.

3 Conclusions

Returning to the questions of this study, as quoted below, there are three main conclusions explained in the following chapter.

How can a zone instated to separate landscapes develop and be designed to accommodate several assets that provides ecosystem services?
What questions need to be addressed in research to overcome the obstacles of general practice?

3.1 The in between landscape provides possibilities for people and ecosystems

The majority of sources included in the knowledge compilation arrive at the conclusion that development opportunities arise when more than one piece of the puzzle is examined. The landscape represents a mosaic of different occurrences in both physical form and process. With inspiration from Jean Hillier 2007 the peri-urban landscape could be described as ‘Folds’. Unlike the sharp demarcation between city and countryside they are filled with opportunities. ‘Folds’ contains a depth of diversity and complexity that is created in a landscape of changing land use (e.g. industry, housing, farming, transport) and where notions of landscape identity are shaken by the different time depths and speeds of land use (e.g. the speed of the motorway in contrast to the pace of the natural area). ‘Folds’ becomes a cultural parallel to the ‘ecotone’ of ecology, which describes the environment that arises when two biological communities integrate and where unique environmental conditions can arise.



Figure 3 A sensible design and management could provide ecotones and spaces for recreation. illustration E. Wade

Burlöv and Sundbyberg's cases are characterized by motorways, agricultural land, forest areas and existing buildings. Motorways and power lines create a clear cut in the landscape and what can be developed in connection with these facilities requires a certain multi functionality. Based on Cervén's thesis on the different qualities of the soundscape, we can draw inspiration from the idea of partly toning down existing nuisances and partly introducing new elements that enhance the experience and act as a buffer between, for example, motorways and housing. In this regard, green infrastructure is a tangible tool and contributes with multifaceted opportunities and functions in one and the same place. Earth embankments and forest-like stands both dampen and disguise noise, absorb stormwater and wastewater, and become a linear node in the green system. Ecoducts can help break up the motorway barrier and link up surrounding areas to facilitate migratory fauna. How the ecological corridors are designed and which vegetation structures are allowed to grow can contribute to the incorporation of more ecosystem services in addition to animal habitat and dispersal opportunities. The participating partners in the project are working with green spaces at different levels and phases.This is why a nature-like planting was a suggested answer for furthering a multitude of functions in the Third landscape.

3.2 Benefits of the Third landscape in various scales

On a regional level, planned with regional authorities, nature-based solutions and nature-like zones, together with the road network's green corridors, can contribute to a more functioning landscape ecology.

At a municipal level, natural plantings between roads and built-up areas can contribute to multifunctional structures that complement parks and larger natural areas. An inspirational example was found where a municipality has identified these zones and included it the comprehensive plan.

At a local level, natural plantings provide a buffer against the road that reduces negative health effects. Examples of this are that a wooded zone can reduce noise annoyance, filter light and mitigate air pollution. By applying a dynamic designing approach (such as Alnarp's Landscape laboratory) with nature-like plantings the areas can become attractive for play, walks and a diverse wildlife. (Deak Sjöman, Wade 2024)

3.3 European Landscape Convention challenges the present operandum

Observing the process we have found that the intentions of the European Landscape Convention gives a possibility to include the perspective of as perceived by people for the organizations/ stakeholders in the partnership project. It is however, not used as a leaver when the two authorities (State and Municipality) discuss the use and value for the Border zone.

In the study we have observed that the expected interaction between stakeholders, including public consultation, only takes place in the development/ planning phase of a project. The Case studies show that the municipalities are in a planning and design phase, while the Transport Administration (TA) is in a governance phase.

The TA works strategically to enhance biodiversity by managing road sides, constructing fauna passages and fencing to avoid road kill. This does not usually involve stake holder interaction. Social aspects such as recreation and noise mitigation on the other hand, are not included in the responsibility during the governance phase.

A conclusion is that the ELC could be incorporated in the terms of reference for the public authorities in both planning, design and maintenance phases. By doing so there is a potential to create multi-functional zones along the highway, that incorporates ecological, social and economic aspects.

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GENERAL LANDSCAPE PLANS, TARGETED LANDSCAPE PLANS : INITIAL LESSONS IN FRANCE

TOPIC: Guiding territories by landscape method

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Keywords : landscape, plan, territory, project, method

Abstract

Landscape plans have existed in France for over 30 years. They are landscape project-program approaches carried out at the territorial level. They are commissioned by local authorities, most often inter-municipal authorities. They receive financial and technical support from the government. They are carried out by landscape designers, often with specific expertise depending on the topics and territories at stake. They cover all types of territories : urban, peri-urban, rural, coastal, mountainous, etc.

The development of landscape plans is traditionally organized into three phases : a diagnosis, guidelines, and an action program. Their originality lies in the method used, which is completely different from the 20th-century land-use planning and equipment-based approach. This approach, which I call "**the landscape method**," can be summarized in five points :

- It is qualitative and not solely quantitative, also based on perception and not just data.

- It is cross-disciplinary and not sectoral, because landscape, viewed as a common good, concerns and transcends all areas of planning.

- It is participatory and not imposed from above, because landscape is not a reserved technical field.

- It is creative and pragmatic, not dogmatic.

- It is inclusive by bringing together all living things, human and non-human, into a single focus.

Landscape plans result in four types of actions :

- Pre-operational actions : on land that must be controlled, finances to be mobilized, public spaces to be developed, but also private spaces through contractual agreements (with farmers, for example).

- Regulatory actions, by contributing to planning and urban development documents.

- Organizational and facilitation actions : reorganization of governance, human and financial resources for facilitation, training, awareness-raising, and information.

- Actions to improve knowledge through monitoring and observatories, studies, or complementary inventory and research projects.

For the past five years, **thematic landscape plans** have been developed to apply the landscape method to targeted issues : the energy transition, the restoration of biodiversity. Perhaps tomorrow we will finally see agricultural landscape plans, which are crucial for the ecological transition.

Two main improvements remain to be made to landscape plans to enhance their effectiveness :

- Associated human resources for facilitation with landscape plans.

The State, regions, and departments would benefit from supporting the creation of landscape project manager positions in local authorities with landscape plans during the first years of implementation.

- Associated dedicated financial resources with landscape plans.

A tax with a very broad base (any action that transforms the living environment would be contributory) and a tiny (painless) rate makes it possible to have a "sewing machine" to act outside the companies of each operational project and to weave links between the existing context and the new thing - whatever it may be.

Text

1. Origins in France

In Europe, landscape planning probably originated in the Netherlands, a country that planned by culture and necessity due to its small size, population density, economic dynamism, and exposure to risks (marine submersion). The Randstad Holland spatial plan dates back to the 1950s : urban development of the cities of Rotterdam, The Hague, Amsterdam, and Utrecht jointly, around a vast central agricultural and natural space, the "groen haert" (green heart).



Figure 1. Randstad Holland Plan (source : www.jeroenfritz.com)

In France, landscape plans were born in the 1980s and 1990s in the Vosges Mountains (eastern France), around a specific issue. In this mid-mountain region, decades of rural exodus led to the abandonment of farmland. The landscape of inhabited valleys closed in, either through natural forest dynamics or through spruce replanting, when it did not become more diffusely urbanized. Towns and villages then found themselves enclosed by woods, losing light, open spaces, and visual connections with neighboring villages. It is therefore to reopen environments, views, and perspectives that landscape plans have historically been implemented, with some success over time : in the Bruche Valley (1991-93), in the Saint-Amarin Valley (Wesserling, 1994), in the « Vallée de la Plaine » (1995) and in the valleys of what today constitutes the Hautes Vosges community of communes. These successes, always fragile but enduring, illustrate the ever-sustainable and societal nature of landscape initiatives, which are simultaneously environmental (reopening of areas), economic (revitalizing agricultural management), and social (rebuilding connections between villages and between stakeholders and residents). They give meaning to our active and sensitive relationship with the world : the gradual reclamation of pride, socio-economic dynamics, biodiversity, and even attractiveness, despite the context of crisis (deindustrialization, population decline).

In 1992-93, the government initiated several experimental landscape plans in other territories and on more general themes, mobilizing the French landscape architects Jacques Sgard, Alexandre Chemetoff, Alain Mazas and Alain Marguerit. The tool was made official in 1995, in the wake of the Landscape Law of 1993. For over 30 years, landscape plans have been implemented on an ad hoc basis throughout France. They are now supported annually by calls for projects from the government to local authorities. Having been producing landscape plans since those early days, I produced the first national methodological guide for developing landscape plans in 1998-2001, at the request of the Ministry of Regional Planning and the Environment (now the Ministry of Ecological Transition) (1\{Folléa2001}).

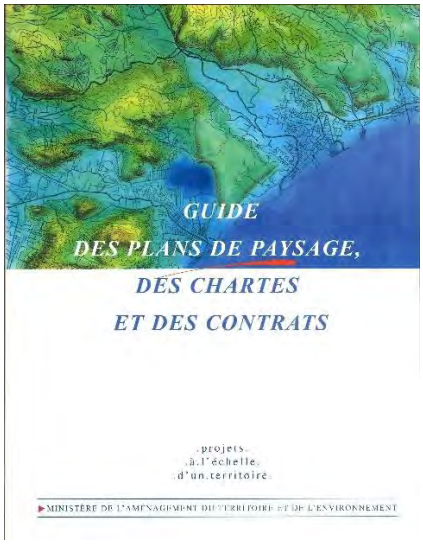


Figure 2. First national methodological guide to landscape plans, charters and contracts
(Ministry of Regional Planning and the Environment, Bertrand Folléa, 2001)

Since then, numerous experiments have taken place across the country and other methodological publications have been published. The Folléa-Gautier agency (landscape architects) has produced more than thirty of these over the past thirty years.

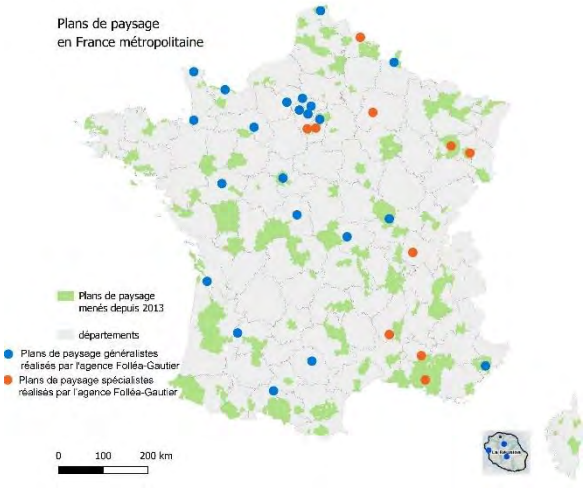


Figure 3. Situation of Landscape plans in France (source : Pierre-Louis Bodet, http://journals.openedition.org/paysage/34857 + agence Folléa-Gautier)

But what is a landscape plan ?

2. Landscape plans : project-programs for territorial quality

Landscape plans are landscape project-program approaches carried out at the territorial level. They are commissioned by local authorities, most often inter-municipal authorities, sometimes municipalities, or sometimes several communities of municipalities within a single territory or grouped under a single Territorial Coherence Plan (SCOT). They receive financial and technical support from the French government (currently : the Ministry of Ecology, the French Agency for Ecological Transition (ADEME), and the French Office for Biodiversity (OFB). They are carried out by landscape architects, sometimes with specific expertise depending on the topics and territories involved (ecologists, agronomists, energy engineers, sociologists, urban planners, etc.). They cover all types of territories : urban, peri-urban, rural, coastal, mountainous, etc.

3. Supporting the Metamorphosis of Our Living Environments

The central idea of the landscape plan is as follows : our living environments have been changing dramatically and rapidly since the end of the Second World War, thanks to widespread and massive access to powerful, abundant, and cheap fossil fuels : a shift to agro-industry and the radical simplification of rural landscapes, soil, air, and water pollution, the disappearance of animal life, land abandonment, the destruction or devitalization of old town centers, the emergence of large housing developments, the standardization of architecture, the parachuting of seaside and mountain resorts, the shearing of infrastructure, the sprawl of urbanization, the disfigurement of our city entrances, the rise of individualism, and the disintegration of social ties. Our contemporary landscapes are the expression of our relationship with a world caught in the great acceleration of the Anthropocene.

Protectionist defense of the landscape alone is ill-suited to the period of ecological transition we are currently engaged in. It is not, in fact, a question of preserving these "oil-soaked"

landscapes. In France, truly protected areas only concern around 3% of the national territory : these are the areas which, for the most part, have escaped the powerful upheavals mentioned above : national parks, listed sites, nature reserves. For the remaining 97%, on the contrary, it's about supporting their transformation into sober, carbon-free, resilient, and vibrant landscapes. The landscape plan is this program, a collective project for a living environment that is chosen, not imposed (2\{Folléa2019}).

But how do we go about it?

4. The landscape method

The development of landscape plans is traditionally organized into three phases : a diagnosis, guidelines (the "landscape quality objectives" provided for in the European Landscape Convention and reaffirmed in France in the ALUR Law (2014) and in the 2016 Law for the Reclamation of Biodiversity, Nature, and Landscapes), and an action program. The originality lies in the method, which is completely different from the 20th-century planning and infrastructure approach. This approach, which underpins landscape plans and which I call "the landscape method," (3\{Folléa, Gautier2019}) can be summarized in five points :

4.1. It is qualitative and not merely quantitative, also based on perception and not just data.



Figure 4. Concertation on site (Landscape plan for Albigeois, agence Folléa-Gautier, 2016)

Collective, on-site landscape readings facilitate the expression of a shared subjectivity expressed through the shared recognition of landscape values. These exchanges aim to move from impression to expression : expressing one's impressions is a process, carried out both through words and images. The values expressed and illustrated serve as a foundation : on this basis, transformation processes can be critically analyzed. Do they enhance or devalue the living environment? Values can also serve as sources of inspiration for further landscape enhancement. At the inter-municipal level, reading tours most often take place via a bus route, punctuated by stops, with surveys and meetings with stakeholders who share their expériences : here a mayor, there a farmer, there a renewable energy developer, there a natural or cultural heritage management association, etc. When developing the action plan, some better-equipped landscape plans can zoom in on specific sites, chosen because they represent significant or representative issues. They then benefit from "walking projects" : the tours are completed on foot ; the assessment and then the intentions are partly carried out on site. To foster a direct connection with the sites, we have sometimes created landscape plans for which all meetings (steering committees, technical committees, workshops, etc.) were held outside, with everyone carrying their own folding stool.

4.2. It is cross-cutting and not sectoral, because landscape, viewed as a common good, concerns and transcends all areas of planning : buildings, architecture and housing, urban forms and public spaces, agriculture and forestry, natural environment management, mobility, heritage, tourism, energy, economic activities, etc.

Meetings and workshops do not separate planning stakeholders by confining them to their strict areas of expertise ; on the contrary, specialists meet, discuss, and work together on landscape issues that focus attention on the margins of their activities ; this is the whole point of what I call relational landscape, which focuses attention on the relationships between things (humans, space), rather than on the things themselves. This is how many landscape problems are brought to light and resolved, whereas sectoral planning approaches leave them

in the shadows and do not address them. For example :
o The relationship between agricultural fields and residential neighborhoods, to reduce nuisances (noise, dust) and risks (plant protection treatments, crop degradation, difficult access to plots, etc.) ;
o The relationship between new residential neighborhoods and the town center, to strengthen local life, for example by creating pleasant and direct pathways between new homes and schools, shops, and services ;
o The relationship between farmers and residents, to rebuild social ties, through direct sales sites, events, and educational trails ;
o The relationship between businesses, to develop short and local supply chains, economic ecosystems, producers of bio-geosourced materials and their users, generating meaningful landscapes; o The relationship between natural spaces and living spaces, by creating not only "green and blue" frameworks (intended for biodiversity) but more generally landscape frameworks (intended for the relationship between humans, biodiversity and living environments): green framework of natural and forest spaces, blue framework of water, but also agricultural spaces, public spaces, edges (interfaces between environments), soft continuities, views and perspectives ;
o The relationship between the city entrance road and commercial and craft activity sites, by redeveloping high-quality reception and work spaces : de-impermeable, revegetated, shaded, open, optimized for land use, self-producing and consuming their own electricity, etc.;
o The relationship between buildings and water spaces, to restore wetlands, riparian forests, flood expansion zones, pathways and amenities, and reduce flood risks ;
o The relationship between the natural site and the reception of tourists and visitors, to reduce visitor pressure, wear and tear on spaces, the presence of bus and car parks, advertising and signs, and to better showcase the landscape, ecological, and heritage qualities of the area ;
o Etc.

4.3. It is participatory and not imposed from above, because landscape is not a reserved technical field.



Figure 5. Involvement of elected officials, technicians and residents (territorial workshop in Martinique, Agence Folléa-Gautier, 2017)

Everyone is sensitive to their living environment ; everyone is an "expert" as a user or daily resident. Listening to and recognizing the user, technician, and elected official, their involvement in the creation of the landscape plan, in the field, in workshops, and through their testimonials, are the surest guarantees of ownership of the results and the hope of their implementation. This role of the landscape architect as mediator has developed considerably over the years ; it can take a wide variety of forms: site visits, field surveys, stakeholder testimonials, debates, workshops based on serious games, maps, charts, quizzes, and questionnaires, participatory projects to garden the street, make furniture, or design a space, performances, etc. Depending on the level of expectation, it may justify the use of sociologist skills, particularly for surveys and participatory activities, but also artists. The role of mediator does not replace that of designer, which must be able to continue to exercise its role as a priority, proposing ideas for spatial transformations expressed in drawings, diagrams, maps, plans, sections, perspectives, and costed action plans.

4.4. It is creative and pragmatic, not dogmatic.
Ideological or dogmatic, sometimes political, stances often hinder the dynamics of debate. The

landscape method, by being anchored in the very concrete reality of spaces to be preserved and managed, adapted and transformed, helps to overcome these obstacles. Some landscape plans advantageously provide for the joint design, on the ground, of planned actions in the form of costed and phased program outlines; this anchoring in operational reality is an effective means of gaining the support of elected officials and partners for the approach. Creativity can be expressed in action proposals; It also greatly enriches mediation programs that encourage the involvement of residents, planning stakeholders, and elected officials: storytelling walks, thoughtful walks, game workshops, drawing workshops, writing workshops, drawing workshops, co-construction projects, etc.

4.5. It is inclusive by considering all living things : human and non-human.

Following the lead of anthropologist Philippe Descola, researchers from multiple disciplines have taught us the extent to which conceptualizing nature as separate and distanced from the human condition can generate destruction. Yet traditional approaches to planning continue to address ecological and social issues separately, in separate chapters or sections, created by unrelated professionals. The landscape method does not distinguish between humans and non-humans. Through its threefold relational dimension (ecological, cultural, and social relationships), it encompasses in a single concept the interrelationships that make up the territory (ecological relationships), the uses, perceptions, and representations (sensitive and cultural relationships between population and territory), and the social exchanges between humans (what psycho-sociologists call connection). It is through this holistic conception of relationships that the landscape approach can skillfully manage the respective aspects of ecological and social relationships, according to the sensitivities of the environments, but without thinking exclusively.

5. Results of landscape plans

Landscape plans are not enforceable regulatory documents. Both local authorities and professionals consider this apparent weakness of authority to be an advantage. Elected officials are indeed wary of regulations. Landscape plans are not "another constraint" but rather project-based approaches, which they can use to develop an overall vision that gives meaning to their political actions. Regulatory translation is only one way out of these programs.



Figure 6. Documents from the Albigeois landscape plan (agence Folléa-Gautier, 2016)

Experience shows that landscape plans lead to four types of actions :

5.1. - Pre-operational actions : these can prepare the land that needs to be managed, the finances to be mobilized (taxes, subsidies, etc.), the public spaces to be developed (outline programs, specifications), but also private spaces through contractual agreements (with farmers, for example).

5.2. - Regulatory actions, by contributing to planning and urban development documents: territorial coherence plans (SCOT), inter-municipal or municipal local urban plans and development and programming guidelines, sectoral plans such as climate plans, travel plans, local housing plans, territorial food projects, etc.

5.3. - Organizational and facilitation actions : reorganization of governance, human and financial resources to facilitate the process, training, awareness-raising, and information.

5.4. - Actions to improve knowledge through monitoring and observatories, studies, or complementary inventory and research projects.

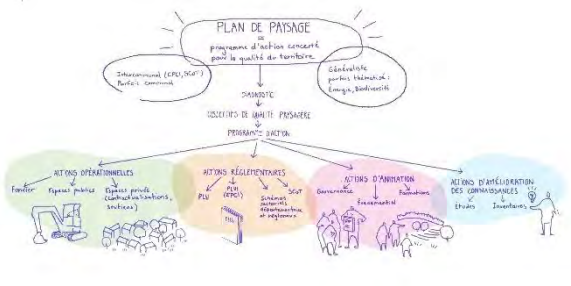


Figure 7. Four types of actions with landscape plans (source : Agence Folléa-Gautier, landscape architects)

In total, landscape action programs can be overwhelming, as landscape concerns all areas : urban planning, housing, architecture, cultural heritage, natural environments and biodiversity, agriculture, food and forestry, water, mobility, energy, tourism, economic activities, etc. They can therefore die of obesity, at the bottom of a pile of forgotten files. To address this problem, a few points of vigilance must be integrated :

- A major effort is needed to identify and coordinate sectoral policies, identifying existing actions, stakeholders, and tools to better identify gaps and propose necessary additions.
- Actions must be costed so that they can be integrated into budgets and programming schedules. - Effective and realistic prioritization must also be carried out in close consultation with elected officials, so as to adapt programs to the necessarily limited timetables and human and financial resources of local authorities. This implementation strategy is crucial to making landscape plans credible and operational.

6. Development Outlook

In recent years, public authorities have strengthened the scope of landscape plans, making them explicitly relevant to the ecological transition. Based on initial experiments conducted by the Landscape and Energy Chair (located at the École nationale supérieure de paysage de Versailles since 2015) (4\{ENSP2015}), the French Agency for Ecological Transition (ADEME) is supporting the development of landscape plans for the energy and ecological transition (PPTEE). These plans are specifically dedicated to energy, in order to integrate the development of renewable energies, as well as energy efficiency, into the frameworks and lifestyles of the French people, in a planned and coordinated manner (5\{ADEME2024}). More recently, the French Office for Biodiversity has supported the creation of landscape and biodiversity plans (tested by the Haute Vallée de Chevreuse Regional Natural Park in the 2010s) (6\{PNR HVC-Folléa-Gautier2011}), in order to facilitate the adoption of measures in favor of living things in all development operations.

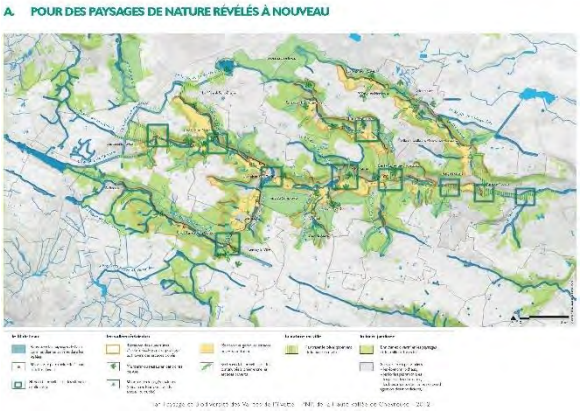


Figure 8. Extract from the first landscape and biodiversity plan (Parc naturel régional de la Haute Vallée de Chevreuse, agence Folléa-Gautier, 2012)

In addition to landscape and biodiversity plans, the Folléa-Gautier agency has experimented with innovative landscape plans dedicated to combating and adapting to climate change (7\{CDC Hautes Vosges-Folléa-Gautier2021})., as well as to urban edges (8\{Métropole Aix Marseille Provence-Agence Folléa-Gautier2023}).





Figure 9. Extracts from the first climatic landscape plan (Communauté de communes des Hautes Vosges, agence Folléa-Gautier, 2020)

We will undoubtedly see the emergence of landscape plans for the agricultural transition in the future, given the major socio-economic challenge for farmers, but also for the population as a whole, with biodiversity, food, water, health, energy, land management and its amenities at stake.



Figure 10. Extract from the first urban edges landscape plan (Métropole Aix Marseille Provence, Agence Folléa-Gautier, 2023)

Two main improvements remain to be made to landscape plans to enhance their effectiveness :

6.1. Combine human resources with landscape plans.

When the landscape architect develops the landscape plan, the intensity of discussions is high, linked to the involvement of stakeholders. When the landscape architect leaves, a void arises if the landscape plan is not embodied by one or more facilitators, ideally and at a minimum, a duo of elected officials and a local authority technician. Because implementing the action program is complex, particularly due to the cross-cutting - and therefore marginal -nature of landscape in the sectoralized administrative and financial structure that prevails in the world of planning : stakeholders' attention must constantly be shifted to make landscape a central objective. The organization of governance is key to improving this cross-cutting approach : the facilitator should be positioned in a cross-cutting role alongside the departmental management, rather than being marginalized in an environmental department office. The State, regions, and departments would benefit from supporting the creation of such landscape project manager positions in local authorities with landscape plans.

6.2. Associate dedicated financial resources with landscape plans.

At the crossroads of multiples areas of planning, landscape suffers from a marginal position that makes it the poor relation of sectoral policies. Considerable energy must be expended by local authorities to assemble disparate resources from dispersed funding sources. It is therefore necessary to establish financial resources specifically dedicated to the landscape, to allow landscape plans to materialize more easily and quickly. This is also one of the recommendations of the think tank “La Fabrique Ecologique” in one of its recent notes devoted to the landscape (9\{La Fabrique écologique2024}). One solution would be to consider that any action that "emerges from the ground," small or large, modifies the landscape. As such, each must contribute to supporting this evolution : the highway and the nuclear power plant, of course, but also the garden shed and the roundabout ; and between these extremes, all the housing developments, houses, business buildings, transport and travel infrastructure, energy equipment—whether for production, transport, or storage—tourist structures, etc. This very broad base would allow for the application of a very low, painless rate. In addition to operational

engagement, the tool would have the merit of constituting a "sewing machine," which is currently lacking. Each stakeholder operates within the strict framework of their controlled land use, without intervening beyond that. Yet this is also where action is necessary, to forge links between the existing context and the new development - whatever it may be - and to integrate harmoniously into a given environment.

Bertrand Folléa

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MOUNTAIN LANDSCAPE VISUAL PERCEPTION PATTERNS: A GEOTAGGED IMAGE ANALYSIS OF CHONGQING'S TWO RIVERS AND FOUR BANKS

TOPIC: Guiding territories by changing the design of regional projects: tools for intervention at different scales, for multifunctional landscapes

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Keywords: visual perception, mountain landscape, GEO-tagged photos, spatial distribution analysis

Abstract

The natural urban landscape is associated with residents' physical and mental well-being as well as the quality of life. Public perception research of these landscapes is increasingly important, particularly where urbanization compromises their integrity and aesthetic value. While most studies focus on visual quality assessments and perceptual preferences of urban landscapes or green spaces, different landscape types affect perception at various scales. Therefore, conducting further analysis on a specific landscape typology is essential for understanding the mechanisms that affect public natural perception.

Mountain landscapes, as a distinct category of natural urban landscapes, offer multiple perceptual layers and angles due to their topography. Particularly in mountainous cities, the interplay between mountain landscapes and urbans becomes more intricate, which brings richer perception. In Asia, due to the cultural influences, urban development needs to consider the spatial configuration of adjacent mountainous areas. Therefore, mountain landscapes represent the local characteristics in urban culture and spatial. Moreover, Asia has some of the most densely built urban regions, which can obstruct sightlines, rendering other natural landscapes invisible. Therefore, mountain landscapes serve as one of the few natural landscapes available for public viewing.

However, literature on the visual perception of mountain landscapes remains limited. Challenges include: (1) most research is confined to rural or protected areas with little focus on urban mountain landscapes, and (2) while some studies use perceptual imagery to assess the impact of different elements, few examine visual perception from a spatial perspective.

This research aims to understand the spatial distribution patterns of public perception in mountain landscapes and explore the underlying causes by collecting geotagged image data. We focus on the core area of the Two Rivers and Four Banks in Chongqing, China. As a typical mountainous city, Chongqing's main urban area contains over 40 mountain bodies. The combination of high-density buildings and mountain landscapes forms the city's overall appearance, making it a representative case for visual perception studies of mountain landscapes. The research plan involves: (1) collecting and filtering image data from social media platforms such as Flickr, Two Steps, Rednot, and Weibo that reflect Chongqing's urban landscape; (2) analyzing the image content using DeepLab V3+, an image semantic segmentation method, to quantify the proportions of various elements and determine correlations with mountain landscape perception; (3) using geotag data in ArcGIS to spatially visualize mountain perception points and discern public perception patterns.

Results indicate that perception points are mainly concentrated around historic urban quarters and landmarks (e.g., bridges, skyscrapers), exhibiting a point-like distribution with low continuity. Visual

attention along riverside roads is minimal. The low perception of mountain landscapes can be attributed to factors such as mountain invisibility, poor traffic accessibility, lack of cultural support, and insufficient facilities. These findings suggest that urban landscape planning should promote a continuous, integrated perceptual experience that highlights the cultural significance of local mountain landscapes.

Text

1. Introduction

Urban natural landscapes are fundamental components of urban ecosystems, contributing significantly to sustainable urban development, fulfilling public aesthetic needs, enhancing residents' well-being and quality of life, and promoting human health and welfare[1]. However, widespread urbanization has led to the encroachment of natural spaces in cities, posing threats to the integrity of urban ecosystems and diminishing both their ecological and aesthetic values . This also results in limited opportunities for residents and visitors to experience and engage with nature. Accordingly, it is crucial to conduct perception-based studies of urban natural landscapes from the perspective of the public.

The European Landscape Convention defines landscape as "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors."[2] Existing research shows that approximately 80% of human sensory perception of landscapes is derived from visual stimuli, indicating the necessity of examining visual attention patterns in public perception of urban natural environments.

Mountainous landscapes are key elements of urban natural systems. Their topographical characteristics allow for diverse visual perspectives and richer perceptual layers, while their cultural significance often serves as a vital embodiment of urban identity and spatial sense of place—particularly in mountain cities. Some cities, such as Hong Kong, have successfully preserved visually engaging mountain–city interfaces, yet many other regions lack awareness in protecting these visual characteristics during urban development. Consequently, these areas face challenges such as low visibility and poor visual quality of mountain landscapes. Understanding how the public perceives mountainous landscapes and how these perceptions are spatially distributed is thus essential. Nevertheless, research focused on mountainous landscapes in high-density urban areas remains limited. Two major challenges persist: first, most studies on visual perception of mountainous landscapes are centered on rural or protected areas, with little attention to urban mountain environments; second, although some studies have analyzed the influence of image elements on mountain landscape perception, few have investigated visual perception behavior from a spatial perspective.

Over the years, scholars have approached landscape perception from various angles. Early studies, constrained by technological limitations, often adopted an objectivist paradigm, classifying landscapes by physical features and assigning aesthetic values accordingly[3]. Although numerous works have since emphasized the public's perspective, the reliance on small-scale surveys has restricted generalizability. With the rise of internet technologies and breakthroughs in artificial intelligence, especially user-generated content (UGC) on social media, a new avenue has opened for large-scale public perception research. UGC imagery has been shown to reflect collective perceptions at specific locations and reveals implicit visual preferences. While many recent studies evaluate landscape aesthetic values based on image content analysis, spatial analysis of visual perception behavior remains underexplored.

Therefore, this study aims to comprehensively analyze the current characteristics of public perception of urban mountainous landscapes and explore their underlying drivers by collecting geo-tagged social media images, integrating data from multiple platforms, and applying deep learning and spatial analysis methods.

2. Methodology

2.1 research area

The case study of this research is the core area of the Two Rivers and Four Banks in Chongqing, China, located in the southwest region of the country. Chongqing is a typical mountainous city, with more than 40 urban mountains within its central urban area, featuring a vertical elevation difference of up to 60 meters and a 38.4-kilometer scenic riverside shoreline. The city is characterized by a high density of mountain landforms, diverse topographic types, and a close spatial integration between built environments and mountain landscapes. Over the past three decades, Chongqing's mountainous landscapes have undergone dramatic transformations driven by rapid urban development and expansion, making it an ideal setting for studying urban mountain landscape visual perception. Figure 1 illustrates the core area of Chongqing's Two Rivers and Four

Banks—the area selected for this study—which represents the highest density of urban mountains and serves as a key visual window for the city's identity.

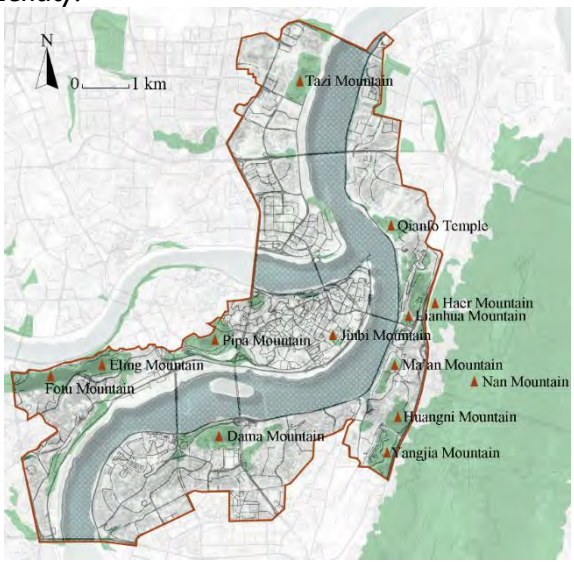


Figure 1. Core area of the study.

2.2 data source and processing

2.2.1 media data collection and filtering

To ensure that the research data reflects a broad spectrum of urban users, this study collected images from multiple social media platforms. These include geotag-enabled platforms such as Flickr and outdoor activity sites like 2bulu and fooooooot, as well as mass-used local platforms like Rednote and Weibo, where users can attach location information through textual descriptions or manual tagging.

The study focuses on the urban mountain landscapes along the Yangtze River section of Chongqing's core area, covering districts such as Nan'an, Yuzhong, Jiangbei, and Yubei. DEM data, 3D building models, and land-use data were collected to assist in the delineation of mountain boundaries within the study area.

To understand how the public perceives the cultural and visual qualities of Chongqing's "Two Rivers and Four Banks" mountain–water urban landscape, this study adopted a big-data-driven approach by collecting user-generated content (UGC) from social media. This approach allows for low-cost, large-scale image acquisition. Moreover, the act of users uploading images inherently reflects a personal preference or value judgment, making social media imagery a powerful medium for visual landscape perception studies.

Geo-tagged images allow for the spatial distribution of perception to be analyzed. Therefore, in addition to collecting data from platforms like 2bulu and Flickr—which provide precise geolocation but are biased toward outdoor and photography enthusiasts—the study also retrieved data from general-use platforms such as Rednote and Weibo, where geolocation was supplemented through user-provided text.

Using web scraping tools, the study employed keywords such as "Two Rivers and Four Banks," "Nanbin Road," "Beibin Road," "Yuzhong District," and "Nan'an District" for geo-tagged platforms, and added additional keywords like "Chongqing riverside," "Yangtze River," and "Jialing River" for Rednote and Weibo. Images posted between January 2019 and November 2024 were collected, including user ID, image content, and location metadata.

The collected image dataset was subsequently filtered and curated. As the study focuses on visual perception of urban landscapes, only images with rich visual information and thematically relevant content were retained. The following types were excluded: overexposed or underexposed images, stylized or heavily filtered images, close-up shots (e.g., of people, food, animals, or plants), indoor scenes, and images with insufficient landscape context [4]. To reduce redundancy, only one high-quality image was retained from sets of near-duplicate images posted by the same user in a short time frame.

All retained images were standardized in terms of file format and resolution. In total, 1,560 valid images were collected. Each image was renamed, and its GPS metadata was extracted and compiled into a CSV file, resulting in a structured UGC-based urban landscape perception dataset.

2.2.2 image data processing

This study employed semantic image segmentation techniques to identify and quantify the proportion of various elements present in user-generated photographs. Semantic segmentation, powered by deep learning trained on annotated datasets, enables the automated, large-scale processing of image instances.

The segmentation tasks were conducted using MMSegmentation, an open-source semantic segmentation toolbox that supports a wide range of model architectures for training and inference [5]. It served as the primary codebase for image segmentation in this study. Specifically, we adopted the SegFormer algorithm, a deep learning model developed in 2021 for semantic segmentation tasks [6]. SegFormer has been widely applied in domains such as autonomous driving, medical imaging, and remote sensing, and its integration here significantly enhances the ability to quantify public visual perception of urban environments.

The model was trained on the ADE20K dataset, which was released by MIT in 2016 and includes

over 25,000 annotated images of complex daily scenes, covering 150 semantic classes.

To ensure the segmentation results align more accurately with the objectives of urban landscape perception research, the semantic categories were reclassified and grouped. Elements irrelevant to outdoor landscape perception, such as indoor furniture, were filtered out. Based on their characteristics, all identified image elements were aggregated into three major categories:

- Natural elements, including: mountains, vegetation, water bodies, land, and sky;
- Artificial elements, including: buildings, structures, roads, transportation infrastructure, and bridges;
- Biological elements, primarily: humans.

The final semantic classification system for urban landscape perception is summarized in Table 1.

Table 1. Semantic classification system for urban landscape perception.

Node number	Type	Detailed Elements
Natural Elements	Mountain	* mountain, hill
	Plants	* tree, palm
	Water	* water, sea, river, fountain
	Land	* earth, land, rock, grass, flower
	Sky	* sky
Artificial Elements	Building	* building, skyscraper
	Structure	* wall, fence, railing, streetlight, traffic light, sculpture, flag, signboard
	Road	* road, sidewalk, path, runaway, dirt track
	Transport	* bus, car, track, airplane, ship, boat, pier
	Bridge	* bridge
Living Beings	Person	* person

2.3 visualization and analysis of spatial information

2.3.1 visualization and influencing factors

We imported the complete dataset—including image IDs, photographic location data, and elemental proportion information—into ArcGIS. All geotagged image coordinates were converted into the WGS84 coordinate system, and overlaid with satellite imagery of the Two Rivers and Four Banks core area in Chongqing to generate a spatial distribution map of public perception points toward the urban landscape.

To better quantify the public's perception of urban landscapes across different areas, we divided the study area into a 200-meter grid of raster cells. The number of user-generated images (n) within each cell was used to represent public perceptual density. This grid resolution offers a balance between sufficient spatial differentiation across cells and content similarity within each cell, effectively reducing analytical errors arising from positional inaccuracies in photo locations.

To further quantify public perception of urban mountainous landscapes and their associated influencing factors, we calculated the perceptual density of different image elements within each grid cell. Drawing from relevant literature, we identified a set of predictive variables that may influence mountainous landscape perception, categorized into two dimensions: viewpoint distribution factors and mountain perception characteristics. Table 2 provides detailed descriptions and computational methods for each predictive variable influencing public perception of mountainous landscapes.

Table 2. Predictive variable influencing public perception of mountainous landscapes.

factors	variables	description
Viewpoint Distribution Factors	VD	distance from viewpoint to mountain
	VE	elevation of viewpoints
	VSD	space distribution of viewpoints
Viewpoint Photographic Feature Factors	MPt	total mountain element proportion of each grid cell
	MPa	average mountain element proportion of each grid cell
	SWI	the Shannon–Wiener Index
	GVI	plants element proportion
	MCR	ratio of mountain-to-building element proportions
	SVF	ratio of sky-to-mountain/building element proportions
	BP	combined proportion of building and structure element
	BrP	bridge element proportion

2.3.2 Spatial Distribution Characteristics of Mountain Landscape Perception Points

Understanding the spatial distribution of mountain landscape perception points can inform the planning and optimization of public viewing corridors and experiential routes, thereby strengthening the natural and cultural identity of the city. Our findings indicate that public landscape perception behaviors in urban areas occur more frequently within linear streetscapes and urban open spaces. Accordingly, we delineated 19 mountain-visible nodal open spaces and a set of key linear routes associated with mountain perception within the study area, following a set of defined spatial criteria (Figure 2).

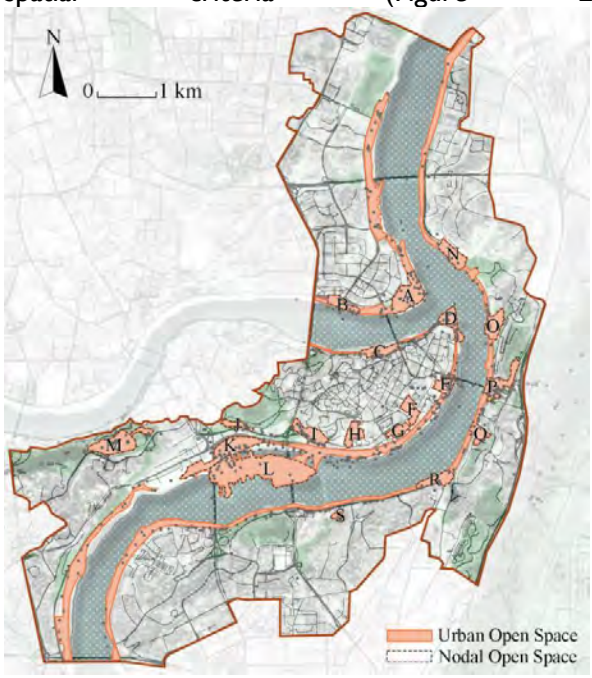


Figure 2.nodal open spaces and key linear routes.

The delineation criteria for nodal (point-based) open spaces were as follows:

(1) Visibility of mountain landscapes;

(2) Spatial concentration of perception points;

(3) Minimum area of 10,000 square meters;

(4) Homogeneity in perceptual content within the space.

For linear perception routes, the criteria were:

(1) Spatial continuity along existing urban pathways or waterfront corridors;

(2) Inclusion of pedestrian/cycling infrastructure and associated linear parks or greenways.

It is generally recognized that public perceptual behaviors differ across spatial types: in linear open spaces (e.g., urban roads), perception tends to be dynamic and continuous, whereas in nodal open spaces (e.g., parks and plazas), perception is more likely to be static and concentrated.

For point-based open spaces, we calculated the number of urban landscape images within each space (n) and used the previously derived mountain element proportion (MP) in each image to obtain two key indicators:

Mountain Perception Density (MPt), and Average Perceptual Intensity (MPa).

These metrics were used to construct a ranked perception density series of mountain landscapes across all nodal open spaces.

For linear street spaces, we adopted the mountain element proportion (MP) in each image as a weighting factor and applied network kernel density estimation (NKDE) to evaluate the "perceptual continuity index" along the linear routes.

Together, the indicators derived for both spatial types provide intuitive, mappable representations of the spatial distribution of mountain landscape perception hotspots and coldspots in the city, offering valuable insights for landscape planning and visual corridor design.

2.3.3 Analysis of Influencing Factors at the Perceptual Modality Level

Viewing distance (VD) and viewpoint elevation (VE) are two key perceptual modality variables that significantly influence the spatial distribution of public mountain landscape perception density.

First, we calculated the Euclidean distance between each geotagged photo location and the edge of the corresponding visible mountain mass. This distance represents the viewing distance (VD) experienced by the public in their mountain landscape perception. Previous studies have shown a strong correlation between viewing distance (d) and the vertical height of the observed object (h): when the ratio d/h approaches 3, the full shape and visual context of the object is most clearly perceived; when d/h≥4, the object tends to be perceived more as part of the background. In the context of this study, the perception distance is further constrained by the width of the Yangtze River, which ranges from 500 to 800 meters in Chongqing's urban core, with an average elevation difference of approximately 400 meters between the river surface and surrounding mountain ridges. Based on these perceptual principles, we classified viewing distances into evenly spaced intervals of 400 meters. For each interval, we calculated the mountain perception density (MPt) and visualized the relationship between VD and MPt through line charts that reveal trends in perceptual intensity across distance categories.

Second, we acquired the Digital Elevation Model (DEM) of Chongqing's central urban area and batch-extracted the surface elevation data corresponding to each photo location. The data show that the elevation of image-capturing

viewpoints ranges between 160 and 400 meters, which encompasses three distinct perception modes:

- viewing mountains from riverbanks,
- viewing mountains within urban areas, and
- viewing mountains from ridgelines.

To analyze how elevation influences mountain perception, we divided VE into 40-meter intervals and computed the aggregate mountain perception density (MPt) within each elevation segment. Finally, a line graph was produced to visualize how MPt varies across different elevation bands.

2.3.4 Analysis of Influencing Factors at the Perceptual Content Level

This section investigates the relationship between the dependent variable—public mountain landscape perception density (MPt)—and a set of independent variables, including Green View Index (GVI), Mountain-City Ratio (MCR), Sky View Factor (SVF), Building Perception Density (BP), and Bridge Perception Density (BrP).

The perceptive density of mountain features (D_E) is a key metric that captures the spatial heterogeneity in public mountain perception across different regions. It reflects both the presence and the visual dominance of mountain features in geotagged images. By utilizing the proportion of mountain elements identified through semantic image segmentation as a weighted factor, the unit perceptual density of mountain elements within each grid cell is calculated as follows:

$$D_E = \sum_{i=1}^{n} P_E \times 100\%$$

where:

D_E represents the perceptive density of a specific element (e.g., mountain) within a single grid cell,

n is the total number of geotagged images located in the grid cell, and

P_E denotes the proportion of the mountain element in image i.

To further capture the average perceptual intensity of mountain elements, we calculate the mean mountain element proportion within each grid cell, which is derived by averaging the perceptive density over the number of images:

$$A_E = \frac{D_E}{n}$$

This set of indicators enables a more nuanced quantification of the spatial distribution of public visual perception of mountainous landscapes, helping to identify perceptual hotspots and cold spots across the urban terrain.

Given the spatial adjacency and heterogeneity of the sample units (raster cells), this study adopts a Geographically Weighted Regression (GWR) model to identify and explore their associations. GWR fits a series of local linear regressions—in lieu of a single global regression—to uncover spatial variability in the magnitude and direction of each explanatory variable's effect across different regions.

3. Result

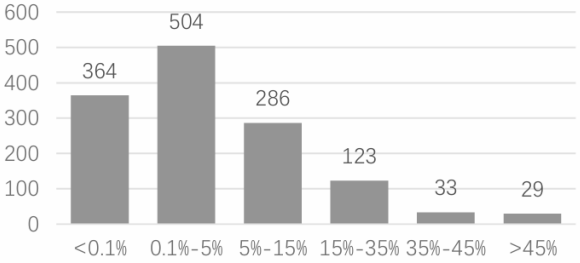
3.1 Semantic segmentation results

The semantic segmentation results of the collected 1330 urban landscape images were further analyzed to determine the mean proportional coverage of each natural element. Sky exhibited the highest mean coverage at 36.36 %, followed by vegetation at 13.69 %, water bodies at 10.76 %, and mountains at 6.63 % (Table 3). Given that mountain elements are more vulnerable to degradation from urban expansion and development than water bodies, focusing on mountains as the frame for public nature perception yields more actionable insights. Indeed, 72.63 % of all images contain mountain elements (proportion > 0.1 %) (Table 4).

Table 3. Urban landscape elements proportion.

Type	Average Percentage
Mountain	6.63%
Plants	13.69%
Water	10.76%
Land	6.49%
Sky	36.36%
Building	16.38%
Bridge	4.84%
other	4.85%

Table 4. Mountain element percentage



Images were then classified by their mountain-element proportion. When the mountain proportion is ≤ 5 %, mountains function merely as distant backdrop: the public's shooting scale is broad, with emphasis placed on other features rather than the mountains themselves. For proportions > 35 %, mountains dominate the scene as principal background, reflecting a tighter shooting scale and localized mountain details. When mountain coverage falls between 5 % and 35 %, the shooting scale is balanced and mountains become a significant compositional component.

A total of 762 images within the 5 %–35 % mountain-proportion interval were reviewed to identify their primary subject elements. These include urban fabric, bridges, landmarks, heritage architecture, cable cars, vessels, vehicles, roads, riverbanks, mountains, rivers, and vegetation. The "subject element" is defined as the feature at the compositional center that motivates the photograph; most images feature one to two subjects. In this interval, the majority of subjects were Chongqing–specific bridges, landmarks, heritage buildings, cable cars, and riverbanks. Bridge–centric images were most numerous, with 369 photographs (48.43 %), while landmarks (143), heritage architecture (59), riverbanks (71), and cable cars (17) together comprised 38.06 % of the subset. Only 74 images featured mountains alone as the principal subject.

3.2 Spatial distribution characteristics

The distribution of public perception hotspots for urban mountains is shown in Figure 3. The study also ranked the density of mountain–viewing viewpoints within each discrete open space (Table 5), finding that Area E (Huguang Guild Hall), the surrounding Areas I, J, K, L of the Coral Dam Park subregion, and Area M of the E'ling–Fotu subregion all exhibit relatively high MPt and MPa values, marking them as significant perception hotspot areas.

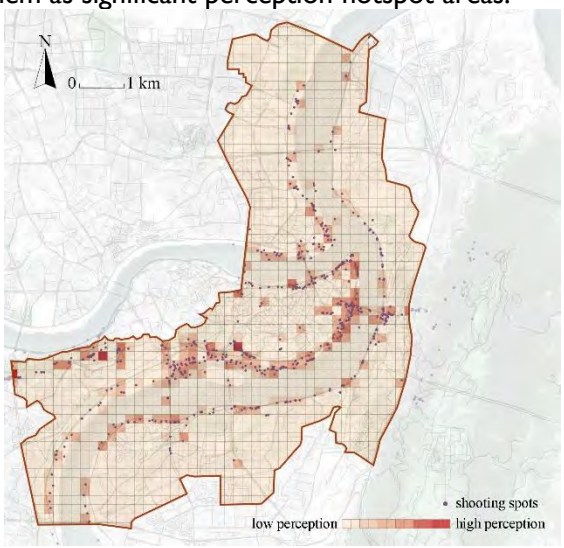


Figure 3. Spatial distribution of mountain's visual perception.

Table 5. The MPt and MPa in node spaces

Node space	Area (10,000 m²)	NMVV	MPt	MPa
I	11.8	50	43.56	10.28
J	4.1	26	41.66	6.57
K	2.6	25	36.92	3.84
E	7.9	47	33.73	5.67
M	22.5	82	26.97	7.4
D	10.5	43	17.40	4.25
C	8.4	25	12.56	4.22
P	13.7	29	5.19	2.45
B	7.3	12	4.70	2.86
A	22.1	43	4.26	2.19
O	10.7	6	2.90	5.17
S	1.6	2	1.98	1.58
L	72	32	1.86	4.19
G	5.1	3	1.64	2.78
Q	6.8	3	1.43	3.25
R	9	6	0.75	1.12
H	8.3	6	0.61	0.85
N	11.5	3	0.12	0.45
F	7.6	1	unconsidered	unconsidered

3.3 Influencing factors at the perceptual content level

We first conducted a spatial autocorrelation assessment on the public mountain–perception data (MPt). The global Moran's I test yielded a Moran's I statistic of 0.0358 for MPt (expected value = –0.000706; variance = 0.000265; z = 2.244039; p = 0.024830), indicating a slight positive spatial clustering tendency (Moran's I > 0) and significant positive spatial autocorrelation (z > 1.96, p < 0.05).

To ensure that multicollinearity among explanatory variables would not bias the regression model, we then calculated the variance inflation factor (VIF) for the seven selected independent variables. All VIF values were below 5, indicating no serious multicollinearity issues and confirming that the chosen indicators are suitable for subsequent regression analysis.

The linear relationships between the influencing factors of each perceptual content and MPt are shown in Table 6 below.

Table 6. OLS results

Variable Name	Coefficient [a]	Robust p-value [b]
Mean Green View Index (GVI)	0.317	0.11107
Mean Sky View Factor (SVF)	0.660	0.27587
Visual Diversity	5.706	0.14796
Built Structure Perception Density	0.367	0.00117*
Urban–Mountain Ratio	1.584	0.20936
Bridge Perception Density	0.271	0.34548
Waterbody Perception Density	–0.209	0.05506

Among the variables, Building Perception Density (BP) was the only one that passed the significance test ($p < 0.01$), indicating that public mountain perception behavior is, to a certain extent, influenced by the presence of built structures. This calls for further investigation into which specific types of artificial structures affect public perception of mountainous landscapes. Although Visual Diversity (SDI) was not statistically significant, it exhibited a relatively large coefficient, suggesting that visual complexity may play a meaningful role in explaining variations in mountain perception density. In addition, the influence of the Mountain–City Ratio (MCR) and Average Openness (SVF) on MPt is likely nonlinear, warranting further in-depth analysis.

4. Discussion

This study, based on geotagged social media imagery, integrates semantic segmentation, spatial analysis, and statistical modeling to explore public visual perception of mountain landscapes in a high-density urban context. It reveals spatial distribution patterns of mountain perception hotspots and identifies key spatial and visual factors shaping public perception intensity.

4.1 The potential of social media in the study of urban landscape perception

User-generated content from social media serves as an effective proxy for public landscape perception. Compared with traditional surveys, such imagery provides real-time, cost-efficient, and spatially rich insight into how people perceive and interact with urban natural landscapes. This approach enhances our understanding of collective visual attention within dynamic urban environments. The use of deep learning for semantic segmentation enables accurate quantification of visual elements within images, thereby constructing a robust indicator system for perceptual factors. Grid-based spatial units help to normalize sampling inconsistencies and facilitate spatial regression techniques such as OLS, GWR, and Moran's I. These tools improve spatial sensitivity and strengthen causal inference.

4.2 Limitations and Prospects

While this study presents a comprehensive spatial framework, image data may still suffer from user bias and platform algorithm influence. Additionally, the symbolic and cultural significance of mountain landscapes remains underexplored. Future research may integrate virtual reality experiments, interviews, and automated analysis of compositional aesthetics to enrich the understanding of landscape perception dynamics.

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The accuracy of the references in the paper is under the full responsibility of the Author/Authors of the paper. All publications cited in the text should be referred to by a number in square brackets, [1,2,3].
The full reference **(maximum 10 references)** should be given in a list at the end of the paper according in the following format / ISO690 / International standart for bibliographic elements :

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LANDSCAPE PLANNING AND DESIGN OF HIGH VOLTAGE POWER LINES. CASE STUDIES IN FRANCE AND THE NETHERLANDS

TOPIC: Guiding territories by changing the design of regional projects: tools for intervention at different scales, for multifunctional landscapes

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Keywords: landscape planning, power lines, energy grid, landscape transition

Abstract
As part of the Creatives Lines project the research explores the landscape and ecological measures for the planning and design of high voltage lines (HVL), in an energy transition context. In the actual framework of development of renewable energy productions, the electricity grid is undergoing a restructuring and extension to answer the needs of an electricity production that is more sprawled on the territories, changing our energy landscapes. The research is based on the premise that the HVL design and planning process constitutes local "windows of opportunity" for the implementation of transition policies. And it is structured around three main questions:
What are the main characteristics of design and planning guidelines for overhead power transmission infrastructure?
How are infrastructure, landscape, energy and ecology connected to each other?
What are the success and failure factors of the studied design and planning guidelines and procedural regulations, with regard to the overall ecological and energy transition objectives?
To answer these questions, we compare case studies in France and the Netherlands, countries with energy transition goals and which have landscape and environmental approaches that are explicitly linked to electricity transmission infrastructure. Semi-structured interviews with main stakeholders together with an analysis of the technical literature as well as of field observations, allow to assess the differences of approaches and governance measures in the two countries, putting the national results in a broader perspective.
The two case studies are grounded in distinct territorial and landscape contexts:
In France, the Lonny-Seuil-Vesle HVL constitutes the backbone of electricity supply in the "Grand Est" Region. The new 400 kV line was inaugurated in 2016 to meet the challenges of economic development and renewable energy. A Plan of Accompanying Measures ("Plan d'accompagnement de projet", PAP) piloted by RTE allowed the co-financing of around one hundred local projects.
In the Netherlands, the new HVL Randstad 380kV between Beverwijk and Bleiswijk opened in 2019. With a total length of 80 km, it closes the high-voltage circuit north of the Randstad. TenneT implemented a landscape design strategy concerning design and spatial integration issues. No formal guidelines for accompanying measures were developed but measures of compensation have been implemented (mainly for biodiversity). Results show that support mechanisms such as

RTE's PAP help finance various local projects, particularly benefiting rural areas with limited self-funding, while also raising questions about the integration of networks into the landscape. In the Netherlands, such national support mechanisms do not exist, and only ecological compensations are covered by operators, with case-by-case solutions. However, landscape integration is considered earlier in the process and on a broader scale beyond the scope of environmental impact studies.

1. Introduction

In the actual framework of development of renewable energy productions, the electricity grid is undergoing a restructuring and extension to answer the needs of an electricity production that is more sprawled on the territories, changing our energy landscapes (1). Public policies accompanying linear infrastructure installations have seldom approached the landscape dimension from a projective standpoint, that is, one that embraces landscape creation in a constructive relationship with the non-human realm. The regulatory instruments governing such large-scale infrastructures, some of which date back to the very origins of French environmental law (notably the 1906 Act on energy distribution, one of the earliest legislative references to 'landscape protection' in France), primarily emphasize the need to preserve landscapes and pre-existing ecological functions, particularly when these are deemed remarkable, of heritage value, or rare, according to prevailing conceptual frameworks in landscape and biodiversity. On another level, infrastructure operators themselves, independently of legal obligations, have long had to engage with the question of landscape design alongside technical planning; that is, to consider the aesthetic and spatial dimensions of civil engineering and the role of creative design in shaping the infrastructures themselves (2, 3), with a focus mainly on their direct scope of intervention, namely, the linear corridors of land they occupy.

As part of the Creatives Lines project (4, 5) the research explores the landscape and ecological measures for the planning and design of high voltage lines (HVL), in an energy transition context. Particularly we analyse territorial support measures, that we define as actions co-financed by the State or local authorities on the one hand, and by private operators in charge of the infrastructure on the other, extending beyond the immediate footprint of the infrastructure and enabling synergies between it and the surrounding territory.

2. The comparisons of two high voltage lines

We compare case studies in France and the Netherlands (6), countries with energy transition goals and which have landscape and environmental approaches that are explicitly linked to electricity transmission infrastructure. We developed semi-structured interviews with main stakeholders from electricity grid as RTE, TenneT, but also local stakeholder as majors, territorial technical services, local association's, farmers etc.

The interviews were complemented by an analysis of the technical literature as well as of field observations, allow to assess the differences of approaches and governance measures in the two countries, putting the national results in a broader perspective.

The French project analysed is Lonny-Seuil-Vesle HVL in the Grand Est region. It is a main energy artery for electricity supply, inaugurated in 2016, it was accompanied by a *Plan d'accompagnement de projet* [Project accompanying plan] (PAP) established by RTE. The PAP document is compulsory for every HVL projects and in the case analysed its fund enabled the co-financing around 100 local projects, ranging from cultural infrastructure to economic revitalization, especially in small rural municipalities with limited access to development capital. These measures were not specifically aimed at integrating the HVL into the landscape but indirectly helped improve local acceptance and territorial cohesion. Moreover Between 2011 and 2017, the line has also been a place of experimentation of the European project Life Elia, dealing with the ecological management of the land projection of the line in order to realise green corridors. By adjusting vegetation management practices and restoring specific habitats, the project sought to transform routine maintenance zones into ecological assets. While promising in their approach, such experiments remain fragile in

the absence of strong institutionalization or national ecological integration standards.
In the Netherlands, the case study is HVL Randstad 380kV between Beverwijk and Bleiswijk, that opened in 2019. With a total length of 80 km, it closes the high-voltage circuit north of the Randstad. TenneT commissioned a landscape architects and funded the development of a *landschapsplan*. This document has the goal to analyse from landscape perspective the HVL at the early stage of project, allowing to discuss its paths as well as integration measures all along the path and in particularly sensitive points. No additional funds are allocated to develop local projects in the municipalities crossed by the HVL. However compensation measures have been implemented, mainly for biodiversity, proportionally to the length of the line.

3. Divergent and convergences in landscape planning linear electricity infrastructures

Drawing from Kingdon's (1984) (7) concept of “windows of opportunity” our results shows, that the project and implementation of HVL creates indeed new opportunities available to local actors, but their significance varies between the two nations. In France the PAP measures, even if not directly landscape related, enable various actors in the affected territories, particularly local authorities, to secure exceptional resources for implementing the operations in the different municipalities (retrofitting of municipal party hall, new publics’ spaces…) which has an impact on the living environment of inhabitants.
In contrast the Dutch cases offer fewer opportunities for collateral projects within the territories affected by the infrastructure, mainly focusing on ecological compensation. Firstly because the scope of the planning-related measures is more limited, and secondly because there are neither legal tools nor any expressed intention on the part of the operator to support such an expansion. This is the case even when, as with high-voltage lines, the creation or renovation of infrastructure is directly linked to the relocation of renewable energy production and therefore to regional-scale energy projects led by the territories.
Another point of attention is that the projects funded by these territorial support measures, such PAP, rise from local interest, but are not linked to initiatives related to an ecological and energy transition. This could be due to the strong influence of sectoral regulations in public policy, which remain highly prevalent. For example, the deployment of renewable energy has its own set of procedures and may already benefit from support mechanisms at various administrative levels. Under these conditions, actions supported in connection with the infrastructure tend to occur in institutional or procedural gaps, and remain modest in scale. Finally form a perspective of landscape related documents, the Dutch case, compared to the French one, shows an early-stage integration of landscape perspective through the *landschapsplan*, which address a broader scale beyond the scope of environmental impact studies. Nevertheless this document, even if could have an influence the HVL paths in some sensitive points, is limited to perimeter surrounding the HVL and does not address additional landscape strategies and actions beyond how to integrate infrastructure itself. In France, landscape is taken into account in the environmental impact study, but with no further exploration, revealing limitations in its conceptualization and integration into project planning and design.

4. Conclusion

In conclusion, the research illustrates that the support measures we analyzed through the lens of landscape function as tools for the territorialisation of infrastructures, capable of aligning ecological, economic, and spatial planning concerns within local projects. However, it is evident that the landscape perspective remains largely confined to mitigation efforts and biodiversity offset measures.

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WALKING AS AN ECOLOGICAL PRACTICE

Topic: Guiding cities with society: Use, memory, artistic creation

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Abstract

This paper explores walking as an ecological practice that addresses the land sickness caused by the new climatic regime of the Anthropocene. Building on walking as an aesthetic practice, we propose that walking can contribute with deeper knowledge about emerging landscapes and support the reestablishment of relationships with a world in environmental crisis. Walking as an ecological practice bridges ethics and aesthetics, offering a means to reorient ourselves in unhomely landscapes and redefine our relationship with a natural world that increasingly feels unnatural. The paper introduces the concept of "watershed walks", emphasising the role of water systems in shaping landscapes and highlighting walking as a tool for understand territorial transformations. By presenting four watershed walks, we aim to demonstrate the potential of walking as an ecological practice in landscape studies, fostering a deeper understanding of unfamiliar landscapes and laying the groundwork for future design responses to them. We argue that walking fosters sensory engagement, enabling a rediscovery of landscapes rendered unfamiliar by the Anthropocene. However, we also highlight the challenge of representing the knowledge gained through walking and call for new methods of documentation and representation.

1. Homeless in the Anthropocene

This paper examines walking as an ecological practice within a rapidly emerging new climatic regime that has led to disorientation, with outcomes dependent on our ability to design differently with the Earth without endangering ourselves or other lifeforms [1]. The point of departure is the experience of 'land sickness,' reminiscent of the sensation sailors feel of a moving Earth when they return to land after a long period at sea. It builds on the realisation that the problems we face not only dog our footsteps; they *are* our footsteps [2]. If we follow Latour and Schultz, we appear homeless in the Anthropocene. Alongside the emerging new climatic regime, there is a rising sense of solastalgia—the experience of homesickness felt when you are, in fact, at home but realise that home has changed so much that you can no longer fully recognise it, and that it will continue to change in unpredictable ways beyond your control [3].

In Wanderlust – a History of Walking, Rebecca Solnit describes walking as a deeply human practice, tracing the shifting cultural significance of walking [4]. In Walkscapes – Walking as an Aesthetic Practice, Francesco Careri reminds us that walking has a profound cultural history of generating art, architecture and landscape architecture [5]. For Henrik Schultz walking is a tool that helps make large-scale landscapes comprehendible and acts as the gateway to and exchange of ideas [6]. And Günter Vogt beautifully exemplifies how walking can be considered an important element in the process of creating landscape

architecture - walking, thinking and making landscape [7]. As such, walking can be regarded a well-established and recognized aesthetic practice within landscape studies. Building on this recognition, we propose that walking might also be considered an ecological practice capable of addressing the sense of homelessness in the Anthropocene outlined above.

It has been suggested that the Anthropocene requires sensible, aesthetic engagements—not only because they are suited to address an unprecedented era, but because they are necessary to encounter and address this situation in meaningful ways, highlighting the relationship between ethics and aesthetics—between responsibility and care [8] [9] [10]. Following this line of thought, we regard walking as a practice that supports the rediscovery of the landscape in ways that might bypass some of the misconceptions that have left us feeling land-sick and homeless. Walking, we argue, can help establish new, meaningful connections in the landscape—making it home. In short, if ecology is *oikos* and *logos*, walking as an ecological practice can be understood as the study, on foot, of our relationship to home in a new climatic regime. Harrison puts it bluntly when he reminds us that ecology cannot remain naïve about the deeper meaning that summarises its vocation. According to him, we dwell not in nature but in our relationship to it:

"Logos is that which binds, gathers, or relates. It binds humans to nature in the mode of openness and difference. It is that wherein we dwell and by which we relate ourselves to this or that place. Without logos there is no place, only habitat; no domus, only niche; no finitude, only the endless reproductive cycle of species-being; no dwelling, only subsisting. In short, logos is that which opens the human abode on earth." [11]

But how can that be, if the Earth seems to be moving beneath our feet? This paper seeks to answer this question through walking as an inquiry-in-action by reintroducing the notion of sauntering, a word closely related to *saint terre*, meaning 'holy land' and *sans terre*, meaning 'without land' [12]. In so doing, we suggest that walking as an ecological practice has connotations with walking as pilgrimage; it is, quite literally, a search on foot for new land. When faced with a period of life-altering transformation, the 21st-century pilgrim takes up walking to regain direction in life. When Werner Herzog in 1974 undertakes his existential journey on foot through a hostile winter landscape, he potentially makes visible one such pilgrimage. His walk is both emotion and motion, and through it he records physical suffering, hallucination, ecstatic revelation, portents, and animistic landscapes in the wreckage of human history and myth [13]. Today, we are "living in a door-less house," and "existence has become a lot more complicated, unfolding in a new geography blurring the local and the global." [2] Following this, we argue that walking can guide landscape studies towards new re-discoveries, and, despite a sense of urgency, it can be the slow reorientation towards feeling at home in otherwise unhomely landscapes. However, for it to be able to do so, it needs to be practiced as "one of those essential tasks of situating ourselves" in Earthly processes [2]. In walking as an ecological practice, this is the oikos in ecology – gleaned through movements on foot, one step at a time, deep into the Earth's thousand folds [14].

2. Follow the water – watershed walks

In seeking to position walking as an ecological practice in the Anthropocene, we have been reflecting on 15 years of experience walking together. Our walks have primarily focused on following the course of water through various river systems, allowing the water to guide us through diverse urban and rural landscapes to gain a sense of how water continues to shape and condition the landscape—both through its own agency and the human urge to control it in different ways. This topic has become alarmingly relevant in light of the new climatic regime.

We have chosen to label our walks as 'watershed walks' because our focus extends far beyond individual segments of rivers or brooks. We are interested in how larger territories influence and are influenced by water systems, and how different logics

related to water intersect both vertically and horizontally on the ground. Furthermore, Latour has highlighted the watershed as a potential framework for what he, drawing on earth sciences, defines as critical zone observatories. While the critical zone refers to the thin layer between the atmosphere and the bedrock, critical zone observatories are described as collaborative efforts by earth scientists working on well-instrumented field sites, ranging from a few hectares to large watersheds [15].

The following examples of watershed walks have been selected to provide an idea of the scope of our walking practice and to highlight aspects that might be important in framing walking as an ecological practice.

2.1. Aire River – in the footsteps of Georges Descombes

The first walk we would like to exemplify took place in the watershed of the Aire River on the periphery of Geneva, crossing the border between Switzerland and France. This walk was conducted as part of a study of the poetic and thought-provoking work of Georges Descombes, which addresses the historical transformation of the larger watershed alongside the present needs for flood protection, ecological improvement, and the maintenance of recreational qualities. The walk followed the course of the water northwards, starting from one of the small tributaries in the foothills of the Salève mountain range in France and continuing to the Aire plain in Switzerland. It ended at Gare de Lancy-Pont-Rouge in the southwestern suburban area of Geneva, where the Aire River disappears into an underground channel leading to the River Arve. The walk, which took most of the day, led us through a diverse urban landscape (Figure 1).

In this example, walking was actively used to contextualise the project work along the Aire River and to gain a deeper understanding of the territorial transformations that have led to the present challenges being addressed. For instance, through walking, it became apparent how the alluvial nature of the water system, combined with the continued urbanisation of the watershed, makes it increasingly vulnerable to flooding—an issue that is likely to intensify with climate change. The walk also provided a strong sense of how the various transformations have each left their marks on the territory, with physical traces of past interventions playing an important role as mnemonic devices, creating a sense of belonging for the people living in the area. These layers in the landscape are elements that new interventions must engage with in dialogue. Based on our walk, we can confidently assert that the work of Georges Descombes appears very much at home in the territory—a territory that Descombes has traversed on foot many times throughout his life.



Figure 1. Walking the Aire River from Mont Saleve in France (top left) to Geneva in Switzerland (bottom right), May 2013.

2.2. Kolindsund – weaving together past, present, and future

Walking also constitutes an integral method of investigation in our teaching. The following examples of watershed walks conducted by students are from a studio course exploring the potential of re-establishing Kolindsund, one of the largest lakes in Denmark, which was drained and cultivated for agricultural purposes during the latter half of the nineteenth century.

One assignment featured a collective walk along the imaginary edge of the former/future lake—a walk of more than 50 kilometres conducted over several days. The walk was documented in an edge-drawing with three photographs taken every 100 metres (Figure 2). This collective walk functioned as a topographical hinge, helping the students weave together past, present, and future in their understanding of the larger watershed.

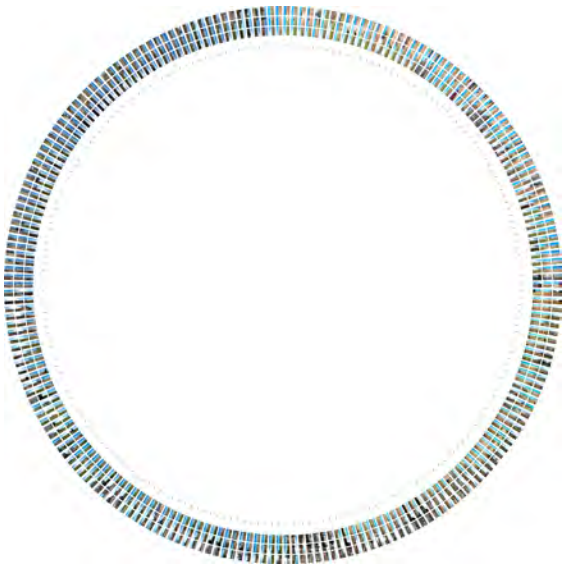


Figure 2. Edge-drawing documenting the walk along the former and future lake edge of Kolindsund, September 2012.

Another assignment involved individual walks traversing the larger basin of the former lake. These walks aimed to document otherwise overlooked transitional situations that would not appear in more conventional mapping. Findings from these walks were used to produce thick drawings that combined information about the hydrological system within the watershed with evidence of the material conditions experienced during the walks. This was an attempt to connect the more immediate aesthetic experience with the distanced perspective of cartography (Figure 3).



Figure 3. Thick drawing with soil samples from a walk across Kolindsund, done by Johanna Catharina Eckerdal, September 2012.

These examples of investigatory walks conducted in an educational setting illustrate how walking can be actively used not only to make sense of existing situations but also to navigate emerging landscapes without losing sight of how the past continues to inform the future. The examples also highlight the immediate challenges of representing walks and the situated knowledge created by these walks.

2.3. Aarhus River – the watershed as a landscape laboratory

Walking close to home can be a revelatory experience. The Aarhus School of Architecture is situated in the Aarhus River Valley, in close proximity to the river itself. The river and its larger watershed have played a key role in Aarhus being located where it is and becoming what it is today; its original name, 'Aros,' simply means 'mouth of the river.' Over several years, we have used the river and its larger watershed as a kind of landscape laboratory, carrying out a series of experimental walks in both research and teaching contexts. These walks have been conducted with the ambition of exploring alternative ways to navigate our local

landscape and, in turn, investigating how haptic knowledge, gleaned through bodily and emotional engagement with the river, can lead to new insights about an otherwise familiar landscape.

In one walk, the authors traversed the full 40-kilometre length of the river, walking from source to sea in a continuous and uninterrupted journey, with the aim of exploring, through bodily movement, the river and the topography of the watershed. During this walk, we realised that we were also walking in the footsteps of others, and our journey became an imaginative exploration of a shared history of settling in the river valley. Other, shorter walks were conducted with and by students, who were encouraged to investigate new modes of representation and, in doing so, explore how to make visible the sensuous encounters with and interconnectedness between body, river, and watershed (Figure 4).



Figure 4. One of the many Aarhus River walks where students have been experimenting with representing sensuous encounters, March 2017.

The knowledge gained from these experimental walks has, in turn, informed the establishment of the Aarhus Landscape Laboratory, which currently consists of three sites ranging from a few hectares to a larger alluvial forest in the Aarhus River Valley. Initiated in 2016 in close collaboration with the municipality and other local institutions, the Aarhus Landscape Laboratory has made it possible to continue, upscale, and reimagine on-site explorations of haptic knowledge about the river and its watershed, experimenting at a 1:1 scale with situated design within an animated river landscape, weaving together our many comings and goings with its deep history.

2.4. Skjern River – tying places together

The final example of a walk we would like to emphasise took place within the larger watershed of the Skjern River system, the most water-rich river system in Denmark, draining an area of 2,338 square kilometres. This walk was conducted in connection with an exhibition addressing the massive transformations that the Skjern River delta has undergone as part of a drainage and land reclamation project (1962–1968) and a subsequent nature restoration project (1999–2003).

Both the exhibition and the watershed walk drew on the previous study of the work of Georges Descombes in the Aire River watershed. The exhibition featured an alternative proposal to the official nature restoration project, with three river gardens inspired by the approach taken by Descombes at the Aire River. The watershed walk was initially planned to support and inform the development of the alternative approach displayed in the exhibition, aiming to contextualise the proposed river gardens within the larger watershed. However, the walk also became an important element in tying together the place of the exhibition and the place of study.

Rather than pursuing a walk along the entire length of the main river, we took advantage of the fact that the exhibition pavilion was

situated next to a brook within the larger river system. From here, we conducted the walk downstream through the river system to the Skjern River delta. This eventually became a 46-kilometre journey, both on foot and by canoe, stretching over two full days. The journey was documented through photography and video, and a video was created for the exhibition with 10 different sequences exemplifying various situations encountered along the journey. In the exhibition, the video was projected onto the wall from the canoe used during the journey (Figure 5).



Figure 5. The journey through the Skjern River watershed was represented on video in an exhibition addressing the massive transformations of the Skjern River delta, January 2018.

Reflecting on the exhibition and feedback from the audience, it is clear that the representation of the journey through the watershed—from the exhibition pavilion to the river delta—played an important role in framing and situating the proposed alternatives to the official nature restoration project. The video not only metaphorically tied together the place of the exhibition and the place of study, but it also literally helped position the exhibition—and thus the audience—within the landscape of interest, making the problems addressed by the exhibition more tangible and relevant.

3. Homebound; walking as re-discovery

The examples of watershed walks described above illustrate how walking can be employed as an exploratory method in the study of landscape. In the first example, walking serves as a way of contextualising existing project work, leading to a deeper understanding of both the project and the landscape in which it is situated. In the second example, walking plays a key role in the process of developing a future landscape scenario that acknowledges both past and present. The third example highlights how walking has been instrumental in framing a watershed as a landscape laboratory for ongoing experiments in both landscape architectural research and teaching. Finally, the fourth example points to the potential of walking as a means of communication in landscape studies.

Walking as an ecological practice can potentially be the footwork for another kind of watershed knowledge than that gleaned from sciences and practices already engaged in the breadth and depth of the critical zone. Firstly, a common characteristic of walking as an ecological practice across the four exemplary watershed walks is a strong focus on a haptic relationship with the watershed being traversed, seeking ways of knowing that involve sensory modalities. Secondly, walking as an ecological practice is not merely a horizontal movement on the Earth's surface but also a vertical movement deep into its manifold layers and its deep time. Thirdly, walking as an ecological practice is not simply a forward-moving motion, but a movement in multiple directions, in the case of our watershed walks along the ghost traces of earlier river meanders and across previous cultural practises. Fourthly, walking as an ecological practice involves walking with animated others, also other-than-human, such as the four rivers we have followed in all four exemplary walks. As mentioned in the introduction, this approach seems particularly appropriate for addressing the ambiguous situation of the Anthropocene, where many conventions about landscape are subject to re-evaluation. In this context, our search for new land, as alluded to in the introduction when positioning walking as an ecological practice, can be framed as a re-discovery of what homely landscapes mean in the Anthropocene. We argue, that walking as an ecological practice can be the first step in

learning the difficult task of feeling at home in unhomely landscapes. Based on our experiences of using walking as an exploratory method in the study of landscape, we do, however, identify a significant challenge in conveying the kind of knowledge obtained through walking as an ecological practice, and a pressing need to experiment with new ways of documenting and representing these experiences.

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HOW CAN LANDSCAPE ARCHITECTS GUIDE THE DESIGN OF NEW RURAL LANDSCAPES ? THE EXAMPLE OF AGROECOLOGY APPLIED TO VINEYARDS

TOPIC: Guiding territories by changing the design of regional projects: tools for intervention at different scales, for multifunctional landscapes

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Keywords: Agroecology, grape conservatory, landscape design, biodiversity, Moët & Chandon

Abstract

As climate change increasingly impacts viticultural territories, the Champagne region—inscribed on the UNESCO World Heritage List since 2015—faces the urgent need to adapt both its agricultural practices and its landscapes. This paper explores how landscape architects can contribute to the ecological and spatial transformation of rural viticultural sites, using the principles of agroecology and vitiforestry. It highlights the role of landscape design not only in fostering biodiversity and improving resilience but also in enhancing the cultural and aesthetic value of wine-producing territories.

The research focuses on a case study in the Champagne region: the **Essentia Grape Conservatory**, designed by landscape architects for Moët & Chandon between 2022 and 2024. This four-hectare site was conceived as a pilot project to conserve grapevine biodiversity while integrating agroecological principles such as regenerative hydrology, habitat creation, and compatible tree planting within a viticultural context. The landscape architects applied a comprehensive methodology, including site analysis, hydrological management, and spatial planning of visitor routes and ecological corridors.

The project demonstrates how a multidisciplinary landscape approach—grounded in both technical knowledge and artistic sensitivity—can provide innovative responses to climate-related challenges. Using the site's natural topography, subtle contour lines were utilized to manage water flows, reduce erosion, and create wetlands. Over 140 tall trees, 500 meters of native hedgerows, flower meadows, and conservation orchards were planted. Biodiversity features such as nesting boxes, stone piles, and amphibian habitats were also integrated. The site has quickly become a living ecosystem, showcasing immediate environmental benefits and serving as an educational tool through self-guided visitor paths.

Nevertheless, the paper underscores the limits of replicability in productive vineyards. Unlike this experimental site, active vineyards face economic and agronomic constraints, including limited planting space, concerns over yield reduction, and root competition. The transformation of these working landscapes must therefore be gradual, context-specific, and based on long-term observation.

Additionally, any landscape evolution in the Champagne region must align with the criteria of Outstanding Universal Value (OUV**)** established by UNESCO. Landscape interventions must reinforce, rather than compromise, the heritage character and identity of the terroir. Thus, the paper advocates for a careful, resilient reinterpretation of the Champagne landscape that respects its historical significance while enabling ecological adaptation.

In conclusion, the Essentia project offers a promising model for how landscape architecture can act as a driver of sustainable transformation in viticultural territories. By bridging ecological science, spa-

tial design, and cultural heritage, landscape architects contribute essential expertise to guide the evolution of rural landscapes in the face of climate and environmental pressures.

Text

1. INTRODUCTION

A rural landscape typically results from a territorial organization shaped by the need to cultivate land for food production or other agricultural resources. Farmers and winegrowers act as landscape gardeners, shaping their environment. Topography, roads, hydrology, and more recently renewable energy installations also contribute to the configuration of French rural landscapes. For example, lines of trees mark the passage of roads, riparian vegetation reveals the course of rivers, and uncultivable slopes or ditches are often naturally or intentionally vegetated.

This rural landscape evolves in response to land parcel reorganizations (such as land consolidation) and changes in agricultural practices.

In such contexts, the involvement of a landscape architect is generally not required, except during upstream planning phases as part of spatial planning documents.

The landscape architect becomes more actively involved when specific challenges arise that require detailed pre-operational landscape assessments. In the current context—characterized by heightened collective awareness of climate change impacts, finite natural resources, and the necessity to preserve French landscape heritage—territorial development practices inherited from the "all-oil" era must be reconsidered.

Key questions include: How can agriculture be reintegrated into peri-urban areas? How can ecological corridors be restored? How can large-scale agricultural buildings be integrated into rural settings? How can renewable energy infrastructures (photovoltaic farms, biogas plants, wind turbines) be spatially and visually harmonized with their surroundings? How can territories be supported in adapting to extreme climate events?

This paper explores how landscape architects can guide the creation and transformation of new rural landscapes in response to this last challenge.

2. Materials and methods

2.1 Study area and context

The study area is situated in the Champagne region, within a vineyard that has been inscribed as a UNESCO World Heritage Site since 2015 due to its cultural and patrimonial significance. Following a rigorous evaluation process, UNESCO recognized the *Outstanding Universal Value (OUV)* of the "Coteaux, Maisons et Caves de Champagne," highlighting, in particular, the distinctive landscape identity and heritage features of its vineyard environment.

Like many wine-producing regions, the Champagne vineyard is progressively acknowledging the need to adapt to the changing conditions driven by climate change. Extreme weather phenomena and seasonal irregularities are inducing shifts that compromise both pedological quality and grape production.

Current observations clearly indicate that climate change is modifying vine phenology and degrading both soil structure and grape composition. For instance, grapes have become sweeter and less acidic, harvest periods are advancing, and extreme meteorological events—spring frost, humid mild winters, and storms—are on the rise. Additionally, the emergence of new phytosanitary threats, such as *Scaphoideus titanus* (leafhoppers), linked to expanding insect habitats, is causing significant damage, including the spread of « flavescence dorée ».

At the same time, as a sector of excellence, the Champagne region is implementing proactive strategies to address environmental pressures, such as reducing synthetic inputs, introducing inter-row grassing, and diversifying ground cover, all within the framework of the "Viticulture Durable en Champagne" (Sustainable Viticulture in Champagne) certification scheme.

2.2 Definitions

Agroecology combines principles of agriculture and ecology to design agricultural systems that maintain ecosystem functions. According to Cambridge, agroecology attempts to design food

systems and managed landscapes in ways that sustain ecosystems.

In France, agroecology applied to vineyards, particularly the integration of tree planting with vine cultivation, is termed "vitiforestry." This specific term, however, is less commonly used internationally.

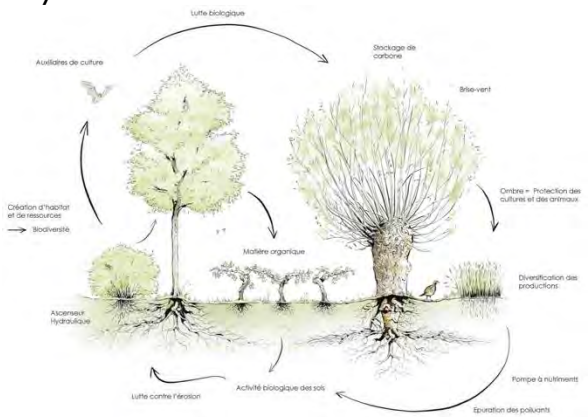


Figure 1. Agroecology applied to vineyards
© Métamorphose

2.3 Design material

This paper is based on the design work and studies undertaken by the landscape design firm Metamorphose between 2022 and 2025 for several Champagne Houses, in particular Moët & Chandon.

2.4 Case Study

The study of a practical case helps to understand how landscape architects are called upon to work in the vineyards at the request of the Champagne houses. The example presented here is the design work undertaken by the landscape architects Ariane Smythe and Benoît Vignes for the world-famous champagne Moët & Chandon within the Essentia Grape Conservatory (2022-2024) in Puisieulx between Epernay and Reims. The documents presented are the result of this design and project management process. [2]

3. ESSENTIA, THE MOËT & CHANDON GRAPE CONSERVATORY

3.1 Moët & Chandon's ambition

Faced with the reality of the impact of climate change on vineyards, Moët & Chandon has been committed to researching and developing new agricultural practices and deploying innovative, sustainable solutions since 2001.

In 2007, Moët & Chandon obtained ISO-14001 certification for all its sites and activities. In 2014, its vineyards - the largest in Champagne with 1300 hectares - were awarded the dual certification of Viticulture Durable en Champagne and Haute Valeur Environnementale. [1]

More recently Moët et Chandon has launched the program Natura Nostra in 2021 to create or restore 100 km of ecological corridors through Champagne region on its own estate but also with its grape suppliers, convinced of the ability of biodiversity to naturally preserve the vine.

As part of this mission, Moët & Chandon took the initiative of creating Essentia, a conservatory for the diversity of grape varieties in the region. By studying the behavior of vine stocks, the aim is to identify the most robust and resilient vines.

Plant material is one of the major levers for meeting the challenge for adapting the Champagne wine growing practices to climate change. The aim of the conservatory is to preserve the genetic heritage of Champagne grape varieties. Some of these plants could have interesting aptitudes, such as resistance to water stress, to disease or late ripening. We are talking about plants from the 1970s, before clonal selections were introduced.

Eventually, 16,000 vine stocks, from 1,800 varietals of the Moët & Chandon grape varieties (chardonnay, pinot noir and meunier) as well as 200 varietals of forgotten varieties, such as pinot gris or petit Meslier, will be assembled on nearly 2.5 hectares of the 4 h site. In order to put together this veritable 'living library' to be passed on to the future generations, the Moët & Chandon vineyard teams, from 2019, have criss-crossed more than 80 plots in Champagne.

Essentia is not only a conservatory for grape variety diversity but also a showcase of biodiversity across its 4-hectare site.

3.2 The request made to the landscape designers

Véronique Bonnet, Biodiversity and Landscape Manager for Moët & Chandon called the landscape architects at MÉTAMORPHOSE to design the masterplan and details for this pilot project, organizing the site around the vine plots with trees and hedges compatible with the vines, managing rainwater, and creating natural habitats, including wetlands.

Constraints were set regarding the required vineyard areas, on-site air currents to mitigate frost risks, and the design of visitor pathways.

3.3 Site analysis

The selected site for the Grape Variety Conservatory was selected by Moët & Chandon for its size, potential for expansion, proximity to the vineyard, and its location near one of their pressing centers on the Romont estate.

The site lies adjacent to a forested ecological corridor identified in the local Green and Blue Infrastructure. This location corresponds to a missing link highlighted in the SCoT2R planning scheme. The proposed Conservatory project is strategically positioned to reinforce this corridor by functioning as an ecological extension zone or a discontinuous "stepping-stone" pathway.



Figure II. Agroecology applied to vineyards
© Métamorphose

The bare plot of land of open agricultural landscape is positioned between the forested slopes of the Montagne de Reims to the south and the riparian vegetation along the Vesle Valley to the north. Although this area constitutes a missing link within the broader ecological corridor, it still contains several vegetated features that provide latent connectivity: remnant vegetation along the Rilly stream, the wooded park at Puisieulx, isolated groves—including one at the site's northern edge—and spontaneous vegetation along road and railway embankments (D33 and SNCF lines).

Through diversified planting and the application of ecological management practices, the Conservatory is expected to enhance the environmental value of the current agricultural site and strengthen ecological continuity by linking with existing groves and vegetated edges.

Even though the site is relatively flat, the landscape designer's instinct is to make use of the natural topography by incorporating contour lines—subtle yet visible to the naked eye—to organize the elements of the future landscape. The site features a modest elevation change of 5 meters between its highest and lowest points, with a slope ranging from 1% to 4.2%. Similarly, careful consideration of views to and from the site helps identify key sightlines that should be preserved.

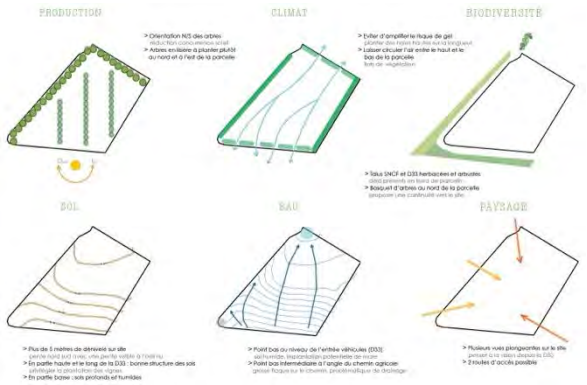


Figure III. Multi-criteria site analysis
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3.4 Creating a new landscape

Le slite slope was enough to imagine a main ditch following a contour line guiding rainwater to the foot of a high hedge planted in another ditch, collecting road water on the way and returning it to the low point of the site in a wetland partly sealed with clay (bentonite). A second wetland manages excess water from the nearby path, which was often flooded. The site's relief, however slight, is thus revealed and useful for the natural watering of the plants.

The equivalent of 1.5 hectares has been landscaped, with 140 tall trees, 500 meters of indigenous hedges and a conservation orchard. Perennials were introduced, including marsh irises, roses and marsh bulrushes, formerly used in vineyards.

Finally, a flower meadow was also planted by Moët. In addition to this, crops based on a mixture of alfalfa, vetch and clover were sown; nesting boxes, perches, stony terrains and piles of branches were created to encourage birds to nest and offer small mammals and amphibians shelter from predators. Moët & Chandon has also installed educational panels to enhance the authorized self-guided tour of the site.

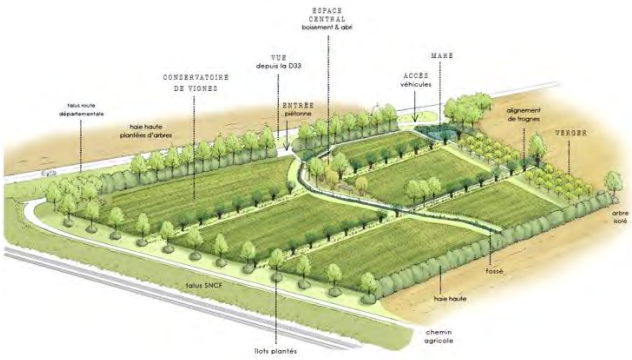


Figure IV. Aerial sketch of the design
© Métamorphose

A "dry feet" circuit has been designed to provide a varied and representative overview of Essentia on a loop of less than 400 m. The composition also takes into account the views of the vine conservatory from the access roads, the orientation of the site to ensure good grape production and the creation of windbreaks.



Figure IV. Aerial photo of the visitors path
© Moët & Chandon

A participatory planting day was organized with volunteers working for Moët & Chandon, as they often do within their Natura Nostra planting program. Essentia is evolving into a new ecosystem around the vines, with birds arriving from the very first year, large numbers of tadpoles in the wetland, deer coming to drink, etc. The site is maintained by the differentiated management of meadows and plantations. Some tree rows will be strongly pruned in the future to reduce shade and root competition with the vines.



Figure V. The participatory planting day, with the Moët & Chandon teams and A. Smythe
© Moët & Chandon

3.5 A showcase site to encourage change

It would be ideal to reproduce the same agroecological principles directly in the vineyard, and this is what some champagne "Maisons" are starting to do, but the constraints are of course greater.

Essentia is seen as a pilot project which means that the conditions were "ideal": the whole site was designed from scratch and nearly flat, it's easily accessible from the road, no need to pull up rows of vines in order to plant the trees considering the economic value of vines and space was available and space was generously available.



Figure VI. One of the many visits
© Métamorphose

Essentia aims to serve as a demonstration model, proving that it is achievable, while maintaining a large test plot to monitor the evolution of ecosystems alongside the health of the vines over time.

4. THE ADDED VALUE OF A PROJECT VISION TO GUIDE THE EVOLUTION OF RURAL LANDSCAPES

4.1 The usual contacts for a wine-forestry project

Several vitiforestry initiatives have been undertaken in Champagne and elsewhere, often led by specialists with more scientific backgrounds—such as agronomists, foresters, botanists, or ecologists. While these approaches yield positive results, they do not always address the broader range of issues involved, such as public accessibility, landscape enhancement, or strengthening brand identity within the terroir.

4.2 At the crossroads of several professions

The landscape architect serves as a bridge between disciplines—particularly between architects, who spatialize and design built environments, and ecologists, who study and preserve living ecosystems. This role also requires sensitivity to hydrological processes, including the management of rainwater and its intentional redirection for ecological functions such as plant irrigation, aquifer recharge, and local humidity regulation.

The landscape architect also possesses the necessary skills to develop detailed technical execution plans, which serve as a reference for contractors during the implementation phase on site.



Figure VII. First technical plans
© Métamorphose

4.3 A holistic vision of the landscape

Beyond being a professional in landscape design sensitive to living organisms and natural environments, the landscape architect envisions the changes to the landscape induced by their projects or proposed actions and assesses the relevance of these modifications in light of the historical evolution of the site or territory.

Unlike a specialist who perceives the world through a precise and rigorous discipline, the landscape architect benefits from a more generalist training, which leads to a broader vision encompassing multiple fields of expertise.

4.4 A multidisciplinary response

The landscape project approach, supported by a rigorous upstream site analysis and applied to a landscape-related issue within a rural territory such as a vineyard, allows for addressing numerous challenges faced by a wine-producing estate—provided that the designers possess a strong local understanding of the soil and climate, the professional viticulture organization, as well as operational constraints (such as track widths or limitations on shading and root competition).



Figure VIII. Fist year after planting the trees and shrubs © Métamorphose

Through their training and experience, the designers adopt a working methodology grounded not only in analytical skills but also in a sensitivity to perceive sites through numerous criteria, initiating an artistic process of conceptualization and transformation. This is complemented by a thorough knowledge of living organisms, particularly plants suited to specific contexts. Their understanding of ecosystem restoration and practical intuition regarding the natural water cycle enable them to propose design solutions focused on the water-soil-tree triad. These solutions aim to slow down, distribute, infiltrate, and store water rather than simply draining and evacuating it. This approach is currently known as regenerative hydrology.

Applied within a vineyard project framework, the landscape architect seeks to enhance the initial

site's landscape value and carefully controls the assessment of the visual impact of the proposed interventions. They also develop relevant solutions to visitor management challenges, including the design of well-adapted visitor routes.

Moreover, the landscape project can address key aspects important to the Champagne Houses, such as reinforcing brand perception and promoting the unique history and identity of their vineyards through interpretative storytelling and other strategic approaches.

5. CONCLUSION

The Essentia project, designed as an agroecological demonstrator within a viticultural context, highlights the potential of a landscape-based approach to support the transition of practices in response to climate change. By combining tree planting, water management, and ecological diversification, this pilot site offers a structured spatial response, tailored to ecosystem preservation and landscape enhancement.



Figure IX. Aerial photos of Essentia
© Moët & Chandon

However, applying these principles directly within productive vineyards remains complex. Economic, land-use, and technical constraints—such as the high value of vineyard land, root and sunlight competition and potential yield reduction—require careful, case-by-case adaptation and gradual implementation over the long term. The transformation of viticultural landscapes must therefore be considered as a phased process, informed by replicable experiments and field feedback.

Furthermore, any landscape evolution within the Champagne vineyards—inscribed as a UNESCO World Heritage Site—must be assessed in light of the criteria for Outstanding Universal Value (OUV), particularly those related to landscape identity and the legibility of the terroir. The challenge is to allow these landscapes to evolve without compromising the attributes that justified their international recognition, but rather to reinforce them through a renewed and resilient interpretation of the viticultural territory.

Acknowledgments
We are very grateful to Véronique Bonnet for entrusting us with this collaboration and for the constructive work we carried out together on these subjects. Our thanks also go to Véronique Bonnet and Patricia Criton for sharing valuable insights into the technical viticulture aspects of Essentia and for providing further details on Maison Moët & Chandon's commitment.

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BEYOND THE SURFACE: TRANSFORMING 2D GREEN INFRASTRUCTURE TYPOLOGIES FOR 3D RESIDENTIAL GREEN SPACE CLASSIFICATION IN SINGAPORE

TOPIC: Guiding territories by changing the design of regional projects: tools for intervention at different scales, for multifunctional landscapes

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Keywords: 3D landscape typology, Residential green space, Point cloud, 3D spatial metrics; Green infrastructure typology

Abstract
Improving the quality of residential green spaces (RGSs) is regarded as an alternative to simply intensifying their physical quantity to create a better urban environment, especially in compact cities like Singapore with limited space for urban greening. Enhancing the quality of these spaces can vary depending on the context, requiring context-specific strategies for well-informed design. Currently, several 2D typologies can be used to characterize RGSs' contexts. For example, the Green Infrastructure Typology (GIT) developed by Bartesaghi-Koc, Osmond and Peters [1] is a landscape typological approach aimed at comparing and reporting the climatological effects of green infrastructures. It is based on physical and spatial attributes, such as the surface fractions of impervious surfaces, grasses, shrubs, trees, and water. However, representing the 3D spatial nature of the landscape (e.g., volume) is still challenging, possibly due to the limited capacity of recording devices to record the landscape in 3D [2].

To address this gap, this study modified the 2D GIT for 3D RGS classification. Specifically, we used a laser scanner to generate 3D point clouds for 144 RGSs in Singapore. We then converted each landscape category from 3D to 2D by removing the vertical coordinates from the point clouds and classified them according to the 2D GIT. Simultaneously, the 3D features of the 144 RGSs were represented using previously developed point cloud-based 3D metrics [3]. The results from the 3D metrics were used to adjust the classification thresholds of the 2D GIT for 3D classification.

The classification process revealed five predominant GIT types in the scanned RGSs, including three impervious groups (i.e., IM1, IM2, and IM4) and two mixed groups (i.e., MX1, MX4) of hard surface and vegetation. These 2D typologies showed significantly different results in 3D spatial metrics, like green volumetric ratio. Based on the results of the metrics, we modified five typologies for 3D landscape classification in Singapore. The significance of this study lies in the modified typological approach for 3D landscape representation and the identification of the main typologies of residential green spaces in Singapore.

1. Introduction

City densification has significantly reduced the quantity and quality of urban green spaces (UGSs), deteriorating the urban environment and as a consequence human well-being as well. UGS broadly refers to "any vegetation found in the urban environment, including parks, open spaces, residential gardens, or street trees" [4]. Planning and managing UGSs has been a crucial topic in

cities, as these spaces benefit cities in multiple ways, such as improving air quality and thermal comfort, benefiting physical and psychological health, creating social coherence, and providing recreation, relaxation, and landscape aesthetics [5].

While most studies have focused on the quality of urban parks in UGS planning and management, we argued that RGSs should be prioritized and hold equal or potentially greater importance than urban parks because there is limited land for new park development in compact cities like Singapore. Additionally, RGSs are the most visited type of UGSs by residents due to their proximity to the residential units [6, 7]. Given the substantial impact of exposure time to green spaces on human health [7] and more time spent in RGS compared to other UGS types, it is imperative to allocate greater attention and effort toward improving the quality of RGS within compact cities.

Enhancing the quality of green spaces requires context-specific strategies tailored to the unique characteristics of each site. Various 2D typologies have been developed to support such context-aware design. For instance, the Green Infrastructure Typology (GIT), proposed by Bartesaghi-Koc, Osmond and Peters [1], offers a landscape-based classification system designed to assess and compare the climatological impacts of green infrastructure. This typology relies on physical and spatial attributes, including the surface coverage of impervious materials, grasses, shrubs, trees, and water bodies. Despite the usefulness of such 2D approaches, effectively representing the 3D spatial characteristics of landscapes (e.g., volume) remains a challenge. This limitation is likely due, in part, to the constrained capabilities of current recording technologies to capture landscape features in 3D [2].

This study aims to modify the 2D GIT for the 3D RGS classification within high-density residential estates in Singapore using 3D spatial metrics. The specific objectives are: (1) to investigate the RGS typology in Singapore through the GIT, (2) to classify RGSs using 3D spatial metrics, and (3) to modify the GIT for 3D RGS classification. This research seeks to adapt the conventional 2D typology framework to incorporate 3D spatial characteristics, thereby enhancing its applicability in the context of high-density urban environments.

2. Methodology

We developed a methodological framework (Figure 1) to classify RGSs in Singapore on a local scale. The framework consists of four components: (1) selecting and scanning a set of RGSs to represent RGSs in Singapore; (2) categorising the RGSs using the GIT; (3) classifying green spaces using 3D spatial metrics; and (4) modifying the GIT for 3D RGS classification.

2.1 Data collection and process

There are three types of housing in Singapore: public housing, private properties, and public-private hybrid. Our study focuses on public housing developed by Housing & Development Board (HDB) because it is the most popular and affordable property type for Singaporeans. Thirty-six public housing blocks in different regions were selected. In each of these blocks, four green spaces were identified from different directions. It is noted that even around the same block, the amount of urban greening can vary dramatically between the four scanned locations. Overall, a total of 144 scanned sites were identified to represent the RGSs in Singapore.

A FARO Focus S350+ terrestrial laser scanner was deployed to collect the 3D point clouds of the 144 RGSs. The three-dimensional nature of the scanned data documents the spatial and physical attributes of landscapes. In each scanned location, we first identified a central viewpoint (the red point in Figure 1) to mimic the people's point of view of the immediate landscape. Then, we scanned the surrounding areas from different locations (yellow points in Figure 1) to avoid any possible occlusions while documenting the RGS. The point clouds collected from all scanning locations were combined and clipped to form a circle since human visual fields are often represented as a circular space radiating out from the central viewing position. A circle of 60m in diameter was chosen to balance the time taken to scan and the context of the RGSs, which tends to be relatively compact.

Subsequently, the unclassified point clouds were manually classified into different categories according to landscape elements defined as grass, shrub, trees, buildings and pavilions, pavements and walkways, and water in this study. Since the point clouds failed to capture information in physically occluded objects, such as the interior of buildings, we manually filled these while eliminating any noise to improve the data reliability. Finally, the classified

point clouds were voxelised to estimate the volume of each landscape category. In this study, each voxel represents a cubic volume (0.2 x 0.2 x 0.2m), and the properties (e.g., colour or classification) of a valid voxel depend on the most common value of the points that fall into the 3D space of the voxel [8].

However, the 3D data collected by the scanner are inconsistent with the 2D approach in GIT. Therefore, we firstly transferred each landscape category from 3D to 2D by removing the vertical coordinates of point clouds. Then, we removed the duplicate points in 2D and calculated the surface fraction of each category to align with classification parameters in GIT. Finally, according to threshold values, all 144 scanned RGSs were classified into their respective types.

2.2 Classifying residential green spaces using a 2D GIT

The GIT developed by Bartesaghi-Koc, Osmond and Peters [1] is a landscape typological approach that initially aims to compare and report the existing climatological effects of green infrastructures. It is developed based on physical and spatial attributes, including the surface fractions of impervious surfaces, grasses, shrubs, trees and water. In our study, the GIT is modified to classify the RGSs because of its applicability at the local scale and the possibility of automating the classification based on the extracted physical and spatial attributes of the scanned sites. Table 1 provides the specific classification parameters and threshold values of modified GIT.

2.3 Classifying residential green spaces using 3D spatial metrics

Spatial composition was quantified by the volume or area ratio between the natural and the human-made landscape. The green volumetric ratio calculated by Eq. 1 is the ratio between the volume of non-ground green (e.g., trees and shrubs) to the entire volume of the non-ground landscape. The green-blue ratio is the ratio of grass and water areas to the total ground area and can be calculated using Eq. 2. A high green volumetric ratio or green-blue ratio indicates that the landscape is close to the preconceived natural environment with few man-made structures visible.

$$GVR = \frac{Gv}{Tv} * 100 \quad \text{Eq.1}$$

$$WR = \frac{Ga+Wa}{Ta} * 100 \quad \text{Eq.2}$$

Where GVR is the green volumetric ratio, Gv and Tv denote the volume of non-ground vegetation and the entire volume of non-ground landscape, respectively, WR refers to the green-blue ratio, the Ga and Wa are grass and water area, respectively, and Ta is the total ground area. We then employed the K-means clustering method, incorporating both horizontal and vertical attributes for the 3D RGS classification. To facilitate comparison between 2D and 3D classification results, the 3D classification uses GVR and WR as criteria, aligning with the criteria (e. g., tree fractions) of the 2D GTI. To ensure the reliability of 3D classification, Kappa statistic was used to compare the classification results.

2.4 Modifying 2D GIT for 3D residential green space classification

To adapt the 2D GIT for 3D RGS classification, we implemented a three-step process. First, we calculated 3D spatial metrics for each 2D RGS type. Analysis of variance (ANOVA) was used to determine whether these 2D types exhibited statistically significant differences in their 3D attributes. Second, we compared the 2D surface fractions (e.g., grass, shrub, tree, water, and impervious surfaces) of both 2D and 3D RGS types to evaluate the consistency of classification thresholds between the two methods. Third, we examined 3D metrics across all scanning sites to assess the necessity of incorporating volumetric criteria. For instance, small building footprints may correspond to large volumes due to building height, which cannot be captured by area-based metrics alone. Based on the statistical distributions of 3D attributes within each 2D RGS type, we defined new threshold ranges and integrated them into a modified GIT framework to enable more accurate and robust 3D classification in compact urban environments.

3. Results

3.1 2D classification of residential green spaces

According to modified GIT, 144 RGSs were classified into six categories (Figure 2). Specifically, 32 RGSs are mostly impervious with grasses (IM2),

Table 1. Classification parameters and threshold values of the modified GIT [1]

Group	RGS type	Description	Surface fractions (%)				
			Impervious	Grass	Shrub	Tree	Water
Impervious	IM1	Highly impervious	>75	≤25	≤25	≤25	≤25
	IM2	Mostly impervious with grasses	50-75	<50	≤25	≤25	≤25
	IM3	Mostly impervious with shrubs	25-75	<40	25-50	≤25	≤25
	IM4	Mostly impervious with trees	50-75	<40	≤25	5-40	≤25
Mixed	MX1	Mostly grasses with impervious	25-50	≤ 50	≤25	≤40	≤25
	MX2	Mixed surfaces without trees	25-50	≤ 50	≤ 25	≤ 5	≤ 25
	MX3	Mixed grasses and bare soils	≤ 25	≤ 75	≤ 25	≤ 5	≤ 25
	MX4	Mixed surfaces with trees	25-50	≤ 50	≤ 25	5-50	≤ 25
	MX5	Mixed grasses with trees	≤ 25	≤ 50	≤ 25	5-75	≤ 25
Pervious	PV1	Mostly grasses	≤ 25	25-75	≤ 25	≤ 5	≤ 25
	PV2	Mixed grasses with shrubs & trees	≤ 25	<60	25-50	≤ 50	≤ 25
	PV3	Mostly shrubs	≤ 25	< 50	> 50	≤ 25	≤ 25
	PV4	Mostly grasses with trees	≤ 25	40-50	≤ 25	5-50	≤ 25
	PV5	Dense trees with shrubs & grasses	≤ 25	≤ 25	≤ 75	>75	≤ 25
Aquatic	AQ1	Water	≤ 25	≤ 25	≤ 25	≤ 25	> 75
	AQ2	Mostly water with grasses	≤ 25	< 40	≤ 25	≤ 5	50-75
	AQ3	Mostly grasses with water	≤ 25	< 60	≤ 25	≤ 5	25-50
	AQ4	Mixed surfaces with water	25-50	≤ 50	≤ 25	≤ 25	25-75
	AQ5	Water with trees	≤ 25	< 40	≤ 25	5-75	25-75

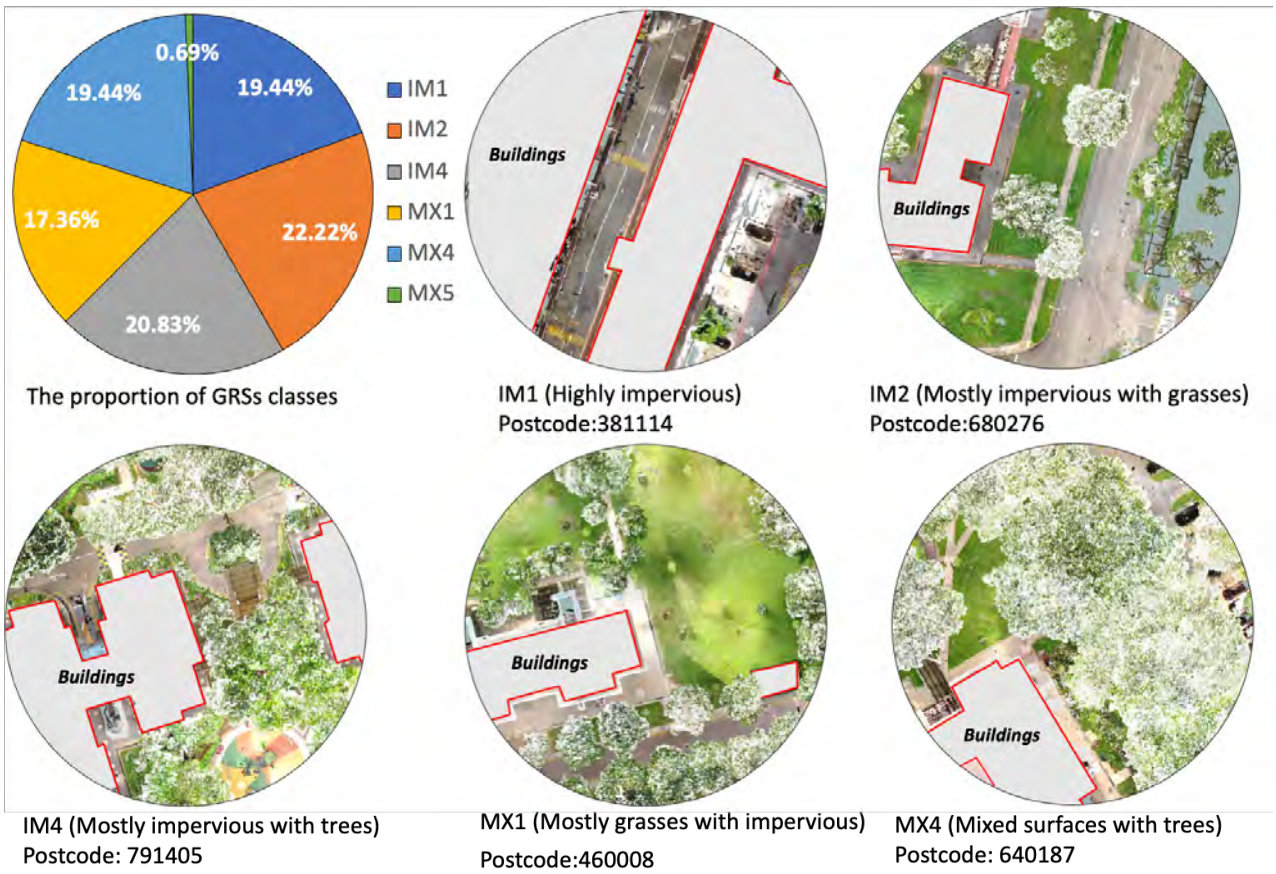


Figure 2. The proportion and examples of predominant landscape types in the study areas

scanned sites. This is followed by the mostly impervious with trees (IM4), including 30 RGSs and 20.83% of total sites. The highly impervious (IM1) and mixed surfaces with trees (MX4) have the same number of sites (28). A total of 25 sites (17.36%) are mostly grasses with impervious (MX1). Comparatively, mixed grasses with trees (MX5) only cover one site, which has the lowest percentage of total sites with less than 1%. To sum up, IM1, IM2, IM4, MX1, and MX4 are the predominant RGSs types in the scanned sites.

3.2 3D classification of residential green spaces

The number of clusters in 3D classification was defined as five, consistent with the number of main GTI types on scanning sites. The Kappa scores showed that the classification results between five clusters and the other number of clusters were consistent. For example, the Kappa scores between five clusters and three, four, six and seven clusters are 0.823, 0.665, 0.723, and 0.809, respectively, indicating their high level of agreement [9]. We, therefore, argue that the 3D classification results based on five clusters are reliable. Figure 3 shows the 3D classification results, including 3D RGS types of A1, A2, A3, A4, and A5 from low to high naturalness.

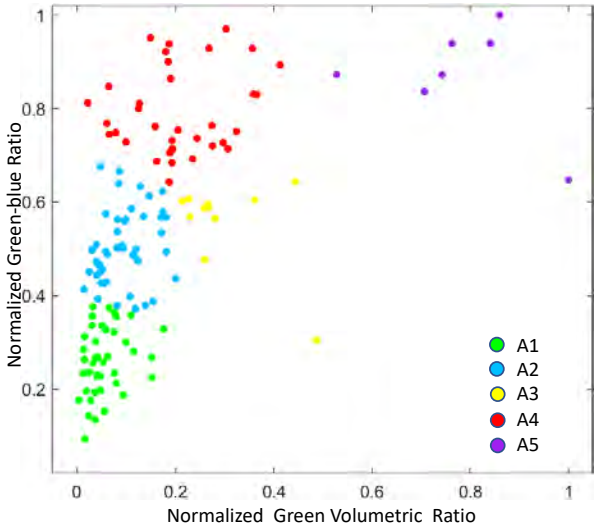


Figure 3. 3D RGS classification

3.3 Modification of GIT for 3D residential green space classification

3.3.1 3D spatial metrics of 2D RGS types

There are six 2D RGS types in the study areas. Since MX5 has an extremely low number of samples due to the residential nature of the scanned sites, it will not be discussed in 3D spatial analysis. ANOVA was employed to analyse the difference between 2D landscape types in the 3D spatial metrics. The results show that IM1, IM2, IM4, MX1, and MX4 have significantly different outcomes ($p<0.05$) on the green volumetric ratio and green-blue ratio.

Figure 4 presents the metric results of five main types of RGSs in this study. The MX4 has the highest green volumetric ratio, with an average value of 6.25. This is followed by the MX1, with a ratio of 5.76. IM1 has the lowest ratio of less than 1. Other groups range from 1.58 and 2.67. For the green-blue ratio, the group with the highest ratio is MX1 (54.25). MX4 also has a high green-blue ratio of 46.05. The green-blue ratio of IM1 is the lowest, with only 15.97. To sum up, the green volumetric ratio and green-blue ratio results are quite similar. MX1 and MX4 have significantly higher green volumetric ratios and green-blue ratios than other RGS types, indicating their high non-ground and ground naturalness. Also, the IM1 shows the lowest green volumetric ratio and green-blue ratio due to its high ratio of building volume to space and pavement area to land.

3.3.2 Surface fractions of residential green space types in 2D and 3D classification

The RGSs' surface fractions of 2D and 3D types (Table 2) were calculated and compared to explore the difference between the 2D and 3D classification methods. Specifically, we ranked the RGS types from low to high naturalness and compared 2D and 3D types with the same level of naturalness. For example, surface fractions of IM1 and A1 were compared as they are at a low level of naturalness. The results (Table 2) show that the thresholds of grass, shrub, and water fractions in 3D classification are consistent with 2D classification. For instance, the grass fraction of A1 (1-17%) falls within the range of IM1 (<25%). However, the thresholds of impervious and tree fractions in 2D and 3D classification are different. For example, the impervious fraction of A4 (27-55%) is out of the range of MX1 (25-50%).

3.3.3 *2D* GIT *for 3D* residential green space *classification*

To explain the different thresholds of 2D and 3D classification in impervious and tree fractions, we compared the building area (or building footprint),

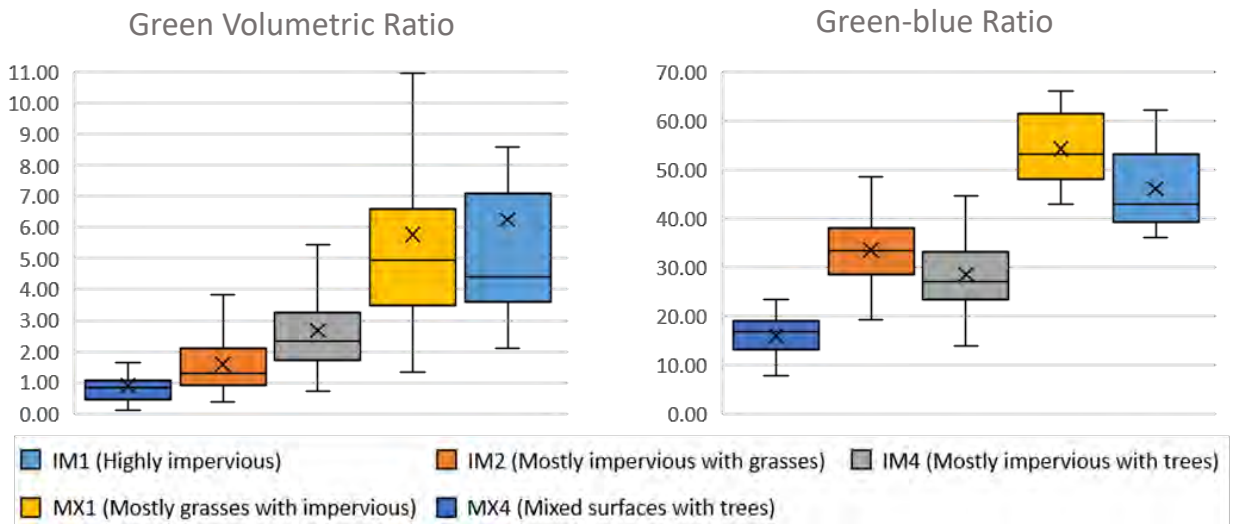


Figure 4. The spatial metrics of five landscape types in high-density resident areas

Table 2. RGSs' surface fractions of 2D and 3D types

	Naturalness	Type	Impervious (%)	Grass(%)	Shrub(%)	Tree(%)	Water(%)
2D classification	Low	IM1	>75	≤25	≤25	≤25	≤25
	Medium	IM2	50-75	<50	≤25	≤25	≤25
		IM4	50-75	<40	≤25	25-50	≤25
	High	MX1	25-50	≤ 50	≤25	≤40	≤25
		MX4	25-50	≤ 50	≤ 25	5-50	≤25
3D classification	Low	A1	60-98	1-17	0-7	1-23	0
	Medium	A2	41-76	12-28	0-22	4-33	0
		A3	24-67	11-24	0-14	17-35	0-22
	High	A4	27-55	21-46	0-22	10-38	0-3
		A5	34-44	22-35	1-10	26-33	0

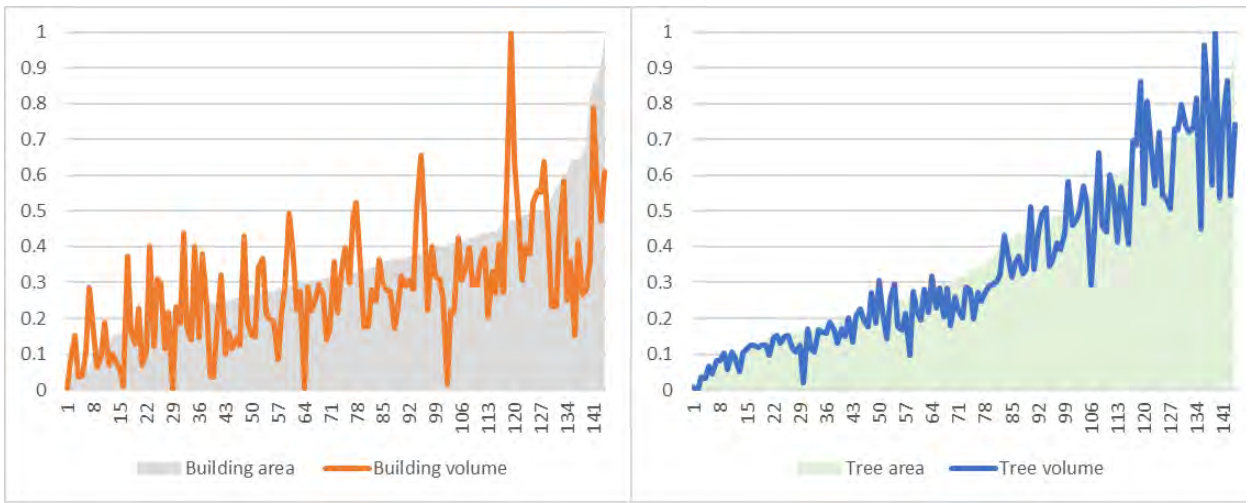


Figure 5. Classifying RGSs with cluster analysis

building volume, tree area, and tree volume of all scanning sites, as shown in Figure 5. The sites with low building areas may have high building volumes since the volume results jointly from building area and height. Similarly, the tree volume depends on the area and height. However, area-to-volume

ratios of trees are less varying than the ratios of buildings because the range of tree heights is significantly less than the range of building heights on the scanning sites. Thus, we argue that thresholds of grass, shrub, and water fractions in the GTI can be used in both 2D and 3D classification of RGSs, while thresholds of impervious and tree fractions fail to support the 3D classification. To improve the GTI in 3D classification, we added criteria of green volumetric ratio and green-blue ratio and identified their thresholds based on our scanning results. Table 3 provides the specific range of each GIT type to support its application in 3D.

Table 3. The 3D attributes of GIT

Classes	Green volumetric ratio (%)	Green-blue ratio (%)
IM1	≤4	≤32
IM2	≤5	19-55
IM4	≤11	13-50
MX1	≤18	42-67
MX4	≤21	36-63

4. Discussion

4.1 Landscape typology of high-density communities in Singapore

Singapore has numerous high-density communities due to both its constraints on available land and its successful public housing policies. Our results show that almost 99% of the scanned locations have half of their land covered by buildings and impervious surfaces. This is an expected result considering our methodology called for the scans to be close to the residential blocks. Meanwhile, the intensive recreational spaces and facilities in Singapore's communities have also led to a high percentage of impervious surfaces. To provide residents with active and healthy lifestyles, HDB estates have developed a wide range of recreational spaces and facilities (e.g., fitness areas, walking and cycling paths, and playgrounds), which are usually covered by impervious surfaces [10].

In addition, the 144 scanned RGSs only cover five main RGS types, indicating that there is a high similarity in landscape composition around the high-density resident areas in Singapore. Two reasons can explain this: First, residential blocks are often built away from water bodies, resulting in a lack of water-related RGS groups; Second, shrub groups are excluded due to the small proportion of shrubs in the scanned RGSs. For example, the highest shrub ratio to total land area is 21%, which is less than the lowest threshold (25%) of shrub categories. The joint effect of the low water body and shrubs ratio leads to the high similarity in landscape types.

4.2 Limitations

This study selected four scan locations in different cardinal directions to represent RGSs around selected residential blocks. The sampling method and the size of each scanned site may not fully describe the landscape composition and distribution around these blocks and certainly not within the estate itself. This limit of a 60m diameter scanned circle also results in landscape elements outside the circled areas being ignored in the calculations. Finally, the study only focuses on public housing estates in Singapore. The private condominiums, houses, parks and gardens that are also important areas of interest in the city are not covered.

5. Conclusion

This study scanned 144 sites representing RGSs in Singapore, subsequently categorised them using a 2D GIT and 3D spatial metrics. The results show five predominant 2D RGS types in the public housing, including highly impervious (IM1), mostly impervious with grasses (IM2), mostly impervious with trees (IM4), mostly grasses with impervious (MX1), and mixed surfaces with trees (MX4). Comparative analysis of these types revealed significant differences in 3D spatial metrics. Furthermore, we found that thresholds for impervious and tree fractions differed between the 2D and 3D classification methods, suggesting that while 2D classifications are applicable for grass, shrub, and water features, they are insufficient for accurately capturing vertical characteristics of buildings and trees. To address this gap, we proposed a modified GIT framework that can not only reflect the 3D attributes of the five 2D RGS types but also supports 3D classification of RGSs in high-density urban environments.

Acknowledgments
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CARE FOR THE LANDSCAPE THROUGH REGENERATIVE VITICULTURE : TWO EXAMPLES IN THE LOIRE VALLEY OF FRANCE

TOPIC: Guiding territories – By changing the design of regional projects (energy landscapes, agroforestry, risks)

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Keywords: Regenerative viticulture, agroforestry, landscape of care, gardening, land-based methods

Abstract

The past half a century of viticultural history has focused on productivity and increasing yields through the extensive use of pesticides, herbicides and a number of fertilizers, degrading and impoverishing soils and terroir while also standardizing wine's global taste. Today, as viticulture attempts to adapt to a changing climate, land-based methods can be used to ease that transition. Professionals working with plants and living systems such as landscape architects are uniquely positioned to endorse a role of advising, guiding, and implementing these methods to accompany vineyard growers.

Two case studies of previously abandoned or degraded vineyards that have now turned to regenerative practices are described through the lens of care for the land. One in the Anjou appellation and one in the Muscadet appellation. These two examples offer novel ways that designers can be engaged in vineyard design and how this involvement benefits the landscape and the physical comfort of the vintner's work. In both examples, the vineyard is treated as a polyculture garden and the vintners are becoming fluent in new agricultural or forestry practices to care for their landscapes.

Vineyard owners in the face of climate change must learn not only how tend to their vines but also how to tend to their "gardens", meaning tending to their entire vineyard ecosystem including vines, trees, human and non-human forms of life. As we zoom out from the individual vineyard scale and start to look at the aggradation of parcels, the fields of viticulture and landscape architecture at large have a unique role in the design of regional projects.

Introduction

Today, as viticulture attempts to adapt to a changing climate, land-based methods relating to regenerative viticulture are increasingly used to ease this adaptation process. According to the regenerative viticulture foundation, regenerative viticulture is defined as a set of farming practices that restore and enhance soil health to create a biodiverse, climate-resilient vineyard ecosystem. There is a growing number of regenerative viticulture initiatives around the world and because of local specificities, it is particularly revealing to look into different applications of regenerative principles on the land. The following research is about two specific regenerative viticulture projects that are not only unique in their scope, but have also benefitted from the contribution of a designer in the process of adapting the vineyard.

The Domaine des Quarres, in the Anjou appellation is an example of the rewilding of a vineyard parcel and the integration of agroforestry and regenerative hydrology principles such as "keylines" in the landscape. The Domaine des Trois-Toits in the Muscadet appellation is a vineyard that recently has expanded on abandoned vineyard land and has called upon the expertise of a landscape architect to design several of their newly acquired parcels.

Alongside the rise of regenerative viticulture in the last decade, a certain return to terroir in winemaking has been happening in France. Terroir is defined as "a bounded place where generations of people have crafted a distinctive way of life during which they have created distinct products".[1] the true taste of terroir has always

been sought after in quality wine-making; and so, today, consumer tastes and global adaptation of the industry to climate-change have made the relationship between vineyard practices, winemaking, and vineyard biodiversity ever more important in preserving that taste of terroir.
In the Loire valley, there are a growing number of vintners introducing regenerative practices. Two case studies of previously abandoned or degraded vineyards that have now turned to regenerative practices are described through the lens of care for the land. The concept of care is one borrowed from the medical vocabulary usually applied to a living organism, but that can also be applied to landscape studies. According to Jacobs and Wiens "care has come to describe hopeful possibilities for how landscapes are researched, maintained, and designed."[2] the concept of care is helpful to frame the practices of these wineries and understand how they can heal the land as well as our relationship to nature.
This research is based on field visits and interviews conducted on site between November 2023 and May 2025 with the two wineries' owners and respective designers.

1. DOMAINE DES QUARRES : HYDROLOGY AND REWILDING

Domaine des Quarres is an example of the rewilding of a vineyard parcel and the integration of agroforestry and regenerative hydrology principles such as "keylines" in the landscape. Owned by Véronique Gourdon and Cédric Aubert since 2008, this unique parcel of 13ha benefits from a southern-sloped exposure above the small Layon River.



Figure I. Aerial view of the stepped parcel circa 2008 : the rows of vines follow the contour lines (photo credit: Domaine des Quarres)

In the 1970's the parcel was terraced to ease access for tractors, and an impressive underground drainage system was laid out to evacuate runoff as fast as possible down the slope.
Conventional viticulture was practiced for decades and by the time the current owners took over in the late 2000's, they found a "completely inert piece of land" according to Gourdon. As they began cultivating the parcel they made two fundamental decisions: one, to let the naturally occurring vegetation grow spontaneously every couple of rows, and two, to stop maintenance on the existing drainage system. These decisions were the foundation for their overall goal of producing wine without compromising the integrity of the *coteau* (sloped terrace). They started to witness an entire ecosystem of plants and animals reclaim the parcel (oak, ash, hawthorn, Spanish broom, fox, deer, birds of prey, butterflies, lizards…) Feeling that this parcel required special attention, and, as drought was becoming more and more frequent, the vintners began looking for design advice specifically on water retention. Since the parcel is terraced they were finding yields were higher the lower they went on the parcel because of the greater water availability. Thus, their goal was to redistribute the water flow more equally and to better retain moisture higher up on the slope.



Figure II. A 17 year-old oak tree is kept as a time stamp by the growers



Figure III. Satellite imagery comparison between 2005 and 2025

French viticultural specialist Alain Malard advised that they integrate some regenerative hydrology principles by implementing three swales of almost 2km in total length, some keylines and eventually a small pond. The swales serve both during heavy thunder storms to collect and slow water drainage making it available later on during dry periods. They have also used the keyline technique theorized by P.A. Yeomans which is a contour line where the inflexion of a slopes changes. [3] Along these lines, thin knee-deep cuts in the soil are made that allow water seepage and some oxygen into the previously compacted soil. Creating a pond also makes water available for animals which are then less induced to eat the grapes, suggests Gourdon.



Figure IV. An 800m long planted swale

Beyond the implementation of these hydrological systems and their positive impact on water retention and infiltration, of particular interest is the way the growers maintain their vines and the parcel as an entire gardened ecosystem promoting wildlife, plants, soil and water health. In recording the ways the growers take care of the parcel, the similarities between the vineyard parcel and gardening in general are manifest. The growers mentioned several methods of maintenance and ways of knowing on the land that are fundamentals of gardening practice: mainly observation, trial and error, repetition of seasonal tasks, daily visits, and enjoyment of the land for leisure use, i.e. picnics, casual walks, bike rides... The vineyard serves two functions, one, as their economic livelihood and two, since the parcel has no fencing and lies along hiking trails, it operates as a place of improved well-being both for themselves and for visitors alike.

They have also expanded the scope of their tasks beyond tending solely to the vines. Grass fills the rows of vines and is cut once or twice a year so as not to compete with the vines. When cutting happens, the growers are attentive to letting wildlife circulate and leave the immediate area. For instance they may delay cutting in that area for several days or weeks if a duck's nest is spotted. Vegetables are also planted throughout certain areas, mainly artichokes, squash, strawberries etc. There are also pomegranate shrubs intertwined with other local vegetation. By offering other types of fruits in the vineyard besides grapes, wild animals such as deer are not automatically drawn to the grapes thus preserving the harvest. By letting the grass grow close to the vines, water retention and soil aeration is enhanced, improving overall soil micro-biology. With climate-change, pruning happens on a different schedule than before with the risk of late frost in spring. These days pruning happens in late winter and in a condensed time-frame, making it the second most important and busiest time of the year after the harvest in the fall. The vineyard growers also mentioned the increased ease of working within a hybrid landscape instead of a vine monoculture. Given that three of their rows equals one hectare, the work, whether pruning or harvesting, can be arduous under tough weather conditions (heat waves or heavy rains). Thus, having more diversity in the landscape through increased shade or protection from the elements is vital towards easing the grower's work. They have even come to naming certain areas within the parcel according to a special feature or an anecdote relating to that area. These names are used both for way-finding for visitors but also as a way to break down the overall work into smaller identifiable parts. For example "The Jungle" area is the wildest part of the parcel with the most vegetation regrowth and animal presence.



Figure V. Sub-areas within the parcel are named after landscape features or anecdotal material (photo credit: Domaine des Quarres)

In an interview with the owners, they describe the parcel as "alive and changing with the seasons like a garden. We never know what we will see during a day's work". The growers were particularly enthused one day by the sighting of a buzzard and a kestrel falcon fighting in mid-air. Working with some shade from the tree or shrub canopy was also described as a relief in the hot summer months. Also, work will not happen in the same areas of the parcel depending on weather.

This example demonstrates how a vineyard initially set up for conventional viticulture can be hybridized into one that follows principles of regenerative viticulture enabling a vineyard better prepared to face climate change through the care of the soil, improved moisture retention and the welcoming of fauna and flora. The vintners are also looking for more ways to perpetuate the care and legacy of this parcel which include firstly, having it named a no-hunting zone, and secondly, through growing a community of "followers" or associates meaning people invested in the maintenance of the parcel, the quality of its wine production and the protection of its wildlife, thus creating a community-supported biodiversity reserve.

II. DOMAINE DES TROIS TOITS : VINEYARD DESIGN AT LA VILLE AU BLANC

Domaine des Trois-Toits in the Muscadet appellation is a vineyard that recently has expanded on abandoned vineyard land and whose growers have called upon the expertise of landscape architect Benjamin Péneau to design several of their newly acquired parcels. Located at the edge of Vertou, a suburb of Nantes, the vineyard abuts a large area of commercial activity.



Figure VI. proximity of commercial adjacencies

The growers acquired several parcels in 2021 and 2022 creating a continuous area of 11ha called la Ville au Blanc. Some parcels had been abandoned for several years and were overgrown with pioneer tree and shrub species such as brambles and birches. Many wires and former stakes were left behind making the clearing even more difficult. Illegal garbage dumping had also become commonplace in the area. Abandoned vineyard land also tends to prevent wind circulation and creates pockets for mildew to appear. Hence, the importance of ongoing maintenance and not letting these fallow lands proliferate in the landscape.

The growers were sensitive to agroforestry practices since they had already created a test parcel a couple of kilometers away with the help of the agricultural bureau. But the sheer size of the newly acquired parcels made them turn to a landscape architect for a more coordinated approach.



Figure VII. aerial view of La Ville au Blanc sector with Vertou in the background (photo credit: Benjamin Péneau DPLG, La plume et le sécateur)

The goals stated by the growers for this area were to implement new vineyard parcels in a resilient mode so as to guarantee continuous and healthy grape production for the future. They also were convinced that the area needed a more robust viticultural system in order to face the ongoing urban growth from the city nearby. As owner Cécile Perraud stated: "Being one of the only growers in this area adjacent to urban sprawl made us even more aware of our main goal of protecting the viticultural use of this area." A comprehensive design framework (*plan-guide)* was developed by iterative exchanges and work sessions between the landscape architect and the growers over the course of several months. A clever system of relatively small parcels was deployed. 18 parcels of 100x50m were laid out. This size is about the size that one person can prune or harvest in one morning as well as the expected amount of grapes that can fit in one VAT tank increasing the connection between the landscape and the wine's taste. Besides these practical reasons, the presence of hedges and trees offers much better work conditions than a bare landscape and increases work satisfaction. The rows of vines are also laid out in a single direction easing the work with machinery. Linking working conditions and landscape design is one of the more innovative features of this vineyard. This is a luxury only possible when designing and planting new vineyards. As landscape-architect Péneau stated regarding fauna and flora: "the design incorporates three biotopes, prairie grasslands around the vines, hedges, and forested patches." Each parcel is separated by hedgerows (newly-planted or existing) or dead hedges made up of branches or old vine stocks from the previous clearings. The species planted are a mix of both native species and species from southern France in anticipation of the warming of the area. (Arbutus, Holly Oak etc.)



Figure VIII. A dead hedge or *andain* (accumulation of wood debris usually seen in managed forests)



Figure IX. A *boqueteau* or large hedge 12m wide

This 12m width is significant for wildlife over a simple row of trees. Alternating dead hedges and planted hedgerows allows winds to circulate and avoids creating pockets where frost can settle. In the event of frost, the hedges help to regulate the amount of sun arriving on the frosted grapes because it is the rapid thawing that is particularly devastating for the young buds. The growers and designer were careful to allow enough distance for a tractor to pass on either side as well. The dead hedges are also great havens for wildlife and demand very little management from the growers. Establishing all of these land-based methods created additional work for the growers on top of their work on the vines themselves.

In the southern portion, Perraud and Barbier wanted to experiment with different support systems for the vines. The strategy was to "sculpt

from the existing vegetation the parcel size needed for
growing vines". They cleared certain areas while keeping some existing vegetation in the form of forested patches. Throughout the newly cleared parcels some trees were left standing and will be used to support the vines as they climb. This is an example of an early trellising method of the *vitis vinifera* plant called *vite maritata* or "married vine".



Figure X. Vines and Holly Oak (*Quercus ilex*) companionship among others

The choice of grape varietals that will be planted was also informed by the goal of resiliency against disastrous climate events like late frosts and mildew attacks that can be severe in the area. Several hybrid varietals were chosen for their resistance to mildew. Melon B, the emblematic varietal of Muscadet was replanted but only on the higher parts as it is the most sensitive to frost and mildew. As mentioned, the vineyard property abuts a growing commercial area and the growers seek to demonstrate a caring approach to their parcel edges. The landscape architect helped the growers retrace the geographical history of the site and they found former sunken walking paths along the edges of the parcel. Today these paths are combined sewer overflows. The growers thus decided to work with the municipality to restore the walking paths as they were convinced of the importance of allowing walkers to be close to the vines so as to reinforce the interface and understanding between agricultural and suburban realms. A partnership with a local agricultural school is also underway to jumpstart a wildlife counting program that will monitor the increase in overall biodiversity.

Finally, in addition to managing their vines, they must now care for 3 to 4 ha of shrubs and wooded land. 30% of the land will be made up of other vegetation than vines meaning additional forestry work has to be done to maintain these areas. Hence the importance of long-term planning to define where and what kind of maintenance work will be necessary.



Figure XI. *Plan guide* with the prairies, hedges, and forest patches typologies (photo credit: Benjamin Péneau DPLG, La plume et le sécateur)

III. DISCUSSION

Both case studies show ways of hybridizing, diversifying and adapting a vineyard monoculture in relationship to climate-change through design. They both transform the vineyard into a more complex landscape.
Domaine des Quarres is a unique example of rewilding a vineyard through letting native species grow and the adaptation of regenerative hydrology on an existing terraced parcel.
Domaine des Trois-Toits is an example of a comprehensive vineyard design framework with the grower becoming also a gardener and forester. The vineyard is treated as a polyculture garden and the vintners are becoming fluent in new agricultural and forestry management practices. The degree of attention given to the flora and fauna in both examples is fundamental and extraordinary in its detail.

Table 1. Comparison table of both vineyards and the land-based methods used

	Domaine des Quarres	*Domaine des Trois Toits*
Location	Rablay-sur-Layon	Vertou
Wine Appellation	Anjou	Muscadet
Size	13 ha	11 ha
Goals	Adapting a unique sloped vineyard parcel	Reclaiming of abandoned parcels and expansion
Approach	Rewilding and regenerative hydrology	New parcel design, vitiforestry
Techniques	Keylines, swales, groundcover, shrub and vegetable plantings	Hedges, forest patches, tree-vine companionship

As for care, both examples show that the growers are attentive to the vineyard as a holistic eco-system and want to ensure a healthy production of grapes, healthy working conditions for growers, and a vineyard that welcomes all forms of life. As Jacobs and Wiens state " 'caring-with' situates humans as part of nature while also acknowledging the need to radically change the systems that unevenly and increasingly cause human-led environmental crisis."[2]
Thus, adopting a sense of care is a vital principal in seeking solutions to the climate crisis. Care promotes a sense of and a dedication to maintenance and reuse of what already exists without deterioration or exploitation. It demonstrates a certain humility on the part of the grower and designer to help all constituents coexist.

These two examples also suggest novel ways that designers can be engaged in vineyard design and how this involvement benefits the essential production of grapes, the physical comfort of the vintner's work and the landscape itself.
As the role of vineyard growers becomes more complex, the help of landscape architects can be useful to growers through their advice and guidance in implementing a co-created design. Vineyard owners facing the threat of climate change must learn not only how to tend their vines but also how to tend to their "gardens", meaning the oversight of their entire vineyard ecosystem including vines, trees, human and non-human forms of life. A vineyard owner cares for his landscape every day and reciprocally a thoughtfully-designed vineyard will promote improved production while also preserving and improving the comfort of the grower's daily tasks.

Professionals working with plants and living systems, such as landscape architects, are uniquely positioned to provide a role of advising, guiding, and implementing these methods to accompany growers in the pursuit of their creation of unique wines:

1) Advising municipalities or vineyard appellations in the enactment of their political agenda regarding landscape (i.e., *Assistance Maîtrise d'Ouvrage*)
2) Guiding all parties in the development of landscape/regional plans or landscape charters (i.e., *plans de paysage*)
3) Implementing by designing and creating practicable projects for agricultural or viticultural lands (*plans guides*).

Sebastien Marot legitimizes this role by stating that "Landscape designers are at the convergence of the agricultural and urban traditions […] to consider public spaces (urban projects) as landscapes and on the other hand to see landscapes (rural projects) as public spaces and therefore projects" [4]
Since the act of healing land at the vineyard scale is possible, moving to a larger, regional scale is the next step towards a broader deployment of care. A regional approach grouping individual initiatives would be particularly effective given the quantity of abandoned parcels in the Muscadet Appellation and the opportunities those parcels represent.
As we zoom out from the individual vineyard scale and start to look at the aggradation of parcels, several scales offer design opportunities for the fields of viticulture, landscape architecture and regenerative hydrology. The watershed scale and the bioregional scale are the most promising. These larger scales can encompass large populations and span suburban and rural communities. In the Layon River watershed, there is already an organization reaching across several municipalities and advocating for an overall watershed approach in the management of their resource. This navigating across scales is an expertise held by the landscape architect and can be invaluable to designing regional care projects.

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DESIGN FOR CLIMATE CHANGE. LANDSCAPE'S STRATEGIES FOR ROME'S ADAPTATION

TOPIC: landscape design for climate resilient cities

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Abstract
The paper will show the progress of some ongoing research on the climate adaptation of Rome in the Department of Architecture and Design of Sapienza, in collaboration with the High National School of Architecture Paris-La Villette (Research Team « Architecture, Milieu, Paysage ») and with the Climate Office of Rome. Research's aim is to define landscape design strategies to support Rome's climate adaptation, through interventions that root in the contexts, integrating cultural, social, environmental, and climatic differences of a complex and historically stratified city like Rome. The recognition of different urban parts is significant in relation to the climate crisis, according to different climate footprints, vulnerabilities and risks (environmental, social, cultural) and above all different possibilities for action and reduction of local and indirectly global climate impact. The differences in climatic behaviour of the different parts of the city are assumed as possible drivers of local adaptation measures, suited to the contexts, going beyond generic and standardized measures.
Fundamental element of the research is the transdisciplinary approach. It keeps together the environmental, cultural, economic and social dimensions defining effective strategies from a technical point of view (through targets and measurable indicators useful for monitoring the results) without forgetting the spatial and aesthetic quality, to trigger processes of empowerment, education, community training and involvement.
Research's innovation also lies on overcoming neutral measures, adopting a pro-active approach. Landscape project, is herefore taken as a tool to overcome playing defence, using only restrictions, mitigations and compensations. It's about playing offense, implementing the recent Nature Restoration Law (June 2024) promoting recovery of biodiversity and resilient nature, restoring degraded ecosystems, even urban ones, limiting local (and global) warming, preventing natural disasters. The multidisciplinary research group collaborates with the institutions that are working on the Rome Climate Plan ("Climate" Office of Rome) and research institutes responsible for climate monitoring on a national scale (National Environmental Information System Service_ISPRA Institute for Protection and Environmental Research). Development and monitoring of the social and perceptive impact of new cultural aesthetic values connected to climate adaption measures are developed in collaboration with the AMP-ENSA of Paris la Villette PLV - in Paris

Text

The climate crisis is manifesting itself in all areas of the planet and in particular in large conurbations, with effects that not only can no longer be denied, but which, above all, are starting to directly affect people's lives. Heat islands, torrential rains, extreme and increasingly frequent weather events are changing lifestyles, the way of moving around, planning the day, planning trips, using and perceiving urban spaces .
Many European cities are adopting tools for climate adaptation, in line with the Paris Agreement and the European Climate Law and with the invitation of

the United Nations to undertake local actions, but the plans still have ample room for improvement, both in quantitative and qualitative terms.
A recent inter-university study published in the journal Nature has highlighted that many plans simply identify risks but do not follow up with specific actions. Even when project measures are identified, they are too often sectoral measures, which concern specific interventions of water management or urban forestation, without addressing the complexity of the urban problem. At the same time, the plans contain generic measures, which fail to interpret the local environmental, socio-cultural, historical-evolutionary specificities, which are decisive in the success of the initiatives, in the rooting in the settled communities and in their active involvement.
To this end, it also appears necessary to adopt communication and collective sharing strategies, both of risks and of prevention and contrast measures, to build a new collective culture of climate adaptation that, together with scientific arguments, is committed to building new cultural and aesthetic perceptions

The Department of Architecture and Design of Sapienza, in collaboration with the High National School of Architecture Paris-La Villette (Research Team « Architecture, Milieu, Paysage») and with the Climate Office of Rome is carrying on a research to define landscape design strategies to support Rome's climate adaptation. The landscape project seems to be a very suitable tool for:
• interpret local differences and specificities, in an evolutionary key, deciphering and representing the changes taking place in different urban contexts, developing targeted, non-generic proposals suitable for supporting effective climate change adaptation strategies at local scale given the difficulty, noted internationally, in developing local action plans (1/Baker et al. 2012; 2/Nordgren et al 2016; 3/Schlingmann et al. 2021). The landscape project is also particularly familiar with investigation methods aimed at understanding the evolution of a territory, and, simultaneously, an interpretation related to the present, undertaking a critical path within long-lasting dynamics and interactions between man and the environment, but also to place the past heritage within contemporary values, imagining new functional and environmental assets, and new configurations of the open space (4/De Marco,Poulot, 2023; 5/ Caravaggi,, 2021)
•bring together ecological, climatic, social, cultural, aesthetic and perceptive aspects, through a trans-disciplinary and integrated approach, combining quantitative and qualitative methods of investigation and design. Through this approach we intend to avoid both the risk of merely formal solutions, unable of effectively addressing climate adaptation and the risk of eminently technical, standardized solutions unsuitable for complexity and multi-dimensionality (in the sense explained by french philosopher Edgar Morin) of a historically stratified context (both from an environmental and cultural point of view) such as the Roman one. The integrated approach also appears to be fundamental for communication and sharing of research by public authorities and local communities: scientific, cultural and aesthetic arguments are essential to dialogue with the community, providing relevant data that allows us to avoid risks of climate denialism and shows the benefits that are truly achievable. Focusing on the spatial quality of the interventions also means focusing on the added value in terms of increasing urban quality and the collective perception of improvement.
•adopt a proactive attitude, going beyond neutral measures, adopting a pro-active approach. The project, and particularly the landscape project, is therefore taken as a tool to overcome playing defense, using only restrictions, mitigations and compensations. It's about playing offense, implementing the recent Nature Restoration Law, (adopted by European Council in june 2024) promoting recovery of biodiversity and resilient nature, restoring degraded ecosystems, even urban ones, to increase biodiversity; limiting global warming to 1.5°C; preventing natural disasters.

Ongoing activities

The working group is carrying out the following activities which will be completed in 2026:
1. Identify, in the city of Rome, different urban parts that are significant in relation to the climate crisis, according to different climate footprints, vulnerabilities and risks (environmental, social, cultural) and above all different possibilities for action and reduction of local and indirectly global climate impact starting from the availability of green areas as they could be seen analyzing land cover and land use, or potentially re-greening areas. In particular morphological, environmental and settlement differences (6/Imbroglini 2019) in the city of Rome will be recognized, starting from the historical city, the consolidated city of the 19th century, the modern city (first half of the 20th century) and the contemporary one which today are more relevant than ever to tackle climate crisis and its local consequences, with direct and indirect effects on the quality of life, social inclusion, urban health, exacerbating great inequalities already underway (https://www.mapparoma.info/.)



Figure I. The city of the 90s neighborhoods. big building complexes equipped with services, accessible from the major urban connection roads, equipped with large green spaces that are not very efficient from a climatic and environmental point of view (photo by Alessandro Cimmino, 2020)



Figure II. the city of informal settlements. Illegal settlements of single-family and two-family homes, lacking primary infrastructure and services that have colonized the territory of the Roman countryside. These are contexts with very low climatic resilience, subject to flooding, landslides, and completely dependent on private transport

2. Develop effective project proposals, both in terms of measurable and monitored effects on local climate (mitigation, compensation and prevention of extreme events) specific for different urban parts, using NBS (https://www.nbsitalyhub.it/) and based on the evidence that urban green spaces and water elements have been recognized as a suitable and cost-efficient strategy for climate challenge . Landscape design interventions - in forms of prototypes - will be tested to support climate adaptation while enhancing ecological an cultural differences and reducing social inequalities.

3. Explore new tools and media to represent new urban conditions and to develop future projects. These explorations are also essential to communicate and spread the collective benefits of the new types of spaces within the local communities, also triggering new aesthetic perceptions, very different from the past, (7/Farahani and Maller 2018), stimulating new forms of sensitivity to climate issue, biodiversity, and First results: the workshop "Depicting and Designing Climate Adaptation".

Preliminary results: Exploring, Depicting and Designing Climate Adaptation

From June 13 to 20, 2025 the fifth edition of the intensive landscape design workshop was held in Rome. The workshop was organized by DiAP – Faculty of Architecture, Sapienza University of Rome, in collaboration with the École Nationale Supérieure d'Architecture Paris-la Villette (ENSAPLV) and the research unit Architecture, milieu, paysage. The workshop involved students and professors from the degree programs in Landscape Architecture (LM3), in Planning and Design of Landscape and Environment (L21), as well as ENSAPLV through the courses Atelier La démarche paysagère pour le projet architectural et urbain, and the seminar Architecture/S & Paysage/S, part of the study domain Milieu, territoire, paysage. Depicting climate change and envisioning potential adaptive and mitigating design responses is necessary to counter persistent forms of denialism—toward both problems and solutions—and to build new imaginaries and stimulate new aesthetic perceptions, new forms of environmental sensitivity and empathy among social groups, in order to foster community engagement.

The strategy proposed by the workshop is to explore the concept of the experimental urban park - understood as a place where urban, socio-economic, and cultural practices intersect with new environmental and climatic needs - and at the same time to explore a medium for depicting the places studied and the projects proposed.

The selected test area for the workshop is the urban stretch of the Tiber River, from Ponte dell'Industria to Ponte Marconi—a site particularly sensitive to ongoing changes and itself the result of rapid environmental and social transformation, shifting from a peripheral industrial district to a residential and cultural area, with large unresolved spaces still vulnerable to extreme events.

Through guided site visits, thematic seminars, invited lectures, and studio work, the workshop aims to raise awareness among the international student group about the potential of experimental

landscape projects as tools to conceptualize, depict, and design urban climate adaptation.
The goal of the workshop was to recompose a vision of the study site starting from a sensitive approach to the place and its physical, spatial, social, environmental, and landscape characteristics, all interpreted through the lens of climate change and the contemporary environmental crisis.
Students are invited to present the outcomes using a primary medium: the collage - an assemblage of image fragments from different sources-enriched with other traditional representation tools (sketches, drawings, photographs, maps, etc.) in order to describe the full range of perceptions, atmospheres, and environments that compose and characterize the study area.
Students were also required to represent a design intention aimed at improving the area in terms of climate, social inclusivity, and biodiversity enhancement. It may be developed from various perspectives: human, animal, plant, soil, or water. In any case, it represents the result of a landscape project intention capable of addressing and countering the challenges of climate change.



Figure III. the collage captures the overwhelming experience of extreme heat in the site, highlighting the discomfort, stress and environmental tension caused by rising temperatures and traffic congestion.

The results of the workshop were very interesting. all groups adopted an empathic, immersive approach to climate adaptation and biodiversity. Students used original ways to describe the perception of temperatures, the sound of the animals, the smell of vegetation, the variation of these elements in the different spaces analysed and in different time slots. The combination of different modes of representation – over and above drawing– allow students to get as close as possible to the specific conditions of the site. the combination of different tools (collages, animated sections and descriptive texts) has proven to be particularly effective in describing the climatic, social and biodiversity characteristics of the study area in a synthetic and immediate way, but also in proposing visions for the future. These have been both eu-topian visions, in which conditions have changed for the better thanks to the project intervention; and dystopian versions, used to communicate the need and urgency of changing course.

Through the processing of sounds, smells, visual perceptions, users are invited to experience climate adaptation emotionally and physically change as the city heals , and vegetation replaces the concrete.



Figure IV. the collage explores how sound waves shape our experience of space and how by listening we can feel and understand our surroundings .

The design proposals for the climate-sustainable design of the Lungotevere in the Marconi area were very different from each other.
One of the groups worked on the sequence of sensory perceptions from the city towards the river, from a fragmented, overheated and polluted urban edge to a cooler, more connected and ecologically resilient riverscape.



Figure V. Resilience of nature. This collage tells The story of nature triumphing over concrete. Trees rise like monuments, flowers release their fragrance into the air, and wild plants grow freely

Another approach focused on integrating ecological awareness, environmental resilience and spatial innovation to connect people and nature along the river. The group explored the concept of "edge" not as a hard boundary, but as a biodiverse transitional zone between river and park, where natural processes and human intervention can coexist. This redefined edge would support microhabitats, ecological corridors, and native species, enhancing both biodiversity and aesthetic richness. the perception of change is facilitated by the installation of a Tiber Climate Thermometer—a visible, interactive, and landscape-integrated system that registers and displays changes in temperature and river water levels over time. This installation acts both as a climate education tool and a symbolic reminder of environmental transformation.
The proposal aim to transform the park into a dynamic, adaptive, and educational landscape prototype for climate-conscious urban public spaces



Figure VI. A new living edge between city and river, adapting over times

Another proposal titled "Reclaiming continuity", focuses on the potential of wild vegetation to restore environmental continuity, guarantee hydraulic permeability , to work as transitional device between fragmented zones. By encouraging spontaneous or low-maintenance plant growth, cities can also address major climate challenges, such as soil impermeability and urban fooding, creating more porous ground where water can infiltrate. In this way, rewilding the city is not only a form of ecological repair, but also a social gesture. It's a way of making space for shared, multispecies futures The empathetic instance is particularly evident: a "desirable landscape" emerges from new spatial configurations that allow vegetation to grow, human and non-human species to move freely, reconnect to the river, colonize new spaces for sociality.



Figure VII. The proposal was illustrated through a display case, in which glass marbles (representing people and animals) were first prevented from moving due to the presence of barriers and then free to move, circulate, and enjoy the natural spaces along the river

Conclusion: Adaptation and Empathy against Climate change

The experience of the workshop, which involved students from very different countries and with different cultural backgrounds, some of whom were dealing with the issues of climate, biodiversity, landscape for the first time, demonstrated with great clarity that the lens of empathy is an effective tool for investigating and addressing our relationship with nature. As suggested, among others, by Laura Boella, who, faced with the awareness of the fragility and interconnection of all living things, underlines the need for a new relationship with nature, of an empathy with non-human animals extended to everything that was once considered inanimate nature (mountains, seas, atmosphere, deserts) and by Gilles Clement who "To be able to seriously apply a policy of survival of humanity on earth", proposes to "come down from an artificially constructed observatory above nature, considered as a territory of experience, domination and market, immerse ourselves in it, accept ourselves as beings of nature, review our position in the universe, no longer placed above or at the centre, but rather within and with". In our research we intend to continue through immersive explorations, which allow the working group to tackle the climate adaptation project in different urban contexts, studying behaviours, perceptions, forms of adaptation and resilience rooted in the specific characteristics of the places.

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COHESIVE AESTHETICS FOR MULTIFUNCTIONAL LANDSCAPE TERRITORIES: IN TIME OF ECOLOGICAL UNDERSTANDINGS

TOPIC: Guiding territories by changing the design of regional projects: tools for intervention at different scales, for multifunctional landscapes

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Abstract

Aesthetics in landscape architecture have always reflected our values and our relationship with nature throughout history. With the emerging climate and biodiversity crisis [1], and Denmark undergoing a nationwide transformation of its rural area from heavily industrialized agricultural land to a multifunctional landscape with sustainability and ecological intentions, we are facing yet another shift in the aesthetic perspectives.

This article explores a new vocabulary based on this shift – on the new ecological and systemic perspectives on landscape architecture and planning. Grounded in theories of holistic and ecological design, including Ian McHarg's ecological design principles [2] and Anne Whiston Spirn's interpretation of landscape as a language [3]. The study further integrates contemporary theories on shifting perspectives from thinkers like Emmanuelle Coccia [4], Jane Bennett [5], Donna Haraway [6], Anna Tsing [7], and Bruno Latour [8], in the relationship between cities, nature and landscapes.

This is conducted within the context of Denmark's ongoing rural and peri-urban landscape transformation, which aims to meet the nation's sustainability goals by 2050 and the national demand for 30% protected nature. This initiative has placed the rural and peri-urban areas under the spotlight, as centuries of deforestation, draining and industrialized farming have left behind barren ecological value. These land use practices have resulted in a monotonous and often overlooked reality, reinforcing a function-oriented aesthetic in both public perception and landscape practices.

The vocabulary is tested and further developed through a primary case study: a large-scale landscape planning project near Aarhus, Denmark. Spanning around 1.000 hectares, this project integrates multiple land-use transformations, including the establishment of an energy park, solar farms, nature restoration, afforestation, and urban development. As a pilot initiative in collaboration with the Aarhus School of Architecture, the project aims to develop new methods and frameworks for understanding large-scale landscape transformation and land-use change.

Through the theoretical inquiry and case study analysis, the article examines the evolving values and perceptions shaping our relationship with the environment. It critically assesses the aesthetic dimensions of landscape practices and their ability to reflect and respond to these shifting values at territorial scales. Based on this, the article proposes new perspectives on aesthetics for multifunctional landscape territories. It presents design strategies that align with evolving ecological and systemic paradigms, using the Aarhus landscape transformation project as a 1:1 research by design study [10]. This case exemplifies a holistic and multifunctional land-use approach, highlighting the evolving role of landscape architects in navigating large-scale ecological transitions.

Introduction

In an era marked by climate change and biodiversity crises [1], landscape architecture faces a critical challenge: to rethink its aesthetic paradigm. Traditionally, landscape architecture has prioritized visual coherence and control, yet today's ecological realities necessitate a shift toward an aesthetic that recognizes and integrates ecological processes - a framework of coexistence [4]. This paper explores how new materialism approaches can inform such an aesthetic - one that interacts with nature as an active co-creator within the landscapes. Pointing to a need for renewed design strategies that embrace more ecological and systemic perspectives on landscape architecture and planning.

These strategies support what we describe as a necessary shift in landscape practice: from curating the experience of nature to activating its inherent potentials - from curation to activation.

The proposed design strategies are developed and further tested through a 1:1 case study: a large-scale landscape planning project near Aarhus, Denmark. Encompassing approximately 1,000 hectares, the project integrates a variety of land-use transformations, including the implementation of an energy park, solar farms, nature restoration, afforestation, and urban development. As a pilot initiative in collaboration with the Aarhus School of Architecture, the municipality of Aarhus seeks to develop new methodologies and conceptual frameworks for understanding large-scale landscape transformation and land-use change in the context of ecological complexity and planetary urgency.

Changing perspectives

New materialism, as articulated by thinkers such as Jane Bennett [5], Donna Haraway [6], Anna Tsing [7], and Bruno Latour [8], challenges the traditional conception of matter and nature as inert and subject to human domination. Instead, it introduces an ontology in which matter is understood as an active participant in the world, possessing agency and the capacity to affect its surroundings. Bennett's notion of vibrant matter conceptualizes matter as lively and dynamic, which carries profound implications for aesthetics within landscape architecture. Here, aesthetics shift from being primarily concerned with visual form and composition to embracing a sensuous, processual, and open-ended approach that acknowledges the agency and temporality inherent in materials themselves.

This understanding is further developed by Emmanuelle Coccia, who, in *The Life of Plants*, formulates a philosophy in which plants emerge as mediators between earth and atmosphere. Plants are not merely passive backdrops to human activity but are integral to an ontological and aesthetic structure that unites the biological and the metaphysical. In landscape architecture, this necessitates an aesthetics that accommodates the transformative capacities of plants – their ability to generate, filter, and connect – thereby expanding the aesthetic field to include living processes and conditions of growth as essential components of design.

Anna Tsing, in *The Mushroom at the End of the World*, offers an anthropological and ecological approach to aesthetics and coexistence, demonstrating how landscapes are formed through multispecies interactions. Aesthetics, in this context, becomes a matter of recognizing emergence and movement as carriers of beauty. For landscape architectural practice, this entails a shift from deterministic design toward the facilitation and activation of situations in which diverse actors – both human and nonhuman – may coexist and interact within open and dynamic systems.

Donna Haraway extends this perspective in *Staying with the Trouble*, introducing the concept of sympoiesis – collective world-making without a central authority. The aesthetic practice thus becomes situated, participatory, and non-linear – a negotiation among species, materials, and temporalities, wherein the architect is but one among many co-creators of place.

Bruno Latour's actor-network theory contributes an epistemological framework that recognizes both living and non-living entities as agents within social and material networks. From this perspective, the aesthetics of landscape architecture must be viewed not as a product of form alone, but as an emergent quality arising from relations among heterogeneous actors. The landscape is thus conceived as a polyphonic composition, in which meaning and aesthetics are generated through interaction and mutual influence.

Taken together, these perspectives position new materialism as a framework that redefines aesthetics in landscape architecture. It moves beyond the pursuit of beauty in isolation to embrace a relational, material, and ecologically complex understanding of design. Aesthetic practice becomes an endeavour to stage conditions for life and coexistence, where unpredictability, process, and affect are acknowledged as foundational dimensions of landscape's becoming – a process of co-becoming [9].

In this light, new materialism can be seen as a contemporary continuation and deepening of longstanding discourses on place and landscape within landscape architecture. Thinkers such as Ian McHarg [2], and Anne Whiston Spirn [3] have each, in their own way, emphasized the interconnectedness of ecological processes, cultural narratives, and spatial form. McHarg's ecological planning advocated for design in harmony with natural systems; and Spirn articulated the landscape as a language through which nature and culture continuously shape one another. While these frameworks have primarily approached landscape through systems thinking and ecological rationality, new materialism supplements this legacy by introducing a more ontologically attuned and materially responsive aesthetic sensibility.

Rather than replacing previous understandings of landscape and place, new materialist thought enriches them by foregrounding the agency of matter, the co-constitutive role of non-human actors, and the affective, temporal, and emergent qualities of landscape. It invites a rethinking of aesthetics not as an external layer imposed upon a site, but as an intrinsic, co-evolving quality that emerges through multispecies relations, material entanglements, and situated processes. In doing so, new materialism supports a more holistic and responsive approach to design - one that is aligned with ecological complexity while remaining attentive to the subtle, unfolding dynamics of place.

The case of Spørring

Spørring is a small village in Denmark, located within Aarhus Municipality, with approximately 1,000 inhabitants. It is primarily surrounded by agricultural land, a former gravel pit, and the area adjacent to the Spørring stream (Spørring Å). This site has been designated as a transformation area within the broader context of Denmark's ongoing rural and peri-urban landscape transitions. These initiatives aim to contribute to national sustainability goals for 2050, including the objective of protecting 30% of the national territory as nature and accommodating renewable energy infrastructure - specifically, solar parks in this context. As a result, rural and peri-urban landscapes such as Spørring have been brought into focus. Centuries of deforestation, drainage, and industrialized agriculture have significantly diminished the area's ecological value, producing a monotonous and often overlooked landscape that reinforces a functionally determined aesthetic in both public perception and landscape practices.

Over the past three years, the transformation of this area has been initiated through a series of workshops, design scenarios, and pilot projects. This transformation reflects a broader tendency observable in other parts of Denmark as well as across Europe - an emergent development paradigm that demands new modes of collaboration, cross-disciplinary cooperation, and alternative perspectives and design strategies. These are necessary to establish multifunctional and coexistent landscapes that are not merely optimized for continued production - whether for renewable energy, biodiversity, or agriculture - but that instead aim to foster habitability for the greatest diversity of species and functions.

In the ongoing dialogue between different disciplines and in the democratic engagement with local residents, Spørring presents a compelling example of the need for new design strategies. These strategies must be grounded in the new materialist perspectives previously outlined in order to support the cross-sectoral and transdisciplinary collaborations required for meaningful ecological transformation.

A concrete manifestation of this approach is found in the transformation of Spørring Gravel Pit, which exemplifies how landscapes can be reimagined with a dual emphasis on biodiversity and recreation, guided not by prescriptive design but by the activation of nature's own processes. The former gravel extraction site is now undergoing a transformation where afforestation and the establishment of recreational paths are implemented with the deliberate intent to make space for spontaneous natural development. This project illustrates how a new materialist aesthetic may be operationalized in practice - by positioning

nature as an active co-creator in the design and formation of landscape.

Through theoretical reflection and empirical case analysis, evolving design strategies are articulated and developed - strategies that align with ecological and systemic paradigms of change. Using the Spørring landscape transformation project as a 1:1 research-by-design study [10], this case study exemplifies a holistic and multifunctional approach to land use. It highlights the changing role of landscape architects in navigating and mediating large-scale ecological transitions through design that is attuned to material agency, relational dynamics, and long-term transformation processes.

Perspectives on new aesthetics and design strategies

The subsequent discussion introduces preliminary perspectives on an emerging aesthetic framework and examines the design strategies that may be derived from this reconfigured understanding of aesthetics.

Brushstroke of all matters

Every material presence - trees, plants, dwellings, water systems, and energy infrastructures - participates in shaping the landscape as part of an ongoing, collective becoming. Drawing on Donna Haraway's concept of *sympoiesis*, the landscape is no longer seen as a static composition of discrete zones, but as a co-becoming system of entangled processes across scales. Similarly, Anna Tsing emphasises the significance of emergent, multispecies interactions in forming dynamic landscapes beyond human control.

This aesthetic shift dissolves the sharp boundaries imposed by traditional land-use planning - between forest and field, settlement and infrastructure - and instead foregrounds a fine-grained, processual landscape. Here, blurred edges and overlapping functions reflect the ecological and ontological complexity of place. The spatial expression is one of ambiguity and interconnection: a post-anthropocenic mosaic where aesthetics emerges through interaction rather than imposition.



Figure 1. Brushstroke of all matters

A New Aesthetic of Honesty

The new aesthetics begins with commitment to honesty - aesthetics rooted not in visual appearance but in the representation of underlying systems. As Alexander Baumgarten proposed in the 18th century, aesthetics is not merely about beauty, but a mode of knowledge and a sensibility toward the world. From this perspective, aesthetic experience arises not from the illusion of lush, green monocultures, but from an awareness of the landscape as an active, diverse, functioning ecological system.

For centuries, the countryside has been idealized in art and media, reinforcing a static and romantic aesthetic that no longer reflects the industrialized and extractive reality. To move forward, honesty must become a core aesthetic value. In the Spørring case, for example, solar parks are discussed as unfenced, making the panels visible and touchable in the landscape.

Bruno Latour argues that design should make actors visible - both human and non-human. In this sense, aesthetics becomes a way of revealing the entangled systems at play, rather than masking them. Industrial fields and solar farms are both programmed landscapes; acknowledging their operations and impacts is the first step in

cultivating a more informed and responsible aesthetic judgment.

Through the Lens of Time

Acknowledging that landscape's becoming is a dynamic and open-ended process formed through the co-existence of all actors, time naturally becomes an integral dimension in aesthetic assessment.

Instead of being projected as static images, landscapes are portrayed over a time span in relation to their historical status and potential future evolution, providing a full picture of their status in a progressing transformation.

In that sense, a solar farm on a former farmland has a higher aesthetic value than if it remains as heavily cultivated land, due to solar facilities' possibilities to contribution to de-fertilizing the land, preparing a better condition for the establishment of diverse actors such as plants, fungi, and animals after operation – if its thought from the beginning of the project.

Looking through the lens of time also calls for a new method for presenting landscape projects as open processes of co-becoming. This means that instead of predicting the final result, it represents all the foreseeable phases from the starting framework to intervention along the process, showing the possibilities of each phase while keeping an open end. The conventional way of presenting landscape design as a static image ignores the long process to achieve the imposed aesthetic and misrepresents the dynamic system.

The essentiality of this temporal framework is demonstrated in the observation in Spørring. Data about each landscape type in the parameters of CO_2 absorption and biodiversity, where collected over time, revealing that each followed a distinct development curve closely tied to its previous status. This provided the critical information in the evaluation of the short-term and long-term effects of the scenarios in a one-year, five-year, ten-year, twenty-year, and fifty-year timeframes.



Figure 2. Through the lens of time

From Curating to Activating

To facilitate the emergence of site-specific multispecies relations rather than imposing human-centred aesthetics upon a site, landscape design must shift from curating towards activating collaborative processes among all actors.

This approach harvests landscapes characterized by spontaneity and elasticity - qualities that essentially give the awing effect as we experience in untouched natural areas. Being surprised and inspired by nature signals a moment of learning - aesthetics as a mode of knowledge.

In Spørring, instead of planting forests in designated shapes, patterns and species compositions, seed island was employed as a strategy to allow the system to develop and define itself. These seed islands - established areas with species richness - function as generators for natural regrowth in surrounding territories. Multiple actors, including animals, wind, and fungi dispersing seeds throughout the area, become co-creators of landscapes that emerge from the combination of human intention and multi-species randomness.

The same strategy is applied in the areas for technical facilities. During the operation of the

infrastructure, areas are reserved for natural growth, which will serve as seed banks to activate the landscape after facilities are removed in thirty years, as planned.

In Multi-Sense Dialog

In this processual process of landscape becoming, landscape design becomes the art of sensing and responding - the art of dialog. It requires the continuous presence of all participants, shifting the landscape architect's role from imposer to active observer, translator, and responder throughout the whole process.

A prerequisite to participating in collaboration is the ability to sense the existence of other actors, which interact through multiple senses. A bodily and mindful experience of the landscape informs us, enriching the dimensions of aesthetic sensation - key to sense harmony.

The visual format of landscape analysis and design misrepresents the landscape of its multi-sensational reality. Diverse methods for representation, its form varying from video, literature, scent, samples and presence, are essential to reflect the shift in our understanding of the landscape beyond the surface.

The landscape wandering in the Spørring surroundings guided by landscape architects and biologists is an example of this new approach to invite the public to experience the landscapes in person.

Conclusion

The integration of new materialism into landscape architecture opens an understanding of the ontology of materials, matters, and beings in territorial systems. Highlighting a critical task to rethink the process of studying, designing, and transforming our landscapes: to become proactive activators of multispecies coexistence rather than gardeners of green façade and imposed forms.

The process through the Spørring case has explored how this theoretical shift can be translated into practice and cultivated perspectives a new vocabulary in a more relational, systemic, processual approach to landscape's becoming. These perspectives provide a set of strategies for extending our senses to the underlying relations beyond visuals, and the dynamic progression over the course of time, moving from the act of curating to activation.

These perspectives also function as detectors of landscapes in need of transformation, enabling landscape architects to be the initiators rather than respondents to development needs. This requires a place-reading method that goes beyond the conventional site boundary and traces the ecological systems across territories, identifying potentials for enhancing diverse relations. Necessitating the landscape architects' role as also advocates and educators to foster a shared public understanding and participation.

The vocabulary and perspective proposed in this paper are open-ended invitations to practitioners and scholars to join the exploration of new aesthetic dimensions and methodological tools for territorial reading and relation fostering - processes essential for achieving cohesive landscapes and our coexistence in nature.

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LANDSCAPE TRANSFORMATION IN THE AGE OF SOLAR ENERGY: A SPATIAL ANALYSIS OF PHOTOVOLTAIC LANDSCAPES IN THE LOESS GULLY REGION

TOPIC: Guiding territories by changing the design of regional projects: tools for intervention at different scales, for multifunctional landscapes

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Keywords: solar power plant, photovoltaic landscape, spatial characteristics, photovoltaic landscape typology, photovoltaic landscape morphology

Abstract

Climate change and resource depletion have accelerated the transition from fossil fuels to renewable energy. Historically, energy development has been a driver of landscape transformation. Compared to traditional energy, solar power requires larger land areas due to its lower energy density, leading to significant impacts on regional landscape patterns. The large-scale construction of solar power plants has reshaped existing landscape, forming a new type of landscape known as the "photovoltaic landscape". Understanding its spatial characteristics and evolutionary patterns is essential for guiding sustainable planning and design. This study analyzes solar power plants in China's Loess Gully Region, which is the main landform unit in the Loess Plateau, establishing a spatial analytical framework for photovoltaic landscapes at both regional and site scales. At the regional scale, the spatial distribution characteristics of solar power plants were identified using kernel density analysis and natural breaks classification in GIS. The spatial relationships between solar power plants and landscape elements such as terrain, landforms, vegetation, land use, human activities, and ecological and cultural values were examined through spatial overlay analysis and multi-ring buffer analysis. Additionally, a two-step cluster analysis combined with fishnet tool was employed to classify landscape types. Furthermore, landscapes and solar power plants were considered as integrated photovoltaic landscapes and subjected to typological classification. At the site scale, a typical sample were selected from each regional photovoltaic landscape category for in-depth analysis through case study and morphological analysis. Using high-resolution satellite imagery, the study examined changes in landscape element before and after the solar power plants construction, analyzing unit patterns, system layouts, patch configurations and array orientations. The findings reveal distinct spatial characteristics at both scales. At the regional scale, solar power plants are predominantly centralized but spatially dispersed, showing strong correlation with terrain, landforms, settlements and other landscape elements. Some plants are located in ecological and cultural sensitive areas. At the site scale, the spatial configurations of photovoltaic landscapes vary significantly based on terrain conditions. In flat areas, photovoltaic arrays are arranged in grid patterns with regular patches and centralized layouts, showing lower adaptability to the original landscape. In rugged areas, arrays align with contour lines, forming irregular patches with dispersed system layouts, demonstrating higher responsiveness to landscape features. This study highlights that the existing photovoltaic landscapes result from historical siting decisions rather than optimized

planning. In some cases, photovoltaic development exacerbates ecological vulnerability or disrupts cultural landscapes. Future photovoltaic landscape planning should focus on optimizing the siting decisions, balancing energy production with environmental conservation, and integrating solar power plants installations with local landscapes to enhance long-term value. The proposed analytical framework provides a scientific basis for assessing photovoltaic landscapes impacts and supports sustainable energy planning, facilitating synergy between renewable energy development and landscape conservation.

1. Introduction

Over the past few decades, climate change and resource depletion have accelerated the transition from fossil fuels to renewable energy. This global energy transition redefines humanity's approach to energy use, while exerting a profound influence on landscape patterns across the planet's surface. Historically, energy development has been a driver of landscape transformation [1]. Compared to traditional energy, solar power requires larger land areas due to its lower energy density, leading to significant impacts on regional landscape patterns [2]. The large-scale construction of solar power plants has reshaped existing landscape, forming a new type of landscape known as the "photovoltaic landscape". Understanding its spatial characteristics and evolutionary patterns is essential for guiding sustainable planning and design.

2. Materials and methods

2.1 Site context

The Loess Gully Region is the main landform unit of China's Loess Plateau, covering a total area of 340,000 square kilometers, accounting for 53% of the Loess Plateau, and involving 7 provinces, 22 cities, and 132 counties (districts). The region is both an important ecologically fragile area and energy-rich region in China, characterized by the coexistence of complex terrain and landforms, abundant solar energy resources, rich land resources, and a vulnerable ecosystem. In recent years, a large number of solar power plants have been constructed in this region, promoting energy transition, bringing about unprecedented landscape transformation phenomena, and redefining the landscape characteristics of the region.

2.2 Data source

The data and sources used in this study are detailed in Table 1.

Table 1. Data sources.

Data Type	Format & Resolution	Source
DEM	Raster, 30m	Copernicus DEM - Global and European Digital Elevation Model (COP-DEM)
Landform	Vector	China Digital Geomorphology Dataset (1:4,000,000)
Land use	Raster, 30m	China Multi-Period Land Use Remote Sensing Monitoring Dataset (CNLUCC)
Vegetation	Vector	China Vegetation Dataset (1:1,000,000)
Solar power Plants	Vector	OpenStreetMap
Settlement	Raster, 10m	Extracted from Sentinel-2 10m Land Use/Land Cover
High ecological and cultural value areas	Vector	China Nature Reserve Specimen Resource Sharing Platform

2.3 Research process and methods

Based on the concept of "photovoltaic landscape", this study establishes a spatial analytical framework for photovoltaic landscapes at both regional and site scales.

2.3.1 Regional scale

This study considers photovoltaic landscapes to be composed of solar infrastructure and the landscape space that supports it. The spatial characteristics of solar power plants are largely influenced by the landscape characteristics where they are located. Therefore, the regional-scale analysis framework follows the logic of "photovoltaics—photovoltaics and landscape—photovoltaic landscape," including three aspects: (1) spatial distribution characteristics of solar power plants, (2) spatial relationships between solar power plants and landscape, and (3) types of photovoltaic landscapes composed of both solar power plants and landscape.

First, a 500m buffer zone was applied to process 1274 photovoltaic vector polygon data, identifying

538 solar power plants. According to land use scale, solar power plants were classified into three categories: small-scale (<5ha), medium-scale (5-30ha), and large-scale (>30ha), Through kernel density analysis and natural breaks classification method, the spatial distribution characteristics of solar power plants of different scales were discussed.

Second, the spatial relations between solar power plants and landscape elements such as elevation, slope, aspect, landform, vegetation, land use, residential areas, and areas of high ecological and cultural value were explored through GIS spatial overlay analysis and buffer zone analysis methods [3].

Finally, the entire Loess Gully Region was divided into 3km×3km grids using the GIS fishnet tool. Terrain, landforms, land use, and vegetation types were selected as landscape characteristic elements, assigning values to each grid. Through SPSS two-step cluster analysis, the landscape characteristic types of the Loess Gully Region were classified [4], and the types of integrated photovoltaic landscapes composed of solar power plants and different types of landscapes were further identified.

2.3.2 Site scale

Inspired by the nine hierarchical types of urban morphological research proposed by Karl Kropf [5], this study considers that photovoltaic landscapes actually contain four nested scales: (1) landscape units formed by the combination of photovoltaic systems and surrounding landscape systems, (2) photovoltaic systems formed by the combination of photovoltaic patches, (3) photovoltaic patches formed by the group of photovoltaic arrays, (4) photovoltaic arrays [6]. Therefore, the site-scale analysis framework is organized around four hierarchical levels of "unit—system—patch—array", specifically including: unit pattern, system layout, patch configuration, and array orientation.

A typical sample was selected from each photovoltaic landscape type identified at the regional scale as the analysis object for the site scale, and morphological analysis was conducted using high-resolution satellite imagery. The unit level mainly focuses on the size and position of photovoltaic systems, especially the spatial relationship between photovoltaic systems and residential systems; the system level mainly focuses on the number and position of patches as part of the solar system, as well as the method that the system layout responds to the original landscape plots; the patch level focuses on analyzing the patch shape and array arrangements within plots; the array level analyzes the orientation of arrays.

3. Result and discussion

Results are presented and discussed from both regional and site scales.

3.1 Regional scale

3.1.1 Spatial distribution characteristics of solar power plants

The kernel density analysis results show that solar power plants in the Loess Gully Region exhibit distinct spatial clustering distribution characteristics, forming multiple high-density core areas (0.008-0.011 plants/km²), mainly concentrated in the northeastern and southern parts (Fig. 1).

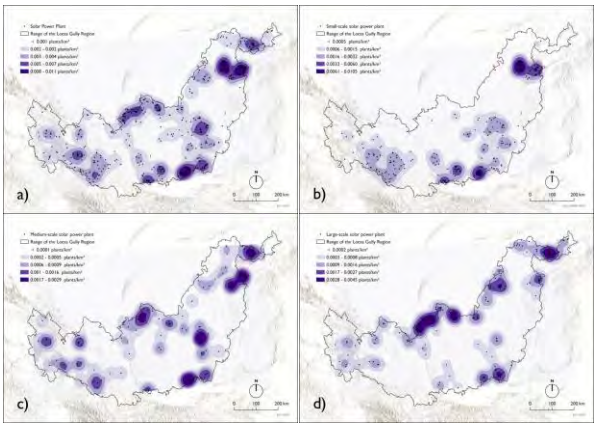


Figure 1. Kernel density analysis of solar power plants: a) all; b) small scale; b) medium-scale; c) large-scale.

The Loess Gully Region has a total of 538 solar power plants, including 249 small-scale, 119 medium-scale, and 170 large-scale plants. The distribution patterns of different scale solar power plants show significant differences, generally exhibiting a spatial pattern of "the larger the scale, the higher the degree of clustering". Small-scale plants are relatively dispersed and flexible in distribution with broader coverage; medium-scale plants present a multi-core distribution pattern;

large-scale plants have the highest degree of clustering, mainly concentrated in specific advantageous areas such as the northern, northeastern, and southern regions.

Table2. Spatial relationships between solar power plants and landscape elements (quantitative statistics).

Solar Power Plant Scale		Small	Medium	Large	Total
Elevation (m)	≤1000	53	17	19	89
	1000-2000	155	75	135	365
	2000-4000	41	27	16	84
	4000-6000	0	0	0	0
Slope	≤5°	79	56	110	245
	5-10°	84	25	39	148
	10-20°	72	36	21	129
	20-40°	14	2	0	16
Aspect	south	41	9	6	56
	southwest, southeast	93	55	68	216
	east, west	57	22	16	95
	northwest, northeast, north	58	33	80	171
Landform	plain	42	32	56	130
	tableland	78	18	23	119
	hill	51	20	27	98
	mountain	77	39	31	147
	aeolian	1	10	33	44
Vegetation	needleleaf forest	3	1	1	5
	broadleaf forest	28	7	3	38
	scrub	17	2	4	23
	desert	0	6	26	32
	steppe	23	23	53	99
	grassland	9	2	3	14
	meadow	3	5	6	14
	cultivated vegetation	166	73	74	313
Land use	farmland	129	52	55	236
	forest land	22	9	3	34
	grassland	74	41	57	172
	built area	16	11	44	71
	water area	3	1	0	4
	unused land	3	4	11	18
	mixed use land	2	1	0	3
Distance to residential areas (m)	≤500	198	72	86	356
	500-1000	27	23	44	94
	1000-1500	11	9	20	40
	> 1500	13	15	20	48
Distance to high ecological and cultural value areas (m)	0	7	2	2	11
	≤1000	10	0	1	11
	1000-5000	37	8	7	52
	> 5000	195	109	160	464

3.1.2 Spatial relationships between solar power plants and landscape

Solar power plants in the Loess Gully Region exhibit distinct spatial associations with various landscape elements. Solar power plants are mainly concentrated in low-altitude areas of 1000-2000m (365 plants) and gentle slope zones of ≤5° (245 plants), with a preference for sunny slopes such as southwest and southeast orientations (216 plants). They primarily located in mountainous (147 plants) and plain (130 plants) landforms, and tend to be distributed on farmland and grassland covered by cultivated and steppes vegetation. Most solar power plants maintain an appropriate distance within 500m from residential areas, while staying far from high ecological and cultural value areas (>5000m) to avoid ecological conflicts. However, some plants are still located within high ecological and cultural value areas (11 plants) or at distances less than 1km (11 plants) (Table 2).

Solar power plants of different scales show significant gradient correlations and scale differentiation characteristics with terrain and landforms. Small-scale plants have the most widespread distribution, being found across various slopes, aspects, and landforms, demonstrating the strongest adaptability to terrain and landforms. Medium-scale plants have secondary adaptability with relatively flexible distribution, but are mainly located in areas with gentler slopes. Large-scale plants have stricter requirements for terrain and landforms, being mainly concentrated in areas with optimal terrain conditions.

3.1.3 Photovoltaic Landscape Types

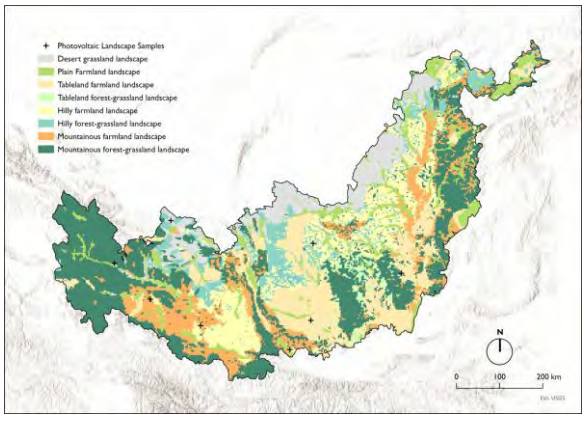


Figure 2. Landscape types in the Loess Gully Region and distribution of eight PV landscape samples.

The research identified eight landscape characteristic types in the Loess Gully Region, namely: desert grassland type, plain farmland type, tableland farmland type, tableland forest-grassland type, hilly farmland type, hilly forest-grassland type, mountainous farmland type, and mountainous forest-grassland type. Correspondingly, by overlaying solar power plants with landscape types, eight categories of photovoltaic landscapes were obtained, and typical samples of each types were further selected (Fig. 2).

3.2 Site scale

3.2.1 Unit Pattern

Among the 8 selected samples, photovoltaic systems are all located in relatively gentle slope areas within landscape units. In terms of system size, except for the tableland forest-grassland type, the system areas of other forest-grassland type photovoltaic landscapes are all larger than those of farmland type photovoltaic landscapes (Fig. 3).

The positional relationships between photovoltaic systems and residential areas also show obvious differences among different samples. Farmland type photovoltaic landscapes, whether plain, tableland, hilly, or mountainous, are often located adjacent to residential areas (<100m); while desert grassland type and tableland forest-grassland type photovoltaic landscapes are at greater distances from residential areas (500-1000m); hilly forest-grassland type and mountainous forest-grassland type photovoltaic landscapes are the farthest from residential areas (>1000m).

3.2.2 System layout

The research found that except for the tableland forest-grassland type sample, the photovoltaic systems of the remaining 7 samples all contain several patches. Even the mountainous agricultural type sample with the smallest system scale (0.27ha) includes 2 patches.

Overall, patch locations and system layouts show high responsiveness to the original landscape plot divisions, with response methods varying among samples of different types. The desert grassland type sample has highly concentrated patch distribution, basically unconstrained by topographic conditions; the photovoltaic system layout divides the original plots into several smaller plots. The plain farmland type sample has relatively concentrated patch locations, with system layout almost completely following the original plot divisions. The tableland farmland type sample has photovoltaic patches dispersed along tableland edges, with system layout partially adjusting the original plots. The tableland forest-grassland type sample has patches concentrated along tableland edges, with system layout merging original small plots into one larger plot. Both hilly farmland type and hilly forest-grassland type patches are dispersed along contour lines, with the former locally adjusting original plot divisions and the latter almost completely following original plot divisions. Both mountainous farmland type and mountainous forest-grassland type sample patches are distributed along contour lines in flat areas at mountain tops, with the former having highly concentrated patch distribution and layout following original plot divisions, while the latter has relatively concentrated patch distribution with system layout partially adjusting original plots (Fig. 3).

3.2.3 Patch configuration

In most cases, patch shapes and array arrangements match the plot shapes, presenting the characteristic that the more complex the topographic conditions, the more irregular the patch shapes, and the greater the variation in array lengths. The patch shapes of tableland farmland type, hilly farmland type, hilly forest-grassland type, and mountainous forest-grassland type samples are all irregular, with significant variations in array lengths. The patch shapes of plain farmland type, tableland forest-grassland type, and mountainous farmland type samples are relatively regular, with gradual variations in array lengths. The desert grassland type has regular patch shapes with uniform array length variations (Fig. 3).

3.2.4 Array orientation

The array orientations of almost all samples are designed with the goal of obtaining maximum solar power generation. Constrained by terrain, the hilly forest-grassland type sample contains multiple array orientations, but its main orientations are still east-west and north-south (over 80%). The array orientations of the remaining 7 samples are all east-west facing south (Fig. 3).



Type	Desert grassland PV landscape	Plain Farmland PV Landscape	Tableland farmland PV landscape	Tableland forest-grassland PV landscape	Hilly farmland PV landscape	Hilly forest-grassland PV landscape	Mountainous farmland PV landscape	Mountainous forest-grassland PV landscape
Size	76.17ha	5.66ha	4.24ha	1.31ha	1.00ha	17.16ha	0.27ha	34.85ha
Distance (to settlement)	500 - 1000m	< 100m	< 100m	100 - 500m	< 100m	> 1000m	< 100m	> 1000m
System layout	Centralized patch distribution. Divide original plots.	Relatively centralized patch distribution. Follow original plots.	Decentralized patch distribution. Partially adjust original plots.	Centralized patch distribution. Integrate original plots.	Decentralized patch distribution. Partially adjust original plots.	Decentralized patch distribution. Follow original plots.	Centralized patch distribution. Follow original plots.	Relatively centralized patch distribution. Partially adjust original plots.
Patch configuration	Regular shape. Uniform variation in array length.	Relatively regular shape. Gradual variation in array length.	Irregular shape. Significant variation in array length.	Relatively regular shape. Gradual variation in array length.	Irregular shape. Significant variation in array length.	Irregular shape. Significant variation in array length.	Relatively regular shape. Gradual variation in array length.	Irregular shape. Significant variation in array length.
Array orientation	East-west	East-west	East-west	East-west	East-west	East-west North-south Northeast-southwest Northwest-southeast	East-west	East-west

Figure 3. Site-scale morphological analysis of eight photovoltaic landscape samples (source satellite imagery: Google Earth).

4. Conclusion

This study analyzed the spatial characteristics of photovoltaic landscapes from both regional and site scales, revealing their distribution patterns and impacts on original landscapes. The research highlights that the site selection and layout of existing photovoltaic landscapes result from historical siting decisions rather than optimized planning. In some cases, photovoltaic development potentially exacerbates ecological vulnerability or disrupts cultural landscapes. Future photovoltaic landscape planning should focus on optimizing site selection decisions, balancing energy production with environmental protection, and integrating solar power plants installations with local landscapes to enhance long-term value. Understanding and revealing the spatial characteristics of photovoltaic landscapes helps optimize the planning and design of solar power plants. The proposed analytical framework provides a scientific basis for assessing photovoltaic landscape impacts and supports sustainable energy planning, promoting synergy between renewable energy development and landscape conservation.

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RESEARCH ON MULTI-OBJECTIVE OPTIMIZATION OF URBAN-RURAL BLUE-GREEN SPACE NETWORK BASED ON NSGAIII ALGORITHM: A CASE STUDY OF CHENGDU EASTERN NEW DISTRICT

TOPIC: Guiding territories by changing the design of regional projects: tools for intervention at different scales, for multifunctional landscapes

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Keywords: Multi-objective optimization, NSGA, Blue-green space network, Chengdu Eastern New Area

Abstract

With the rapid advancement of global urbanization, urban expansion has brought significant ecological issues and resource conservation challenges. This is particularly evident in newly developed urban areas, where imbalances between urban and rural blue-green spaces exacerbate human-land conflicts and intensify resource disputes. Addressing these issues has emerged as an urgent international challenge. Meanwhile, with the rapid iteration and advancement of artificial intelligence technology, the question of whether new technologies can be harnessed to leverage the role of landscapes will remain a key focus for the landscape architecture discipline in the future.

This study employs the Non-dominated Sorting Genetic Algorithm III (NSGA-III) and uses Chengdu Eastern New District—characterized by rapid economic growth and dramatic shifts in urban and rural blue-green spaces—as a case study to conduct multi-objective optimization research on urban and rural blue-green space networks. By applying the artificial intelligence optimization algorithm NSGA-III to regional blue-green space networks, the research seeks optimal spatial layout solutions that balance the objectives of carbon storage resources, water resources, and biodiversity benefits.

A significant innovation of this study lies in its application of the multi-objective optimization algorithm NSGA-III to the field of landscape architecture, specifically in optimizing the layout of urban and rural blue-green spaces. By innovatively integrating intelligent algorithms with landscape architecture planning, this research explores the potential of NSGA-III to resolve high-dimensional ecological design conflicts. It offers a replicable model for the sustainable planning of blue-green spaces in rapidly urbanizing regions, aligning with the demands of sustainable development. Another key innovation is the development of urban and rural blue-green space networks through multi-objective optimization. This approach proposes a systematic method that incorporates water resources, biological resources, and carbon resource benefits as optimization objectives, while integrating spatial layout and ecological protection requirements.

This research not only provides theoretical and practical guidance for sustainable urban planning in Chengdu Eastern New District but also establishes a reference framework for promoting high-quality development in other urbanizing regions.

1. Introduction

The rapid pace of global urbanization has led to significant ecological problems and posed substantial challenges to resource conservation [1]. This phenomenon is particularly acute in the emerging development zones of major Chinese metropolises, where the spatial imbalance of urban-rural blue-green spaces has exacerbated human-land conflicts and intensified resource disputes [2]. Addressing these challenges has become a pressing global concern. Concurrently, harnessing advanced artificial intelligence (AI) to address complex ecological issues has emerged as a strategic

imperative within the discipline of landscape architecture [3].

Urban-rural Blue-Green Space (BGS), a form of strategic ecological infrastructure, plays a critical role in mitigating human-land conflicts and safeguarding regional ecological security [4]. The organic integration of blue and green spaces supports a range of ecological functions, including climate regulation, air purification, water conservation, and biodiversity protection, thereby enabling the provision of diverse ecosystem services. This study concentrates on three pivotal ecological benefits: carbon storage, water yield, and biodiversity (quantified as habitat quality). However, traditional planning methods are often ineffective in addressing such complex tasks. These approaches, which typically rely on qualitative assessments or single-objective frameworks, are ill-suited to produce definitive spatial layout solutions. Furthermore, their decision-making processes are frequently influenced by subjectivity and lack a systematic mechanism for optimizing trade-offs among multiple ecological objectives.

To address these challenges, Pareto-based Multi-Objective Optimization Algorithms (MOOAs)—a class of advanced AI techniques—present a compelling avenue. Among them, the Non-dominated Sorting Genetic Algorithm (NSGA) has become one of the most widely adopted MOOAs owing to its Pareto-based optimization structure and rapid convergence characteristics [5]. Although the NSGA-II algorithm has been applied in certain studies, such as land-use spatial optimization in the Kashgar region [6]and scaling Low Impact Development (LID) facilities [7], its performance deteriorates considerably when applied to high-dimensional problems involving three or more objectives. The Non-dominated Sorting Genetic Algorithm III (NSGA-III), a state-of-the-art algorithm tailored for many-objective problems, exhibits enhanced capability through the incorporation of a reference-point-based selection mechanism. However, its application to resolving complex ecological design conflicts in landscape architecture has yet to be fully investigated.

This review identifies a critical methodological gap: existing planning methods are insufficient in balancing multiple ecological objectives, and the application of advanced AI algorithms such as NSGA-III in solving many-objective spatial optimization problems within landscape architecture remains underdeveloped. To bridge this gap, an effective optimization framework must spatially quantify ecological services. The Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) model serves as an authoritative tool for this purpose, offering quantitative assessments of services such as carbon storage, water yield, and habitat quality [Hamel et al., 2021]. The key challenge, therefore, lies in developing an integrated framework that combines the spatial outputs from the InVEST model with the optimization capabilities of the NSGA-III algorithm.

To address the identified research gap, this paper proposes and evaluates a multi-objective optimization framework for urban-rural BGS networks by integrating ecosystem service valuation with the NSGA-III algorithm. The Eastern New Area of Chengdu—an archetypal region experiencing rapid economic development and significant transformations in its BGS patterns—was selected as the case study. Through this framework, we aim to identify Pareto-optimal spatial layout solutions that balance three core objectives: carbon storage, water yield, and biodiversity benefits. A key innovation of this research lies in applying the NSGA-III algorithm within landscape architecture to address complex many-objective spatial planning conflicts. This study not only provides practical insights for the sustainable development of Chengdu Eastern New District but also presents a replicable planning paradigm for other rapidly urbanizing regions.

2. Study area and datasets

2.1. Study area

The Eastern New Area of Chengdu (104°19′ to 104°56′ E, 30°20′ to 30°60′ N) is located on the western edge of the central Sichuan Basin, situated in the southeastern part of Chengdu, along the eastern foothills of the Longquan Mountains and the middle reaches of the Tuo River.

Topographically, the area features a higher elevation in the northwest and lower elevation in the southeast, with gently rolling hills as the dominant landform. Climatically, it falls within the subtropical monsoon climate zone, characterized by distinct seasonal monsoons and a pronounced synchronization of heat and precipitation.

2.2. Data Sources

Data were primarily obtained from the following key sources: the annual land-cover dataset for China at 30 m resolution covering 1985–2023, published by Professors Jie Yang and Xin Huang of Wuhan University (https://zenodo.org/records/12779975; accessed 15 May 2025); and the monthly precipitation

dataset for China, released by Professor Shouzhang Peng via the National Tibetan Plateau Data Center (https://data.tpdc.ac.cn/zh-hans/data; accessed 23 May 2025). In addition, to meet the InVEST model's requirements for the Carbon Storage and Sequestration, Water Yield, and Habitat Quality modules, mean reference evapotranspiration and soil hydrologic group data were obtained from the sources recommended in the InVEST User's Guide.

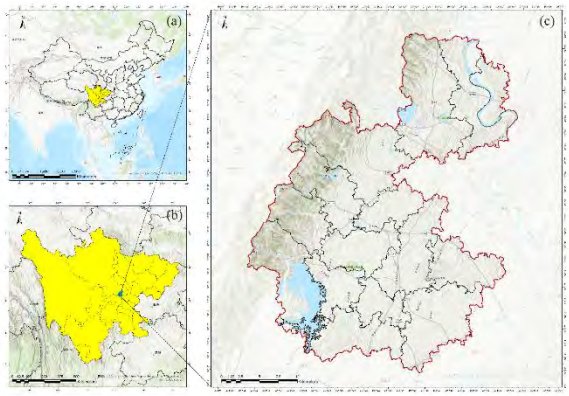


Figure 1. Location of the Chengdu Eastern New District.(a) National context:China. (b) Provincial context: Sichuan Province (yellow). (c) Detailed administrative map of the Chengdu Eastern New District

3. Methods.

3.1 Construction of Multi-Objective Functions Based on the InVEST ModelFormulation of Multi-Objective Functions Based on the InVEST Model

This study utilizes the Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) model, which was jointly developed by Stanford University, The Nature Conservancy (TNC), and the World Wide Fund for Nature (WWF).

All figures and tables must be numbered, captioned and centred as they appear in the column. Examples of a figure (Figure 1) and a table (Table 1) are given below. Two 11pt spaces should separate the top of the figure and caption from the surrounding text. Leave an 11pt space between the figure and the caption. The same requirements apply to tables.

The images and tables must be free of rights and remain, like the rest, under the responsibility of the author

This study focuses on the practical application of the Carbon Storage, Water Yield, and Habitat Quality modules of the InVEST model. These modules correspond to three objective functions under the resource conservation framework: the carbon storage function, the water yield function, and the habitat quality function.

The establishment of these three objective functions, derived from the InVEST model and framed within a resource conservation perspective, is predicated on the hierarchical classification of the blue-green space network proposed by Cheng Yuning and Zhou Conghui. Furthermore, these functions were specifically tailored to align with the policy planning and actual conditions of the Eastern New Area. Additionally, to ensure that the optimization results align with practical needs, this study incorporates specific constraints into the model based on the actual conditions of the Chengdu Eastern New District. These constraints include land use type restrictions and ecological protection redlines.

Based on a review of relevant literature, the core computational formulas for the objective functions of carbon storage resources, water yield resources, and biodiversity conservation are presented below (Table 1).

Table 1. Formulas for Calculating the Objective Functions

Objective Function	Calculation Formula
Carbon Storage Function	$C_{\text{total}} = C_{\text{above}} + C_{\text{below}} + C_{\text{soil}} + C_{\text{dead}}$
Water Yield Function	$WY = \min\left(1, \frac{249}{\text{Velocity}}\right) \times \min\left(1, \frac{0.9 \times \text{TI}}{3}\right) \times \min\left(1, \frac{\text{Ksat}}{300}\right) \times Y_{xj}$
Habitat Quality Function	$Q_{xj} = H_j\left(1 - \frac{D_{xj}^z}{D_{xj}^z + k^z}\right)$

In the computation process, some default data are calibrated for the United States. Therefore, in the subsequent empirical research, this study references the applied research of multiple Chinese scholars on the InVEST model to convert foreign-calibrated parameters to values appropriate for the context of China.

3.2. Multi-Objective Synergistic Optimization Method Based on the NSGA-III Algorithm

3.2.1. Construction of the NSGA-III Optimization Model NSGA-III

In this study, the Non-dominated Sorting Genetic Algorithm III (NSGA-III) was employed to achieve multi-objective coordinated optimization of the urban–rural blue-green space network in the Chengdu Eastern New District. NSGA-III is a multi-objective optimization method based on genetic algorithms, which identifies a set of Pareto-optimal solutions through non-dominated sorting across multiple objectives.

Three objective functions were established in this research, namely: (1) carbon storage benefit, (2) water resource benefit, and (3) biodiversity

conservation benefit. The formulation of these objectives was grounded in blue-green space theory, aligned with the regional planning policies of the Eastern New Area, and designed to be compatible with the optimization capabilities of the NSGA-III algorithm.

3.2.2 Carbon Storage Benefit Objective

The carbon storage benefit objective is derived from the Carbon Storage module of the InVEST model. This module estimates the current or future carbon stock in a landscape based on land use/land cover (LULC) maps and the carbon pools, which include aboveground biomass, belowground biomass, soil organic carbon, and dead organic matter. To ensure the accuracy of carbon storage simulation, this study localized the carbon density parameters by referencing existing research specific to the Sichuan-Chongqing region.

3.2.3 Water Resource Benefit Objective

The water resource benefit objective is calculated using the Annual Water Yield module of the InVEST model. The provision of water resources is considered a fundamental ecosystem service, yet it is highly sensitive to changes in land use and land cover (LULC). Shifts in LULC can alter the hydrological cycle by affecting evapotranspiration, infiltration, and water retention processes, ultimately impacting water availability for services such as hydropower generation. Therefore, the land use configurations under different preference-based scenarios in the Eastern New Area will directly influence water supply capacity.

3.2.4 Biodiversity Conservation Benefit Objective

The biodiversity conservation benefit objective is derived from the Habitat Quality module of the InVEST model. According to relevant literature and InVEST applications, habitat quality and rarity are regarded as key indicators of biodiversity. The habitat quality evaluation in InVEST is based on the spatial distribution and intensity of threats exerted on habitats.

4. Results

4.1 Constraint Conditions of the Objective Functions

In the NSGA-III multi-objective optimization model, the formulation of constraint conditions is essential to ensure that the optimization outcomes align with regional realities and policy requirements. Based on the Master Plan for Territorial Spatial Development of Chengdu Eastern New District (2021–2035) and other relevant specialized planning documents (see Table 1), this study defines a set of core constraints, which are subsequently translated into mathematical expressions in Python for integration into the NSGA-III algorithm.

Table2. Constraints associated with the objective functions

Planning Document	Constraint Conditions
Master Plan for Territorial Spatial Development of Chengdu Eastern New District (2021–2035)	Farmland area ≥ 226.40 km²
	Arable land retention target (≥ 0.30 million mu by 2035)
	Permanent basic farmland ≥ 187.29 km²
	Urban development boundary ≤ 156.85 km²
	Ecological protection redline ≥ 3.1 km²
Special Green Space System Plan of Chengdu (2021–2035)	Green coverage ratio ≥ 45%
	Blue-green space proportion ≥ 45%

4.2. Multi-Scenario Optimization Model Solving Based on the NSGA-III Algorithm

To solve the above multi-objective optimization model, this study employed the NSGA-III algorithm with diversity maintenance mechanisms, implemented in a Python environment. The workflow integrates several key libraries, including GeoPandas (for vector geospatial data processing), Rasterio (for raster data handling and spatial analysis), NatCap.Invest (for ecosystem service modeling), and Pymoo (for multi-objective optimization).

Given the high-dimensional nature of the optimization problem in the Eastern New Area and the computational complexity of the InVEST model, the population size was set to 100 and the number of generations to 50. A total of 10 Pareto-optimal solutions from the final generation were obtained. These parameter settings were informed by commonly adopted optimization ranges in the literature. This configuration strikes a balance between computational efficiency and the diversity and quality of the solution set.

As illustrated in Figure 2(a), the "3D Scatter Plot of Multi-Objective Pareto Front," the 10 optimal solutions form a clear Pareto front in a three-dimensional objective space defined by carbon storage, annual water yield, and habitat quality. Each solution (represented by red dots in the figure) corresponds to an optimal land-use scenario. In these scenarios, any improvement in one objective can only be achieved at the expense of at least one of the other two objectives.

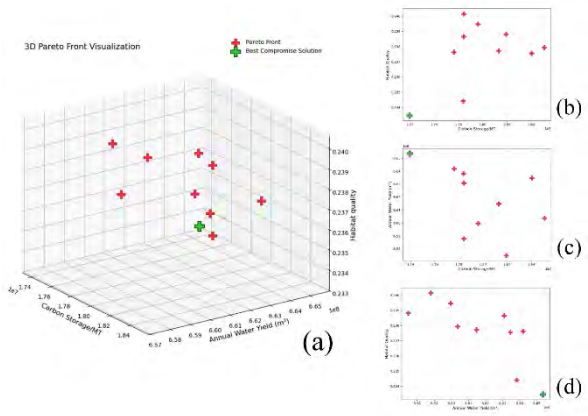


Figure 2. (a) 3D Scatter Plot of the Multi-Objective Pareto Front; (b) 2D Pareto Plot of Carbon Storage vs. Habitat Quality; (c) 2D Pareto Plot of Carbon

4.3. Analysis of the Multi-Scenario Optimization Model Based on the NSGA-III Algorithm

Within the framework of the NSGA-III algorithm, each solution on the Pareto front (i.e., a point in the three-dimensional objective space) inherently corresponds to a unique set of decision variables. In the optimization model of this study, each optimal solution composed of decision variables represents a specific spatial land-use configuration within the study area.

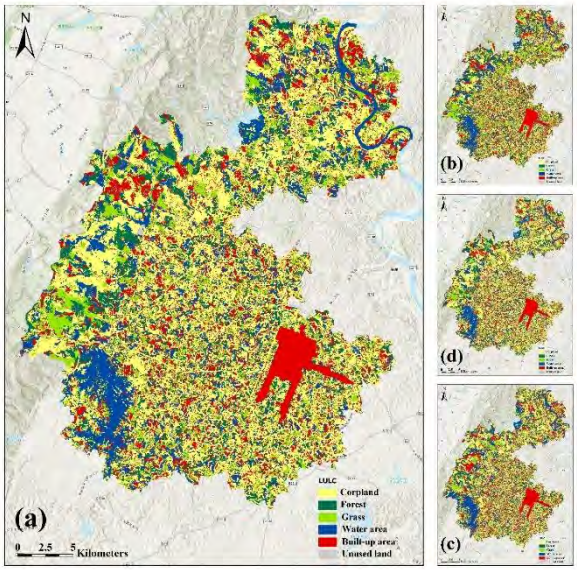


Figure 3. Land Use Maps under Four Preference-Based Scenarios in the Eastern New Area
(a) Balanced Development Scenario (b) Carbon Storage–Oriented Scenario (c) Water Yield–Oriented Scenario (d) Habitat Quality–Oriented Scenario

Each scenario exhibits a distinct land use configuration that intuitively reveals the spatial divergence and internal trade-offs among the different ecosystem service objectives. The Balanced Development Scenario, representing a compromise solution, displays a relatively mixed and heterogeneous land use pattern, characterized by a mosaic of land types. In contrast, the Carbon Storage–Oriented Scenario (Figure b) and the Habitat Quality–Oriented Scenario (Figure d) exhibit highly similar and ecologically intensive spatial patterns. These two scenarios show a significant ecological transition, primarily marked by a large-scale expansion of forest and grassland, especially in the ecologically favorable northern and southeastern regions of the study area, where contiguous forest–grassland ecosystems are formed. This expansion is mainly achieved through the conversion of existing cropland.

Conversely, the Water Yield–Oriented Scenario (Figure c) displays an opposite trend. To maximize water yield, forest areas are substantially reduced, with much of the original forest converted to cropland. This transformation stems from the model's tendency to minimize evapotranspiration—a major water loss mechanism—by favoring land use types with lower leaf area indices.

Driven by multi-objective optimization, the land use structure of the study area has undergone significant transformation, exhibiting three core spatial trends: (1) protective intensification of cropland, (2) systematic expansion of blue–green infrastructure, and (3) controlled, compact urban growth. As shown in Tables 8 and 9, all scenarios adhere to the strict baseline of farmland protection (≥ 226.4 km²), achieving land intensification through differentiated land reduction strategies. Notably, in the Carbon Storage–Oriented Scenario, cropland is most drastically reduced—down to 173.9 km². Meanwhile, water bodies and grasslands, as key components of blue–green space, show systematic increases across all scenarios—for instance, in the carbon storage scenario, net gains of 91.46 km² and 145.81 km² are observed for water and grassland, respectively. Built-up land increases moderately, ranging from 21.56 to 47.21 km², constrained by the fixed urban development boundary, reflecting a cautious balance between development demands and ecological protection.

Table 3. Comparison of Land Use between Current Status and Four Optimized Scenarios

Land Use Type	Land Use under the Four Optimized Scenarios						
	Balanced Development		Carbon Storage – Oriented		Water Yield – Oriented		Habit C
	Area (km^2)	Proportion (%)	Area (km^2)	Proportion (%)	Area (km^2)	Proportion (%)	Area (km^2)
Corpland	375.65	43.20	284.73	32.75	375.65	43.20	326.51
Forest	98.04	11.27	96.03	11.04	98.04	11.27	97.02
Grass	96.04	11.05	150.13	17.27	96.04	11.05	102.19
Water area	139.16	16.00	150.47	17.30	139.16	16.00	145.28
Construction area	159.28	18.32	181.92	20.92	159.28	18.32	184.92
Unused land	1.38	0.16	6.26	0.72	1.38	0.16	13.61

5. Discussion

5.1 Quantitative Characteristics of Multi-Scenario Blue–Green Space Optimization Solutions

The solution set generated by the NSGA-III algorithm demonstrates good diversity and reveals the significant synergies and trade-offs among the three ecological objectives: carbon storage, water yield, and habitat quality. From the land use statistics under different scenarios, it is evident that the optimization paths driven by each objective differ significantly in both the intensity and direction of land use conversion. For instance, the Carbon Storage–Oriented Scenario enhances regional carbon sequestration capacity by converting 173.9 km^2 of cropland into grassland and wetland. In contrast, the Water Yield–Oriented Scenario maintains relatively stable cropland areas while compressing forested areas to increase surface runoff, thereby maximizing water yield functionality.

5.2 Spatial Characteristics of Multi-Scenario Blue–Green Space Optimization Solutions

The spatial reconfiguration of blue–green infrastructure under different optimization scenarios reflects the internal logic of multi-objective planning in balancing ecological prioritization with land use coordination. The Balanced Development Scenario exhibits a compound pattern characterized by an interwoven distribution of multiple land use types. It represents a relatively moderate spatial strategy that balances cropland protection with the diverse provision of ecosystem services.

In contrast, both the Carbon Storage–Oriented and Habitat Quality–Oriented Scenarios show a strong tendency toward ecological intensification. These scenarios focus on large-scale expansion of forest and grassland in ecologically sensitive areas—primarily in the northern and southeastern parts of the study area—forming continuous ecological patches and species migration corridors. This strategy significantly enhances landscape connectivity and the overall integrity of the ecological security pattern.

On the other hand, the Water Yield–Oriented Scenario adopts a distinct spatial strategy. To reduce evapotranspiration loss associated with dense vegetation, this scenario strategically replaces forests with agricultural land in areas where farmland already exists, mainly in the central and southern regions, thereby spatially optimizing water provision services. Under policy constraints, all scenarios strictly adhere to the cropland protection baseline and the urban development boundary, achieving a rational balance between ecological preservation and urban development.

6. Conclusions

This study aims to explore multi-objective optimization pathways for the urban–rural blue–green space network in Chengdu Eastern New District from a resource conservation perspective, using the NSGA-III algorithm. By setting benefit objectives for carbon storage, water resources, and biodiversity, and incorporating appropriate constraint conditions, the study investigates how to achieve both effective resource conservation and rational spatial planning through multi-objective optimization.

The results indicate that multi-objective optimization has driven significant restructuring of regional land use, characterized by three core trends: protective intensification of cropland, systematic expansion of blue–green infrastructure, and compact, intelligent growth of built-up areas. These spatial transformation patterns offer practical optimization strategies and strategic references for future blue–green space planning in Chengdu Eastern New District.

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LANDSCPAE ARCHITCTURE OR REVOLUTION?

TOPIC: The five modes of landscape architecture in the age of Generative AI

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Keywords: Landscape Architecture, Artificial Intelligence, Generative AI, AI application, GANs

Abstract
As artificial intelligence (AI) continues to reshape creative industries, landscape architecture remains comparatively underexplored in its adoption of AI-driven design methods. This article presents a theoretical framework that classifies four distinct modes of AI generative design, with a particular focus on the potential of AI image generation technologies for advancing innovation in landscape architecture. The first mode, creation by logic, is rooted in rule-based and functionalist approaches. From early computational tools like SYMAP and the Geodesign Framework to recent AI models such as ArchiGAN and genetic algorithms, logic-based AI methods offer optimized planning and design outcomes. The second mode, creation by mimesis, builds on the aesthetic tradition of imitation. Recent AI generative tools enable photorealistic landscape renderings, while AI artists like Refik Anadol and Daniel Bolojan demonstrate how AI can reinterpret both nature and architecture, extending beyond surface-level replication. The third mode, creation by misunderstanding, introduces creative novelty through intentional deviation from learned data patterns. AI models like DeepDream, Pix2Pix, and CycleGAN generate unexpected, imaginative outputs through misrecognition and reinterpretation, aligning with Walter Benjamin's concept of non-sensuous similarity. The fourth mode, creation by differentiation, focuses on producing contextually distinct and original designs that move beyond imitation. Tools such as DALL·E, Midjourney, and Creative Adversarial Networks (CANs), along with case studies like the generative planting design model by Youngmin Kim and Kijeong Kim, illustrate how blending multiple AI modes and human intervention can foster originality. The article concludes by emphasizing the need for landscape architects to engage critically with AI's mechanisms and creative potential, shaping the discipline's role in an AI-driven design future.

1. INTRODUCTION

In 1923, Le Corbusier issued a provocative manifesto in his monumental book *Vers une Architecture*, posing the question: "Architecture ou Révolution?"(Corbusier 2008) This bold declaration called for a departure from traditional architecture and the reconstruction of a new architectural paradigm as a critical instrument for addressing and solving the social ills of the machine age If we set aside the evaluation of whether Le Corbusier's architecture was successful or not, both his opponents and proponents would agree that he presented a new model and the aesthetics for the architecture of the machine age and ultimately changed the course of architecture and urbanism. Interestingly, 100 years after Le Corbusier declared a new direction for architecture, we find ourselves in a similar situation—on the verge of a technological revolution expected to fundamentally transform our lives and ways of thinking. This time, the revolution is being driven by artificial intelligence.

Tafuri analyzed that the new potential of technology was first interpreted into the aesthetics of Modernism by avant-garde artists, followed by modern architects who completed the model of integrated aesthetics and technology(Tafuri 1996). The field of landscape architecture totally missed

the opportunity to participate in the revolution of the early 20th century. Today, the transformation triggered by AI seems to be following a similar pattern to that of 100 years ago. Recently, AI-generated art has emerged, challenging the foundations of established aesthetic structures. Shocked by the conceptual implications of AI-based art, the field of architecture is now actively exploring the potential of artificial intelligence. Witnessing these rapid developments, landscape architecture can no longer avoid the wave of technological change. Unlike a century ago, the current pace and scale of transformation leave no time for landscape architects to wait for a generation before engaging with this revolution.

Therefore, it is crucial to examine how AI will reshape the concept of landscape architecture and to explore the new potentials of AI technology in landscape design. This article aims to classify the different modes of AI application in landscape architecture, with a particular focus on design innovation through AI image generation technologies. Rather than merely categorizing current trends in AI usage, the article seeks to theorize their significance from both academic and practical perspectives, drawing on discourses and case studies from the adjacent fields of art and architecture.

2. TRENDS

In the history of AI development, a significant turning point occurred in 1997 with two major advancements: IBM's Deep Blue, the first AI algorithm to defeat a world chess champion, and the introduction of Long Short-Term Memory (LSTM), a type of recurrent neural network (RNN) that greatly enhanced AI's capacity for sequential data processing (Leach 2025). Following these breakthroughs in the 1990s, AI technologies began to find broader applications in both academic research and various industries. In the field of AI-powered art and design, although there had been earlier attempts to generate art using computer algorithms—most notably AARON, developed by Harold Cohen. in the 1970s—it was not until the emergence of Generative Adversarial Networks (GANs) in 2014 that AI achieved the ability to create complex and realistic visual outputs(Chaillou 2025).

Research on AI-assisted design and creative practices using AI algorithms and tools is not confined to any single field of design or art. Early literature on AI technologies related to image generation was predominantly rooted in computer engineering. However, as AI applications expanded into the arts, a growing body of scholarship emerged that reexamined concepts such as authorship and the philosophical implications of art creation in the age of artificial intelligence. In the field of architecture, the number of publications on AI applications has increased significantly in recent years, prompting several studies to systematically analyze the existing literature and map the evolving landscape of AI integration in architectural design. Li C. et al. conducted a systematic literature review focusing on the use of generative AI models in architectural design(Li, Zhang, Du, Zhang, Xie 2024) . Their study categorized current AI-assisted design practices into six stages: concept design, 3D form generation, plan design, façade design, structural system design, and section design. Similarly, Li Y. et al. analyzed 92 relevant articles selected from a pool of 1,810 papers related to AI technologies (Li, Chen, Yu, Yang 2025). They identified three major areas where generative AI is being applied in architecture: environmental data collection, plan generation, and design evaluation.

Comparable systematic literature reviews have been conducted in the field of landscape architecture. Fernberg and Chamberlain reviewed 100 articles from a total of 600 to highlight trends in publication and to synthesize emerging AI themes in landscape research and practice (Fernberg, Chamberlain 2023). They identified six key themes: design generation and evaluation, ecological modeling, predictive analytics, and landscape policy evaluation. Although relatively few studies focused specifically on design generation, the paper noted that AI's most evident impact on landscape design lies in the growing integration with computational design ecosystems. Xing Y. et al. conducted a separate literature review aimed at framing the fundamental concepts of AI application in landscape architecture (Xing, Gan, Chen 2024). They classified recent AI applications into six thematic areas: ecosystem simulation and evaluation, visualization, simulation and prediction, landscape planning and design, landscape construction, landscape maintenance and management, and landscape heritage protection.

3. FOUR MODES OF AI GENERATION IN LANDSCAPE ARCHITECTURE

3.1. Creation by Logic

The initial introduction of AI into the design field was rooted in functionalist thinking. In the 1960s, when scientific methodologies and quantitative

approaches heavily influenced architecture, designers began to focus on the computational methods' capacity for logical analysis. Landscape architecture followed a similar trajectory. Ian McHarg, in his book Design with Nature, introduced a geo-based planning technique that proposed a scientifically driven planning method for landscape architecture. Howard Fisher developed SYMAP, one of the earliest computer-based mapping and analysis programs, which later played a foundational role in the development of GIS (Miller 2012). A notable example of early computational planning in landscape architecture was the Delmarva Study conducted by Carl Steinitz in 1967 (Figure 1). While these scientific planning frameworks incorporated computational processes into landscape projects, they are not strictly categorized as AI-generated design. Rather, they served primarily as analytical tools supporting decision-making processes in landscape planning. In 2012, Steinitz further advanced this computational planning discourse by proposing the Geodesign Framework, a theoretical model for planning and design methods based on geospatial information and GIS-based analytical processes. In his book, *A Framework for Geodesign*, he outlined eight models for Geodesign, among which the rule-based approach—structured as a set of computer algorithms following specific logic—offers a conceptual foundation for AI-generated landscape planning (Steinitz 2012).

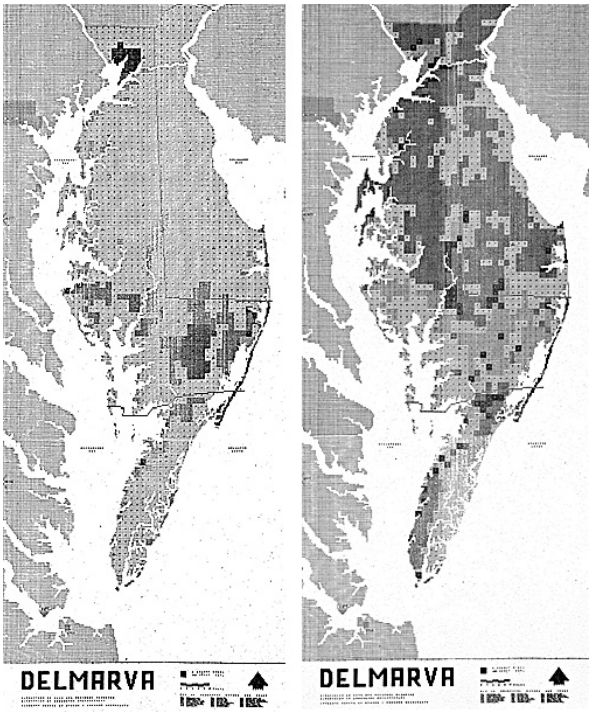


Figure 1. Delmarva project in 1967 by Steinitz C.

A project conducted in the planning studio at the University of Seoul (UOS) offers a example of Steinitz's rule-based approach, enhanced using more advanced AI-based optimization techniques, specifically genetic algorithms. In this project, a new town planning scheme for Gyeyang, Republic of Korea, was redesigned with the objective of optimizing water discharge and pollution control. By running the genetic optimization algorithm for over 500 generations, the process achieved convergence toward an optimal solution around the 100th generation, ultimately producing highly fit and contextually suitable design alternatives (Figure 2).

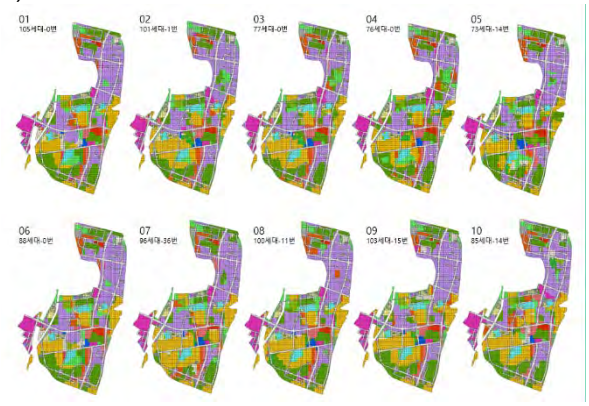


Figure 2. Gyeyang Newtown Planning generated by a genetic algorithm optimization

One of the most recent advancements in AI-driven design generation based on specific logic is ArchiGAN, proposed by Stanislas Chailou in 2019 (Chaillou 2020). ArchiGAN is a generative AI model that produces architectural floor plans using Generative Adversarial Networks (GANs). After being trained on a database containing more than 800 apartment floor plans, ArchiGAN became capable of generating new apartment layouts (Figure 3). GAN-based approach to architectural plan generation has since evolved into several commercial AI design tools, such as Finch, Maket AI, Planner 5D, and Sidewalk Labs. While these methods originated in the field of architecture, their applications are now expanding into urban design and landscape architecture. Although the underlying logic of ArchiGAN differs from Steinitz's rule-based design approach, both share a common objective: to produce optimized design alternatives that follow a defined set of logical constraints.



Figure 3. AI generated plans by ArchiGAN by Chailou C.

3.2. Creation by Mimesis

Imitation is currently the most widely adopted AI application strategy in the daily workflow of design studios. As client expectations for visual representation continue to rise, landscape architects are spending more time on modeling and rendering than ever before. AI-based rendering engines such as Lumion, D5 Render, KREA and Enscape have enabled designers to produce higher-quality images with greater efficiency (Figure 4, 5). In landscape architecture, visual representation primarily aims to simulate real landscapes. However, because these images depict conceptual designs that do not yet exist, the process involves not only imitation but also creative interpretation and invention.



Figure 4. Original rendering done in D5



Figure 5. Manipulated image using KREA and Adobe firefly

The creative potential of AI-powered imitation lies not only in producing effective and photorealistic graphic representations. In classical aesthetic theory, imitation has long been regarded as a fundamental principle of artistic creation, a concept supported by thinkers from Plato to the Neo-classicists of the 18th century. Plato initially viewed artistic creation as a form of double imitation: art imitates nature, which itself is an imitation of ideal Forms. Aristotle later reinterpreted Plato's theory, arguing that art directly imitates the Idea (or *eidos*), rather than a mere copy of it. In this view, art becomes a more essential representation or expression of existence itself. Eighteenth-century aestheticians such as Winckelmann, Batteux, and Diderot further developed this perspective, proposing that by imitating nature, art can reveal and create the ideal beauty immanent within it (Kultermann 1993).

The aesthetic theory of imitation was not exclusive to Western thought. Traditional garden art in Japan and China was also grounded in the idea of achieving perfection through imitation. The Ryoan-ji rock garden in Kyoto exemplifies one of the most sophisticated approaches to creating an ideal landscape through this principle. While the garden represents an imitation of the sea, its highly abstracted form elevates the viewer's experience to a different level of landscape perception. In this case, the copy (*Abbild*) has no direct visual connection to the original (*Vorbild*), yet it simultaneously transcends and reinterprets the beauty of the original source.



Figure 6. Machine Hallucinations — Nature Dreams by Refik Anadol

Refik Anadol is an AI artist whose work employs a similar strategy of imitation. His series "Machine Hallucinations" can be understood as a form of dual imitation of nature (Figure 6). To represent natural forms, Anadol collected millions of images, including satellite photographs of the Earth, images of Mars, and underwater scenes. These visual datasets were then restructured using AI models based on DCGAN, PGAN, and StyleGAN algorithms. However, the new digital landscapes generated through this process are not mere recreations of nature. Anadol conceptualizes image data as collective visual memories of space, nature, and urban environments. The process of reconstructing these images through AI reflects a mimesis of the human memory system itself. Thus, his work represents not only an imitation of nature but also an imitation of human memory (Duke 2018).

Daniel Bolojan has applied a dual imitation strategy similar to *Machine Hallucinations*, but with an architectural focus. Using convolutional neural networks (CNNs), he trained AI models to identify and extract relevant compositional elements from Gaudí's Sagrada Família. Gaudí himself is well known for drawing inspiration from natural forms, particularly forests, in his design of the cathedral. The goal of his project was to transfer the underlying compositional characteristics of one domain (nature) to another (architecture), thereby imitating the human learning process (Bolojan 2022). Although this level of AI-generated mimesis has not yet been widely explored in landscape architecture, the works of Anadol and Bolojan reveal new potentials for AI-driven design processes in the field.

3.3. Creation by Misunderstanding

In the application of AI to artistic creation, engineers and artist have consistently faced the issue of novelty. Both AI image generation and image classification rely on the AI's ability to learn image features from large datasets. If an AI can recognize patterns within images, it can also synthesize new images with similar patterns, having internalized the statistical representation of those features. Algorithms such as VAEs and GANs typically generate images that resemble the training data. For example, StyleGAN has demonstrated the ability to produce images that are nearly indistinguishable from real photographs, reaching what could be considered an ultimate level of creation through mimesis. However, the goal of artistic creation does not lie solely in producing flawless imitations of the real world. Models like DeepDream, Pix2Pix, CycleGAN introduce new pathways for generating novel imagery—not through direct imitation, but through processes of abstraction, reinterpretation, and even intentional "misunderstanding" of learned features.

The concept of creation through misunderstanding was not a major theme in classical aesthetics. However, this strategy began to emerge more prominently in the works of many modern artists in the early 20th century. Maurits Escher, for example, employed deliberate visual misunderstanding in his etchings, often based on optical illusions and perceptual paradoxes. Similarly, Surrealist artists such as Salvador Dalí, Max Ernst, and René Magritte incorporated strategies of misunderstanding in their paintings, exploring dreamlike, illogical, and paradoxical imagery that challenged conventional perceptions of reality(Guyer 2018). It was Walter Benjamin who first introduced the concept of misunderstanding as a central theme in aesthetics. In his essay *Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit (The Work of Art in the Age of Mechanical Reproduction)*, Benjamin argued that the aura of art is, in essence, a misunderstanding of the aura of ritual (Benjamin, Zohn 2018). In another essay, *Über das mimetische Vermögen (On the Mimetic Faculty)*, Benjamin proposed a theory of similarity grounded in the concept of mimetic faculty (Benjamin, Tarnowski 1979). Although he discusses mimesis, Benjamin's understanding does not align with classical aesthetics, which traditionally emphasized faithful imitation. Instead, he focused on the differences that emerge through misunderstanding within the mimetic process. One example he offers is the interpretation of constellations: despite the absence of any real connection between the physical arrangement of stars and their perceived meaning, humans create patterns and linguistic associations. Benjamin referred to this phenomenon as non-sensuous similarity (unsinnliche Ähnlichkeit), a form of similarity that emerges through imaginative misrecognition and creative reinterpretation.

DeepDream, Pix2Pix, and CycleGAN demonstrate image-generation processes that align with Walter Benjamin's notion of non-sensuous similarity. DeepDream, developed by Alexander Mordvintsev, utilized the InceptionV3 model to train the AI(Miller 2019). Unlike typical training models that use gradient descent to minimize error, DeepDream employs gradient ascent, running the process in reverse to maximize specific feature

activations, thereby generating unexpected and hallucinatory images from the original input. Through this process, the AI produces novel images that deviate from the source material via intentional misinterpretation (Figure 7).



Figure 7. Aurelia Aurita by Martin Thomas



Figure 8. Gloomy Sunday by Memo Akten

Memo Akten's artwork "Gloomy Sunday", created using Pix2Pix, offers another example of how AI can generate novel images through processes of misunderstanding (Akten, Fiebrink, Grierson 2019). Pix2Pix, built on the conditional GAN (cGAN) framework, transforms input images into outputs with a different visual style. Akten trained the AI to produce radically different results from the same input, allowing the system to "look out into the world" through the camera lens but only perceive what it already knows—effectively reinforcing Benjamin's idea of mediated and biased perception (Figure 8).

Unlike traditional GANs that generate images from random noise, CycleGAN employs an architecture designed to translate images from one domain to another without paired training examples (Zhu, Park, Isola, Efros 2017). Using CycleGAN, Fernando Salcedo trained AI to reinterpret the textures and shapes of fabrics as architectural forms, resulting in structures visually reminiscent of designs by Zaha Hadid. These examples illustrate how AI can offer entirely new modes of artistic creation, including applications in architecture and landscape architecture (Figure 9).



Figure 9. Zaha Hadid Dataset by Fernando Salcedo

3.4. Creation by Differentiation

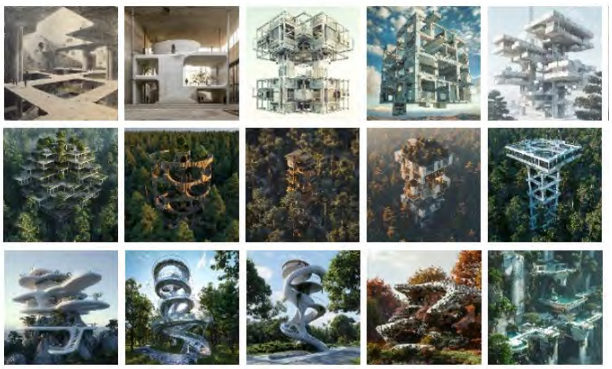


Figure 10. Landmark tower design options created by Midjourney

Many designers anticipate the emergence of AI systems capable of producing designs comparable in quality to those created by well-trained human designers. While achieving such fully autonomous generative design would likely require advances toward Artificial General Intelligence (AGI)—a technology that remains beyond current reach—there are already AI applications demonstrating creativity and problem-solving capabilities comparable to human designers within specific domains. More recently, AI image-generation tools such as Midjourney, DALL·E 3, Stable Diffusion, and Canva widely used in the practice of landscape architecture have begun to generate original design outputs with minimal designer intervention (Figure 10). However, for AI to move beyond its current role as a supportive tool in the design process, it must be able to generate synthetic design schemes that demonstrate genuine originality, rather than

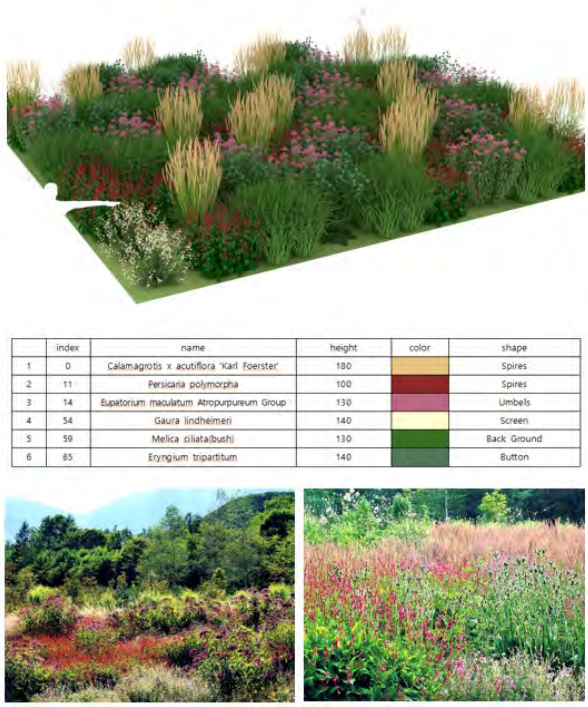
merely replicating existing design styles or imitating past projects. Consequently, achieving a higher level of differentiation in AI-generated outputs has become a critical challenge for both engineers and artists.



Figure 11. Edmond de Belamy by Obvious

One significant breakthrough in the discourse on creative differentiation was Portrait of Edmond de Belamy, produced by the artist collective Obvious using a Generative Adversarial Network (GAN) (Figure 11). The work gained international attention as the first AI-generated artwork sold at a major auction house, fetching $432,500 at Christie's in 2018. Although the artistic value and appraisal of Edmond de Belamy were highly controversial, the sale marked the first time an AI-generated artwork received recognition comparable to that of works created by human artists. Building on this momentum, Ahmed Elgammal and his colleagues developed Creative Adversarial Networks (CANs), a system designed to generate art by learning from existing styles and then deliberately deviating from them (Elgammal, Liu, Elhoseiny, Mazzone 2017). This approach enables CANs to produce artworks that are not only aesthetically pleasing but also conceptually distinct from the stylistic patterns of prior artists.

However, the process of creative differentiation cannot rely on a single algorithmic approach, as the conceptual scope of differentiation is broad and encompasses numerous strategies for achieving creativity. Creativity depends not only on the generation of novel ideas or concepts but also on the development of new methods for synthesizing existing techniques and facilitating diverse forms of interpretation. Therefore, the mode of creation through differentiation can be achieved by combining multiple generative approaches. The generative planting design model developed by Youngmin Kim and Kijeong Kim serves as an example of creative differentiation realized through the integration of different modes of generation. In this project, the planting design methods of two prominent garden designers—Dan Pearson and Thomas Rainer—were encoded into a generative system built on the Grasshopper platform. As the model imitates the design styles of existing landscape architects, it operates within the mode of mimesis. At the same time, because the system is driven by parametric rules and specific design constraints, it also incorporates elements of the logic-based generative mode. This combination allows the model to produce planting designs that are both stylistically informed and algorithmically diverse. However, by changing the plants selection different from original designers and modifying the module and patterns the mode was able produce results different from original design (Figure 12).



	index	name	height	color	shape
1	0	Calamagrotis x acutiflora 'Karl Foerster'	180		Spires
2	11	Persicaria polymorpha	100		Spires
3	14	Eupatorium maculatum Atropurpureum Group	130		Umbels
4	54	Gaura lindheimeri	140		Screen
5	59	Melica ciliata(bush)	130		Back Ground
6	65	Eryngium tripartitum	140		Button

Figure 12. Generative planting design model used Grasshopper

The thesis project by George Guida presents another good example of combining different modes of AI application to achieve originality differentiated from the original sources. Gudia generated the architectural images imitating two architects Carlo Scarpa and Zaha Hadid using VQGAN and StyleGAN. Then, combining Diffusion

based AI generation tools architectural plan was created. At the very last stage of design process Guida engaged in the design and manually modified the AI produced results. Combining several different modes and human engagement create novel design which was different from design of two original architects (Figure 13).



Figure 12. Multimodal Architecture by George Guida

4. Conclusion

This article has sought to provide a theoretical analysis of four distinct modes of AI generative design, with the aim of identifying new methods and applications within the field of landscape architecture. By surveying recent technological innovations and creative applications across various fields of art and design, it has become clear that the traditional boundaries between disciplines and genres are becoming increasingly obsolete in the age of AI-driven transformation. AI technology now serves as a platform that enables a wide range of possibilities across creative domains. However, one notable observation is that the application of creative AI in landscape architecture remains relatively underdeveloped compared to other fields.

To fully realize the potential of AI generative technologies, landscape architects must look beyond immediate, end-use applications. A deeper understanding of the underlying mechanisms—how AI systems function and operate—is essential for maximizing their impact in both design practice and research. Furthermore, it is critical to engage in theoretical reflection on the meaning of these technological shifts and their implications for the discipline and professional practice of landscape architecture. Finally, we must consider how a landscape architecture field empowered by AI could, in turn, influence other design disciplines and broader societal contexts.

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ENHANCING THE POSITIONAL ACCURACY AND REPRODUCIBILITY OF LANDSCAPE 3D MODELS USING UAV PHOTOGRAMMETRY WITH RTK-GNSS

TOPIC: Guiding territories by changing the design of regional projects: tools for intervention at different scales, for multifunctional landscapes

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Abstract

The digitalization of Landscapes management in Japan is accelerating with advancements in 3D modeling and remote sensing technologies. Many urban parks, developed during the period of rapid economic growth from the mid-1950s to the early 1970s, now face severe maintenance challenges due to aging infrastructure, financial constraints, and labor shortages. To address these issues, the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) has launched initiatives such as Project PLATEAU, which aims to construct nationwide 3D city models. However, current 3D models rely primarily on aerial photogrammetry conducted by manned aircraft, which has a fundamental limitation: the difficulty of accurately reconstructing vegetation on the ground surface. This paper explores a method to improve the positional accuracy and reproducibility of Landscapes using UAV-based photogrammetry with RTK-GNSS. This investigation was conducted at the Atsugi Campus of Tokyo University of Agriculture. Referring to the previous study by Losè et al and Forlani et al, UAV equipped with RTK-GNSS was used to capture high-resolution aerial images, comparing two imaging methods: nadir (orthophoto) and oblique photography. While orthophotos provide a top-down view commonly used for mapping, oblique images, taken at an angle, enhance the visibility of vertical surfaces and shaded areas. To optimize measurement accuracy, flight parameters were determined based on the UAV surveying guidelines of the Geospatial Information Authority of Japan, setting a ground sampling distance (GSD) of 1.5 cm and a flight altitude of 119.4 m. Aerial triangulation analysis revealed that oblique imagery significantly outperformed orthophoto-based models in positional accuracy. The root mean squared errors (RMSE) for oblique images were ±0.034 m (horizontal), ±0.041 m (vertical), and ±0.053 m (3D), demonstrating superior precision compared to traditional orthophoto methods. Notably, oblique imaging captured detailed tree structures and shaded ground areas that were challenging to reconstruct using orthophotos. These results clearly indicate that 3D reconstruction using oblique imagery substantially enhances both positional accuracy and spatial reproducibility compared to conventional methods. The findings of this study extend beyond park management, suggesting potential applications in ecological monitoring, Landscapes design, and urban forestry through enhanced digital twin technologies. The ability to create high-precision 3D models using UAV photogrammetry reduces reliance on labor-intensive ground surveys and makes geospatial data more accessible to various stakeholders. Furthermore, integrating this method into Project PLATEAU could strengthen Japanese and global digital mapping Infrastructure, enabling more accurate and comprehensive representations of natural environments. As UAV technology and photogrammetric techniques continue to evolve, the fusion of high-precision 3D modeling and digital twin technologies are expected to transform how Landscapes are visualized and managed. This paper represents a step toward a future where digital Landscapes mirror real-world complexity with exceptional accuracy. Further advancements in UAV photogrammetry will expand its applications in smart city initiatives, ecosystern conservation, and sustainable urban planning.

1. Introduction

The current global landscape, particularly in countries like Japan, faces significant challenges in maintaining and managing existing social infrastructure. Many of these assets, constructed during rapid economic growth, are now over 50 years old, with accelerating deterioration. Similarly, green spaces, including urban parks, face increasing difficulties in upkeep and preservation due to demographic shifts (declining birthrates, aging population) and local government financial constraints. In response, Digital Transformation (DX) is gaining widespread attention across various fields, including landscape architecture, aiming to enhance park management efficiency, sophistication, and labor-saving.

A prominent DX initiative in Japan is Project PLATEAU, a digital twin project by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), seeking to develop, utilize, and open-source nationwide 3D city models. This digital twin concept involves acquiring real-world information via advanced 3D surveying and internet-connected devices, then replicating this physical environment in a virtual (cyber) space. One application, at Echigo Hillside National Park in 2023, constructed a 3D park model using Project PLATEAU's 3D city models, establishing a GIS standard specification (Japanese Profile for Geographic Information Standards, JPGIS) for park management system creation.

However, a fundamental limitation persists in current 3D city models: while they excel at reproducing architectural structures with clear geometric shapes, they struggle significantly with accurately representing complexly shaped objects like plants. This is critical in park management, where precise understanding of tree health, plant distribution, and overall vegetation condition is paramount. Consequently, existing models often lack the detailed information necessary for effective vegetation maintenance and comprehensive landscape assessment.

To overcome these challenges and obtain more detailed information on landscaped green spaces, advanced 3D surveying technologies, notably Unmanned Aerial Vehicles (UAVs), are increasingly adopted[1,2]. While traditional aerial photogrammetry often uses nadir (straight-down) imagery for mapping, this approach frequently struggles with accurately capturing vertical surfaces and occluded areas, such as tree trunks and the ground beneath dense canopies. Therefore, to precisely represent landscaped green spaces and integrate detailed vegetation information into park management, it is imperative to establish new technical approaches. This paper focuses on the critical role and enhanced accuracy of UAV-based oblique photography as a key technology for achieving highly reproducible and positionally accurate 3D models of landscape environments.

2. Research Objectives

This study aims to construct highly reproducible and positionally accurate digital maps (orthomosaic images) and 3D models within green spaces. To achieve this, we conducted aerial photogrammetry using RTK-GNSS equipped UAVs at the Atsugi Campus of Tokyo University of Agriculture. Beyond conventional nadir (orthophoto) image acquisition, we specifically incorporated oblique photography, which involves taking images at an angle to enhance the visibility of vertical surfaces and shaded areas that are typically difficult to capture with straight-down views. We hypothesize that this combination will significantly enhance the visual reproducibility of areas obscured by trees, such as shaded ground surfaces, compared to traditional methods, thereby facilitating the creation of highly reproducible 3D models of landscaped environments in the digital realm.

For the UAV survey in this study, the determination of flight parameters was based on established guidelines, specifically employing (Eq. 1) from the "Manual for Public Surveying Using UAVs (Draft)" issued by the Geospatial Information Authority of Japan or Article 146 of its "Surveying Work Regulations". This equation allows for the calculation of the UAV's relative altitude based on desired ground resolution. We aimed for a Ground Sampling Distance (GSD) of approximately 1.5 cm (0.015 m) to ensure sufficient detail for landscape elements. Based on the camera's pixel size and focal length, the UAV's relative altitude was fixed at 119.4 m during image acquisition to consistently achieve this GSD across the survey area. This precise control over flight parameters is crucial for maintaining the quality and consistency of the acquired data, which directly impacts the accuracy and reproducibility of the resulting 3D models.

$$\text{Flight Altitude} = \frac{\text{Ground Sampling Distance}}{\text{Digital Camera Pixel Size}} \times \text{Focal Length} \quad (1)$$

3. Materials and Methods

This study primarily focused on verifying the positional accuracy of UAV photogrammetry data

acquired using RTK-GNSS. The comprehensive verification process was conducted at the Atsugi Campus of Tokyo University of Agriculture. Specifically, we meticulously compared the positional differences between coordinates of validation points obtained by a high-precision GNSS receiver and those derived from 3D models constructed through Structure from Motion (SfM) and Multi-View Stereo (MVS) processing. This comparison was systematically made based on variations in two key factors: the number of Ground Control Points (GCPs) established (0, 1, or 4 points) and different imaging conditions (nadir-only photography vs. oblique-photography), thereby enabling a robust evaluation of the UAV photogrammetry data's positional accuracy.

3.1. Equipment Specifications

The primary equipment utilized for UAV photogrammetry in this study included a DJI Matrice 350 RTK, a state-of-the-art Unmanned Aerial Vehicle, and a DJI Zenmuse P1 full-frame camera. The Matrice 350 RTK is known for its suitability for high-precision mapping missions, featuring a maximum flight time of 55 minutes. It is equipped with a comprehensive Global Navigation Satellite System (GNSS) supporting GPS, GLONASS, BeiDou, and Galileo. Its RTK positioning accuracy (RTK FIX) is notably high: 1 cm + 1 ppm horizontally and 1.5 cm + 1 ppm vertically, which is fundamental for achieving centimeter-level precision without extensive ground control.

The DJI Zenmuse P1 camera, integrated with the Matrice 350 RTK, is designed for professional aerial photogrammetry. It features a 35.9×24 mm full-frame sensor with an effective pixel count of 45 megapixels (8192×5460 px), providing high-resolution imagery. The pixel size is 4.4 μm. It is fitted with a DJI DL 35mm F2.8 LS ASPH lens. The camera supports both mechanical shutter speeds (1/2,000 to 1 second) and electronic shutter speeds (1/8,000 to 1 second), crucial for minimizing motion blur during aerial surveys. The camera is mounted on a 3-axis stabilized gimbal (tilt, roll, pan), ensuring stable image capture even during flight maneuvers, with a precise angular vibration range of ±0.01°.

The DJI Matrice 350 RTK UAV utilized in this study is illustrated in **Figure 1**, highlighting its robust design and integrated Zenmuse P1 camera.



Figure 1. The DJI Matrice 350 RTK UAV with Zenmuse P1 Camera

For positioning correction during RTK-GNSS measurements, a DJI D-RTK2 mobile station was deployed as the base station. The D-RTK2 is a highly accurate GNSS receiver supporting multiple frequencies and constellations including GPS, BeiDou, GLONASS, and Galileo. Its RTK positioning accuracy is specified as 1 cm + 1 ppm horizontally and 2 cm + 1 ppm vertically, offering high precision for base station operations.

For acquiring the precise coordinates of GCPs and validation points, a CHCNAV M6 GNSS receiver was utilized. The M6 supports a broad range of frequencies and constellations, including GPS, BeiDou, GLONASS, Galileo, and SBAS (QZSS). It performs high-precision positioning via the Virtual Reference Station (VRS) method, with a VRS accuracy of 8 mm + 0.5 ppm horizontally and 15 mm + 0.5 ppm vertically.

3.2. Overview of GNSS Positioning Methods

Global Navigation Satellite Systems (GNSS) encompass various satellite positioning systems like GPS, GLONASS, Galileo, BeiDou, and QZSS. While basic single-point positioning, commonly used in smartphones, offers approximate locations with errors around 10 meters, high-precision applications like surveying demand more advanced methods.

Real-Time Kinematic (RTK) positioning is an advanced relative positioning method providing real-time centimeter-level accuracy. It utilizes a stationary "base station" and a "rover" (moving station). The base station transmits correctional data to the rover in real-time, allowing the rover to precisely refine its own position. This method is widely used in applications requiring immediate and precise positional information, such as drone navigation.

Further extending RTK capabilities, Network RTK positioning (Virtual Reference Station - VRS method) provides uniform high-precision positioning over a wide area. This involves multiple networked base stations (e.g., electronic reference stations) creating a "virtual base station" near the rover, which generates customized correctional data for real-time transmission. The VRS method effectively corrects errors across a broad area, enabling efficient centimeter-level precise positioning.

3.3. UAV Surveying Procedures and Settings

The RTK-GNSS UAV aerial photogrammetry in this study was conducted at the Atsugi Campus of Tokyo University of Agriculture. Building upon previous research on accuracy verification concerning the presence or absence of GCPs in UAV aerial photogrammetry, we established one GCP and three validation points for this study. The DJI Matrice 350 RTK was utilized as the rover, while the DJI D-RTK2 served as the stationary base station, performing real-time positional correction using the RTK-GNSS method.

When using the D-RTK2 as a base station, positional correction relies on observation data from the M6 receiver as the base station coordinates. Since the positional coordinates acquired by the M6 are in a plane rectangular coordinate system, they needed to be converted to latitude and longitude for input as base station coordinates. This conversion was performed using the latitude and longitude conversion tool provided by the Geospatial Information Authority of Japan. In addition to latitude and longitude, altitude information is essential for base station coordinates. The base station altitude was calculated using (Eq. 2), yielding a value of 80.422 m, which was then input as the base station coordinate. The geoid height, necessary for this calculation, was obtained using the geoid height calculation tool provided by the Geospatial Information Authority of Japan. While the formal method for GNSS surveying often involves providing ellipsoidal height and subsequently converting to orthometric height using geoid height in post-processing, a simplified approach that directly uses orthometric height as height information was adopted in a previous study and confirmed to yield nearly equivalent accuracy. Therefore, this study also adopted this simplified method.

Base Station Altitude
=Antenna Phase Center Height
+Antenna Bottom Height
Base Station Elevation+Geoid Height (2)

To define the positional accuracy when constructing orthomosaic images and 3D models from the acquired aerial photographs, the following horizontal datum settings were adopted for the measurement of base station, GCPs, and validation points:

- Geographic Coordinate System: JGD2011
- Geoid Model: JGD2011_height (jp_gsigeo2011)
- Projected Coordinate System/Plane Rectangular Coordinate System: Japan Plane Rectangular CS

The positional coordinates (X/N, Y/E, Z/U) of the base station and points 1 to 4, acquired by GNSS, are presented in **Table 1**.

During the UAV survey, the flight parameters were consistently set according to (Eq. 1). Specifically, the Ground Sampling Distance (GSD) was targeted at approximately 1.5 cm (0.015 m), and the UAV's relative altitude was fixed at 119.4 m for image acquisition. This consistent parameter setting ensures comparability and reliability of the acquired data. The results of the aerial acquisitions are summarized in **Table 2**.

Table 1. M6-GNSS Acquired Position Coordinate Data

Name	X/N (m)	Y/E (m)	Z/U (m)	Horizontal Accuracy (m)	Vertical Accuracy (m)
P1	-63267.091	-43824.138	41.277	±0.005	±0.005
P2	-63243.986	-43871.45	47.232	±0.005	±0.005
P3	-63280.814	-43834.691	44.817	±0.005	±0.005
P4	-63261.873	-43823.604	41.29	±0.005	±0.005
P5	-63127.383	-43956.635	29.226	±0.005	±0.005



Figure 1. Locations of Survey Points on Atsugi Campus

Table 2. Survey Results by Shooting Angle

Shooting Angle	Nadir (-90°)	Oblique (-60°, -90°)
Survey Range	0.186 km²	0.162 km²
Survey Time	15 min	25 min
Number of Photos	801	1776

3.4. UAV Photogrammetry Data Processing

To construct 3D models from the aerial photographs acquired by the UAV, Agisoft Metashape Ver. 2.1.1 was used. The processing began with the "Align Photos" function in Metashape, which analyzes the acquired photographic data and reconstructs the 3D structure based on each camera's position and orientation. This process is based on the Structure from Motion (SfM) principle, a technique that simultaneously estimates camera positions and object structures from multiple images. Alignment was applied with the highest accuracy settings, and static tie points were excluded to enhance precision. This step accurately analyzed the spatial relationships between multiple photographs, generating a sparse point cloud.

Following the alignment, the sparse point cloud was used to generate a dense point cloud using Metashape's "Build Dense Cloud" function, with a point spacing of 0.05 m. In this process, depth maps were generated and utilized as source data. The quality was set to "High," and the depth filter was set to "Mild" to accurately reproduce detailed information of buildings and vegetation.

Analysis of the resulting dense point clouds, categorized by camera angle (nadir and oblique), revealed distinct characteristics. For nadir (straight-down) photography, while the ground surface and building roofs were clearly captured, significant data gaps were observed on building facades and tree trunks/lower parts due to limitations in viewing angles. Specifically, for vertical surfaces of buildings and lower sections of trees, insufficient data was acquired due to directional constraints, indicating limits to the accurate reproduction of 3D structures. The areas underneath dense tree canopies or narrow spaces between buildings also showed reduced point density, affecting the completeness of the model in those regions.

In contrast, dense point clouds generated with oblique photography, utilizing a camera tilt of 45 degrees, demonstrated improved reproduction of building facades and portions of the ground surface. This approach complemented information that was missing in nadir-only capture, as the additional angular views provided more comprehensive coverage, allowing for better reconstruction of vertical elements and side surfaces of objects. However, even with improved viewing angles, challenges persisted in reproducing areas difficult to observe from the air. These included the innermost parts of dense tree trunks and the very interiors of dense vegetation where light penetration was limited. Data gaps remained prominent, especially in deeply shaded areas of buildings and complex undergrowth, suggesting inherent limitations in capturing all hidden geometries from aerial perspectives alone.

Subsequently, a 3D mesh model was constructed using Metashape's "Build Mesh" function, based on the dense point cloud generated from oblique photography data. Furthermore, the "Build Texture" function was utilized to apply high-quality color information derived from the photographic data to the mesh model. This step further enhanced the visual quality of the model, particularly with the introduction of oblique photography, which led to a certain degree of reproduction of building facades and the three-dimensional structures of trees. This enhanced the representation of vertical surfaces of structures and tree forms, which was difficult to achieve with nadir-only photography, thereby improving the overall reproducibility of the model.

3.5. Accuracy Verification Method

The accuracy verification in this study was conducted by evaluating positional accuracy along three axes: horizontal (X and Y axes), vertical (Z axis), and integrated 3D space (X, Y, and Z axes). This evaluation targeted orthomosaic images and 3D models constructed from aerial photographs

using RTK-GNSS and Exif (Exchangeable Image File Format) information. The 3D spatial error, in this context, refers to the spatial difference between the coordinates of the four validation points obtained by GNSS surveying and the coordinates of the same points calculated from aerial photographs via SfM-MVS processing. Root Mean Square Error (RMSE) was employed as the evaluation metric to capture both the magnitude and distribution tendency of these errors. Additionally, a comparative analysis was performed between models generated solely from nadir photography (orthophoto models) and those incorporating oblique photography (oblique photo models) to specifically analyze the differences in accuracy attributed to varying surveying conditions. These results are presented in **Table 3**.

Table 3. RMSE Results for Ortho and Oblique Photography

Ortho	Horizontal Error (m)	Vertical Error (m)	dx (m)	dy (m)	dz (m)	3D Error (m)
GCP0	±0.097	±0.176	±0.079	±0.056	±0.068	±0.118
GCP 1	±0.097	±0.176	±0.065	±0.043	±0.083	±0.114
GCP 4	±0.078	±0.145	±0.053	±0.043	±0.070	±0.103
Oblique	Horizontal Error (m)	Vertical Error (m)	dx (m)	dy (m)	dz (m)	3D Error (m)
GCP 0	±0.065	±0.065	±0.027	±0.027	±0.059	±0.071
GCP 1	±0.043	±0.043	±0.027	±0.027	±0.059	±0.071
GCP 4	±0.065	±0.086	±0.051	±0.027	±0.048	±0.080

4. Results and Discussion

The accuracy verification results demonstrated that oblique photography consistently achieved remarkably low positional accuracy errors, with all horizontal, vertical, and 3D dimensions showing errors of less than 0.1 m, irrespective of the number of GCPs utilized. This level of precision significantly surpasses the established standards set by Article 106 of the "Surveying Work Regulations" for mapping information level 250 (scale 1/250), where the specified standard deviations are 0.12 m for horizontal position and 0.25 m for vertical position. This quantitative superiority underscores the robust capability of oblique photography combined with RTK-GNSS for high-accuracy mapping in landscape contexts.

Beyond quantitative accuracy, oblique photography also profoundly impacted the visual reproducibility of the models. It effectively reduced the detrimental influence of shadows cast by trees and buildings, leading to a substantial enhancement in visual realism. This finding is consistent with the research outcomes reported by Forlani et al[3]. and Losè et al[4]. , which likewise confirm the significant contribution of oblique photography to improving both positional accuracy and visual fidelity in 3D reconstruction. The ability to capture comprehensive data from multiple angles allows for better reconstruction of occluded or complex geometries, such as dense tree canopies and building facades, which are often poorly represented in nadir-only datasets.

As illustrated in **Table 3**, a comparative analysis of the various parameters strongly suggests that for UAVs equipped with RTK-GNSS functionality, the method of setting only one GCP during oblique photography offers an optimal balance between efficiency and accuracy. This efficiency gain is particularly noteworthy as it reduces the labor-intensive effort associated with establishing multiple ground control points, making large-scale surveys more practical and cost-effective. However, it is crucial to recognize that this finding is specific to this study's conditions, which utilized a UAV capable of RTK-GNSS positioning. The inherent capability of RTK-GNSS to provide precise initial positional accuracy for each shooting location, often recorded within the image's Exif information, plays a pivotal role in this efficiency. In contrast, UAVs lacking RTK functionality would typically necessitate an increased number of GCPs to achieve comparable accuracy, highlighting the importance of considering specific equipment specifications when planning survey methodologies. The robust initial positioning provided by RTK-GNSS minimizes the propagation of errors during the SfM-MVS process, allowing for accurate model reconstruction even with minimal ground control.

The visual quality of the resulting 3D models further supports the findings. Compared to traditional orthophoto-based models, the oblique imagery captured detailed tree structures and shaded ground areas that were particularly challenging to reconstruct previously. This enhanced level of detail and realism is critical for various applications in landscape management, including precise inventorying of vegetation, detailed landscape design, and effective monitoring of environmental changes. The improved representation of vertical elements and complex forms allows for more intuitive visual analysis and more reliable quantitative measurements of features that were previously difficult to assess from aerial data alone.

5. Conclusion

This study successfully demonstrated the enhanced positional accuracy and reproducibility of 3D models in landscape spaces through the strategic use of oblique photography with RTK-GNSS equipped UAVs. The results indicate that oblique photography significantly outperforms traditional nadir-only methods in terms of positional accuracy, with Root Mean Square Error (RMSE) values well within the stringent requirements of Japanese surveying standards. This method not only improves the quantitative accuracy but also enhances the visual realism by effectively capturing detailed tree structures and shaded ground areas that are challenging to reconstruct with orthophotos. The ability to create high-precision 3D models using UAV photogrammetry offers a practical solution to the maintenance challenges faced by aging urban parks in Japan, reducing reliance on labor-intensive ground surveys and making geospatial data more accessible to various stakeholders.

Looking forward, the findings of this study suggest broad potential applications beyond park management, including ecological monitoring, landscape design, and urban forestry through enhanced digital twin technologies. The integration of this high-precision UAV photogrammetry method into initiatives like Project PLATEAU could significantly strengthen Japanese and global digital mapping infrastructure, enabling more accurate and comprehensive representations of natural environments. As UAV technology and photogrammetric techniques continue to advance, the fusion of high-precision 3D modeling and digital twin technologies is poised to revolutionize how landscapes are visualized, managed, and interactively experienced. This paper represents a crucial step towards a future where digital landscapes mirror real-world complexity with exceptional accuracy, expanding applications in smart city initiatives, ecosystem conservation, and sustainable urban planning.

This study's successful demonstration of enhanced UAV photogrammetry accuracy, particularly with oblique imagery, lays a crucial foundation for developing even more comprehensive and precise 3D landscape models. Building upon these findings, future research will focus on integrating this high-accuracy UAV data with Terrestrial Laser Scanner (TLS) data[5]. This integration aims to overcome the individual limitations of each technology UAV excelling in canopy and roof capture, and TLS providing detailed ground and trunk information to create truly holistic and highly reproducible digital twins of complex landscape environments. Such integrated models will further expand applications in detailed ecological monitoring, advanced landscape design, and comprehensive urban planning.

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Short papers

TOPIC 2
Guiding territories by changing the design of regional projects: tools for reinventing territories in situation of risk and environmental change

HOW TO LIVE WITH FIRE?
TOWARDS STRATEGIC PLANNING OF PYRO-LANDSCAPES

TOPIC: Guiding territories by changing the design of regional projects: tools for reinventing territories in situations of risk and environmental change

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Abstract
This article addresses a central and pressing question: how can wildfire risk in Mediterranean territories, especially in the context of climate change, urban sprawl, and land fragmentation, be transformed from a destructive threat into an opportunity for territorial adaptation? Through the lens of landscape planning, the article explores how fire, traditionally feared and suppressed, can instead be integrated as an ecological and cultural process within spatial design strategies. It argues that developing a shared and proactive approach to fire risk requires a shift in paradigm, one that acknowledges fire as both a structuring force and a creative ressource in Mediterranean landscapes. The article introduces the concept of the pyrolandscape, inspired by Gilles Clément's work on the *Domaine du Rayol, The Garden of the Mediterranean*, where fire-adapted plant communities from across the Mediterranean climate zones are assembled into a living ecological mosaic. These landscapes reveal how fire has historically shaped ecosystem resilience. In this perspective, fire is no longer seen as an external hazard but as an internal ecological process essential to landscape health and regeneration. The garden becomes a space of experimentation, reframing fire as a natural energy rather than a disaster.

This conceptual shift is particularly decisive in France's southeast *Prometheus Zone* (Provence-Alpes-Côte d'Azur, Occitanie, Auvergne-Rhône-Alpes, and Corsica), where structural vulnerabilities are escalating. The expansion of peri-urban zones, rural abandonment, and fragmented private landownership, where nearly 70% of land is privately held, have created dense, unmanaged fuel beds. These conditions, compounded by climate change, extend fire seasons, increase fire intensity, and expose urban settlements to critical levels of risk. Traditional firefighting systems like DFCI (Forest Defense Against Fire) focus on short-term suppression, failing to address the root causes of fuel accumulation and social vulnerabilities. To respond to this, the article explores a landscape-based strategy anchored in territorial gardening, a planning approach that integrates ecological management, cultural practices, and local economies. This concept implies reactivating controlled burning, rotational grazing, and agricultural maintenance not just as prevention tools, but as part of a strategic planning of pyrolandscapes. The aim is to transform combustible edges into multifunctional, inhabited, and productive areas. An emblematic case study is the Giussani Landscape Plan in Corsica, which demonstrates how 200-meter agro-sylvo-pastoral buffer zones can restructure fire-prone edges around villages. By coordinating legal obligations (50 meters of brush clearing) with multifunctional land uses (150 meters), the project fosters collaboration among landowners, local institutions, and cooperatives. It reconnects fire prevention with economic and cultural value chains, from beekeeping to forestry, breeding to non-timber product harvesting illustrating a new model for landscape governance.

These principles converge in the emerging idea of flammability urbanism: an urbanism that does not eliminate fire but designs with it. In this model, wildland-urban interfaces become active thickness of resilience, education, and co-production. Landscape design serves as both a planning tool and a cultural language, helping communities visualize risk, build collective responsibility, and imagine new ways of living with fire.

Introduction: Fire animates our desire for landscapes

In many ways, Mediterranean forests in Europe are different from the forestry models used in temperate forests in the rest of the continent. Mediterranean forest landscapes are the result of many generations of different socio-economic systems. For thousands of years, humans have shaped these areas. Landscape is a way to understand the political and social choices of a society. It is the expression and the legacy of how people live in a specific territory. Today, older standardized models of land use have become outdated. They must now be adjusted to new climate conditions. These conditions are creating the need for new ways of living in and planning our territories. Similar changes in thinking have already happened in the way urban planners manage flood risk. A few decades ago, planners began to treat flooding not only as a danger to avoid, but also as a dynamic condition that landscape projects must integrate. In the same way, fire risk must now be considered a design element for planning.

The Mediterranean Garden at the Domaine du Rayol, located in the Var department in south of France, was created in 1989 by French landscape architect Gilles Clément for the Coastal Conservatory. The garden presents a unique vision of his *planetary garden* concept. It brings together "landscape fragments" from Mediterranean-type climate regions (MCRs) [1], such as California, Australia, Chile, South Africa, and the Mediterranean Basin itself. Each zone is identified by characteristic plants that reveal a shared ecological logic: resilience through fire. All these plant communities have adapted to fire as a natural and necessary energy. Gilles Clément called them *pyrolandscapes* because fire plays a central role in their regeneration. In this garden-laboratory, fire is not seen as a destructive threat but as a natural internal energy that keeps Mediterranean ecosystems in balance. A key contribution of landscape designers lies in their capacity to translate ecological data and risk dynamics into spatial representations, while simultaneously constructing strategic narratives that are both intelligible and mobilizing. These narratives help build collective understanding of post-fire regeneration processes, what Gilles Clément describes as expressions of the landscape's *natural genius.* [2]

These experiences in collective gardening in Mediterranean zones help us look at fire differently. They offer a new perspective on wildfires and a change of scale, just when summer fires are increasing across the Mediterranean, especially on the French coast. Today, territorial vulnerability is rising due to several factors: growing land artificialization, the decline of farming and herding practices, and a general lack of understanding of fire ecology in local communities. This lack of knowledge helps justify fire suppression policies instead of prevention. In addition, land ownership is often fragmented in these regions. Around 70% of land is privately owned, making it harder to organize a consistent and shared fire management policy. This results in major challenges for public safety and modern firefighting systems. It also creates big regional differences. Land is often divided into very small lots, with many different owners. This situation breaks responsibilities apart and weakens collective actions to manage these commons goods.

This context raises a central question: how can we build a collective strategy for wildfire prevention in a landscape with fragmented land ownership, high land use pressure, and growing climate-related risks? How can landscape design support a shift in thinking, turning fire from a feared symbol into a practical tool for living differently in Mediterranean territories?

This article looks at wildfire prevention in France through the lens of landscape planning. It focuses on using landscape tools and strategies to adapt territories. It pays special attention to the southeastern part of the country, known as the *Prometheus Zone* in national risk management plans. This zone includes the administrative regions of Provence-Alpes-Côte d'Azur, Occitanie, Auvergne-Rhône-Alpes, and Corsica. These areas are historically exposed to forest fires. They now face urgent challenges linked to the wildland-urban interface, land governance, and the need to integrate fire risk into public planning and development policies.

I. Pyrolandscapes and ecological adaptation to climate change

Fire is a major ecological element in the Mediterranean biome. This biome is found on the western sides of continents between 30° and 40° latitude. Its ecosystems have evolved over time with regular fire cycles as a natural part of regeneration. [3] In this climate zone, between oceanic and continental influences, plants have developed strong adaptations to fire.



Figure 1. Pyrolandscapes from the cork oak series of the Massif des Maures (Var, France) - TPFE ENSP Versailles-Marseille "The power of fire" © Jordan Szcrupak, 2014.

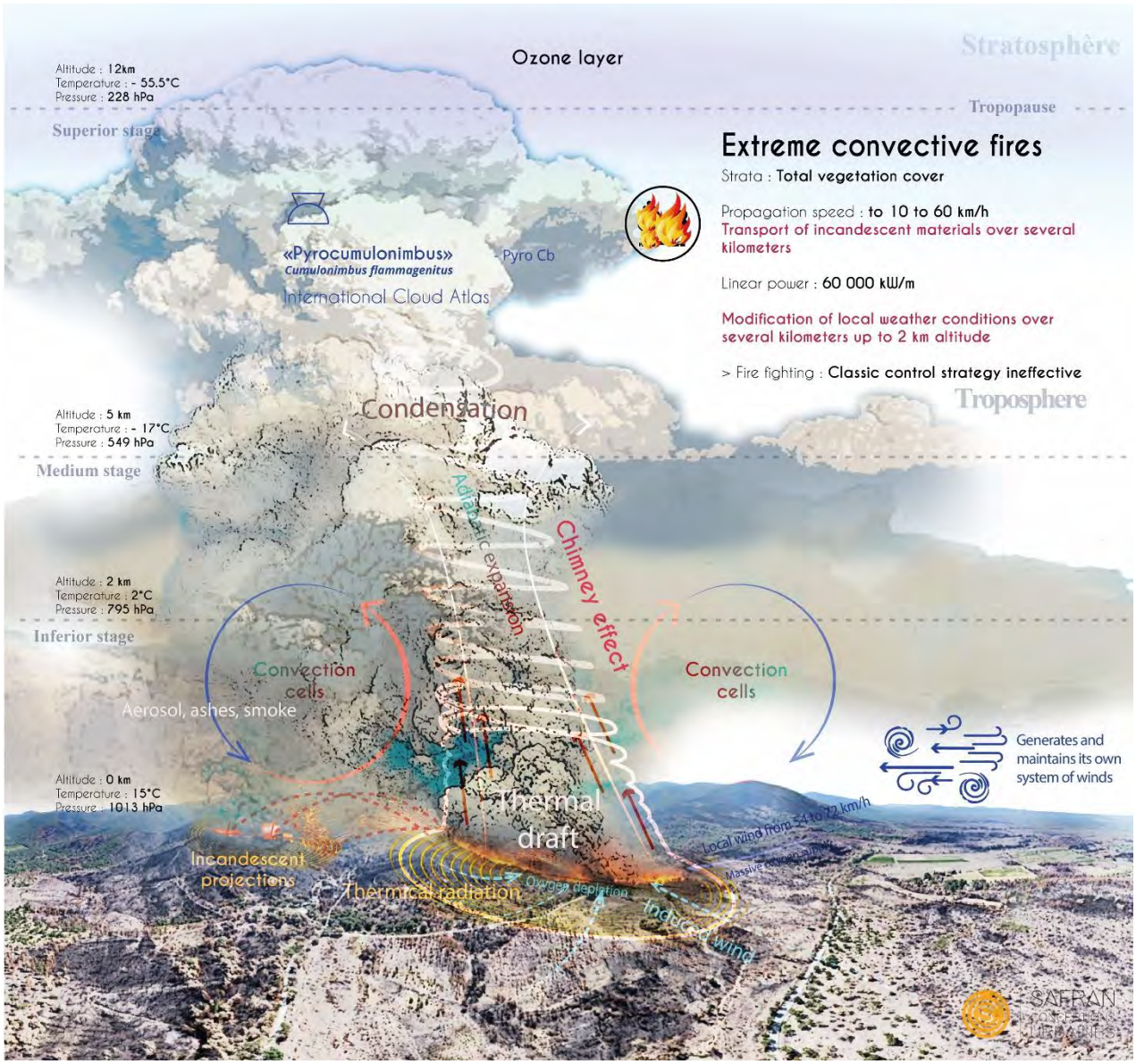
Some species, like cistus, need heat from surface fires to complete their life cycle. Fire, whether natural or used by Indigenous peoples as a land tool, has helped shape areas with rich biodiversity. Each region within the Mediterranean climate has its own fire regime shaped locally by weather variations, ecological factors, and human-induced pressures. This combination determines the frequency, seasonality, and scale of fires. Looking at fire from a landscape perspective reveals a huge paradox: fire is a natural disturbance, but in Mediterranean ecosystems it has become a major threat to urban areas. Fires today are faster, stronger, and more destructive. Far from being a marginal hazard, fire embodies a structuring energy of Mediterranean territories. Today, fire regimes are becoming unstable due to climate change. Recent research by INRAE [4] highlighted a phenomenon of acceleration of fire dynamics: the burned areas are increasing at a rate three times higher than the Forest-Weather Index, reflecting an expected decoupling between meteorological conditions favorable to fire and an increase in fuel likely to significantly worsen the annual balances. This shift brings three majors upheavals: fires now reach higher altitudes, fire season starts earlier and ends later (extending into autumn), and extreme fire events, like convective fires, will be more frequent. These events have unpredictable behaviour and release powerful thermal radiation. They put Mediterranean ecosystems, peri-urban zones, and critical infrastructure like transport and energy networks at serious risk. As the risks grow and become more visible, public policy must move beyond short-term rules and emergency response. It must consider long-term natural processes, what we call the “time of the Living”. Because, systemic risks involve temporally non-linear processes, characterized by discontinuities, thresholds, and feedback loops that challenge conventional predictive frameworks. [5] Landscape projects offer practical tools to link mediation, design, and planning. They help build strategies for adapting wildland-urban interfaces to fire risk. [6] These projects use territorial intelligence. This means combining technical knowledge and symbolic meaning of places.

Projects are designed in a way that reflects local culture and geography. By connecting biophysical data, memory of land use, and ideas for future activities, landscape planning allows us to create territories where fire is no longer a threat to avoid, but a creative resource to manage and work with.

II. Wildland-urban interfaces: urban vulnerabilities and fuel accumulation

According to statistics, most wildfires start or spread through wildland-urban interfaces (WUIs), which are peri-urban areas where human settlements meet unmanaged or poorly managed vegetation. More than 90% of ignitions are human-caused, either accidental or deliberate. The vulnerability of these zones comes from their hybrid nature: they combine human-built environments, dense flammable vegetation, and geographical factors such as slope, wind, and southern exposure. These WUIs are also complex from a legal and social perspective. They are a regulatory boundary between urban and forest domains, and often involve conflicting views between social uses and ecological realities [7]. Houses are scattered, access is limited, and legal brush clearing obligations (OLD in French law) are hard to enforce due to weak coordination and lack of technical or financial support. Furthermore, people have strong emotional ties to these places through recreational, aesthetic, or sports-related practices. Without proper public education and communication, this emotional attachment can turn into resistance or even mistrust toward forestry work and brush clearing, actions that are vital for public safety and legally required under the French Forestry Code (art. L131-10 à L131-16).

Figure 2. Extreme convective fire scenario: Gonfaron Fire Management and Rehabilitation Program © J. Szcrupak, (Safran project manager),2022



Furthermore, the systematic fire suppression policies implemented since the 1990s have led to the emergence of a paradox: by reducing the burned areas, they have encouraged the accumulation of woody fuels, ultimately increasing the probability of future extreme fires. What some researchers call the *firefitghting trap* [1] illustrates one of the limitations of current models called in France: Defense of the Forest Against Fire (DFCI), whose budgets and operational resources (land and air) are focused on fighting rather than proactive prevention.

As firefighting has been increasingly successful, fuel has accumulated naturally each year due to spontaneous vegetation growth, between 1% and 2% annually, especially in areas with little or no human activity. With declining agricultural and pastoral use, vegetation has taken over. In gardens and property borders, highly flammable plants such as cypress, bamboo, mimosa, and Aleppo pine are often present. These act as fire bridges between vegetation and homes. When drought, heat, and strong winds occur together, they create conditions for extreme fires. In such cases, emergency response capacity can be overwhelmed by the number and speed of simultaneous fires.

The growth of peri-urban housing developments along forest edges has greatly increased structural vulnerability. Detached houses are often built on former farmland, with ornamental hedges or plastic fencing that can easily catch fire. Construction materials like plastic window frames or non-fireproof roofs further increase risk. Without home protection measures, fire can jump quickly from vegetation to buildings. Wildfires, are now merging with urban fires in metropolitan suburbs. In southern France and Corsica, land pressure, rural depopulation, and abandoned farmland have allowed forests to regrow in an uncontrolled way. These rewilded areas form dense, highly flammable forests dominated by species like Aleppo pine. Without active forest management, the once-open landscapes shaped by grazing have turned into closed, fire-prone ecosystems. The old planning model, strictly separating residential zones from natural areas, no longer works. We must rethink planning rules based on defensibility and resilience. Fire risk is not just a hazard to avoid; it is part of the land's identity and a force that shapes the environment. However, the latent existence of risk should be considered as an intrinsic value, an active energy that contributes to shaping the character of territories [9]. Thus, it appears that it is up to societies themselves to perpetually re-evaluate their legitimate place within the spatial inequalities produced by these dynamic mechanisms.

III. Redesigning agri-urban edges: landscape planning as a strategic tool

Edges, often seen in the past as as simple adjustment variables of urban sprawl, now play an ecological and political role. These areas, located between urban neighborhoods and forest or agricultural spaces, are key to connecting city planning with farming and forestry activities. Unfortunately, the decline of agropastoral and community-based practices over the past fifty years has led to the loss of their social function, their role in maintaining open landscapes, and their economic value through local production chains.

In southern regions, it is necessary to reconsider these historical and geographical factors. Resilient territories must include a mosaic of land uses based on patterns, that reduce the risk of large fires. The development of a 'risk culture' within communities should be paralleled by the establishment of a 'project culture' in hinterland areas. This means using territorial planning tools to connect different public policies (urbanism, agriculture, forestry, energy, transport, tourism) [2,5].

Wildland-urban interfaces represent a key opportunity for developing multifunctional projects. These areas can become agro-sylvo-pastoral buffer zones linked to peri-urban living areas. A landscape strategy based on proactive management of peri-urban edges can redefine the relationship between human settlements and fire-prone landscapes. Four key principles can be advocate: (1) restoring the landscape mosaic by reintroducing open spaces; (2) use prescribed burning as a tool to maintain resilient ecosystems and rediscover a fire education; (3) promoting long-term ecological processes that enhance landscape fertility; and (4) reintegrate domestic animals as active gardener in edge maintenance.

This helps reduce fire risk, make better use of local resources, and manage ecological processes around cities. By restoring the structuring role of these spaces, the landscape project enables territorial reorganization based on multifunctionality and cooperation. It is a way of anchoring territorial adaptation in concrete, situated forms that can be appropriated by both communities and residents.

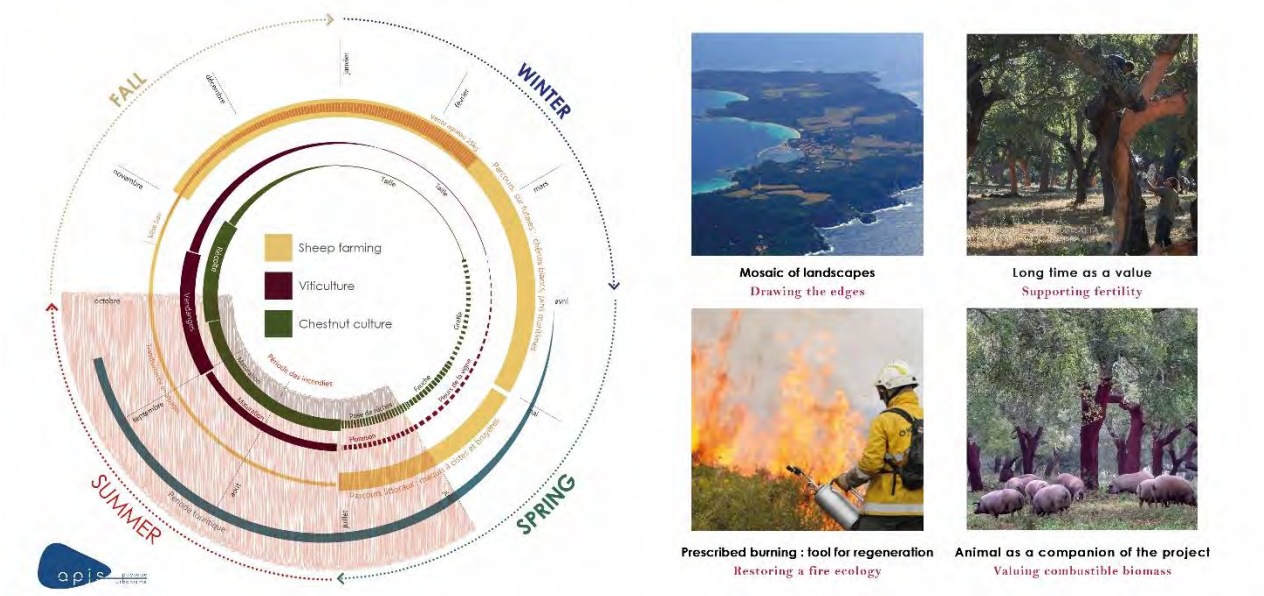


Figure 3. A fire-smart landscape project based on a care strategy - TPFE ENSP Versailles-Marseille "The power of fire" © J. Szcrupak, 2014.

In the Giussani area, in Balagne (Corsica), the association U SBIRRU has led a project since 2019 with support from the Ministry for Ecological Transition. The landscape plan, titled "Landscape and Fire Culture Integrated into Territorial Development," was created by the teM landscape's agency and supported by the national energy and environment agency (ADEME) and the regional environmental office (DREAL Corse).

At the heart of this project is a 200-meter-wide agro-landscape management zone around the four villages (Olmi-Cappella, Pioggiola, Mausoleo, Vallica). This includes the legally required 50-meter brush clearing obligations and a 150-meter public-interest buffer zone. In this space, grazing, farming, controlled burning, and food gardens mix to reshape the wildland-urban interface. This multi-scale strategy, from region to parcel, helps coordinate landowners and supports land management using existing tools like the Pastoral Land Association (AFP) and the Environmental and Economic Interest Group (GIEE). It also helps redefine how common lands are managed in urban planning documents at all levels.

This network allows regular maintenance, supports local food chains, and helps residents take part in building a lived-in, fire-resilient landscape. The main goal is to create gaps in the continuous fuel layer and to reconnect fire prevention with the local economy. Local production sectors, honey, chestnuts, firewood, meat, dairy, are not just about goods. They also support ecosystem services that help restore landscape mosaic. [10] By activating cooperation between local actors, fire risk reduction transcends purely security-oriented logics to adopt a systemic landscape-based approach, one that can be described as a form of "territorial gardening," where planning, ecology, and governance are intertwined within an adaptative and shared spatial project. The landscape project here deals with uncertainty and brings together different public policies, urban, agricultural, forestry, energy, and supports their integration. This return to local governance offers an alternative to top-down crisis responses.

Discussion: Territorial narrative "From Combustible to Edible"

Reclaiming fire also requires cultural change. In Mediterranean societies, fire was once a shared management tool: pastoral burning, charcoal making, and agricultural burning were part of traditional community life. The disappearance of these practices has led to a loss of knowledge, and a symbolic break. Fire is no longer understood, arouses extremely polarized emotions mainly of fear, danger and rejection. This sensitivity now blocks new strategies and isolates people in the face of their own vulnerability. The landscape project helps bring back this fire culture, turning it into an operational ecology. The idea of "from combustible to edible" shows this change in perspective. Risky landscapes become creative resources. Interfaces become shared lands managed by both private and public actors, with different levels of involvement. Fire is no longer something to run from, it becomes a shared goal.

"To take fire as a possible tool for global gardening, to accept it as a dynamic part of the landscape, means thinking about our relationship with the environment by including fire as an ecosystem element – and turning it into an ally. Like rain and wind, fire speaks to everyone."
Gilles Clément, 2013 – TPFE ENSP Versailles-Marseille, "The Power of Fire" © J. Szcrupak, 2014.

This transformation is based on local mediation. Tools such as participatory mapping, in situ project workshops, collective initiatives, public exhibitions, educational gardens, and quality labels like the FireFlokcs initiative in Catalonia (Spain) which brings together local farmers, butchers and restaurateurs, all help bring the project to life economically and socially. These tools also create a new connection between people and their territory. The landscape project becomes a language. It makes prevention work visible and shows how resilience is built on the ground. By making the logic of vulnerability visible and comparing it with the experience of residents, it encourages collective appropriation of risk, legitimization of planned interventions, and increased dialogue between citizens, elected officials and technicians. It helps people understand the territory through direct experience, while also using professional planning tools. By connecting meaning and action, the project becomes a shared narrative.

Conclusion: Toward a flammability urbanism?

The concept of the pyrolandscape changes the way we think about our territory. By recognizing fire as an internal ecological process, not only as an external threat, it suggests a new model for how we live in fire-prone areas. This model is based on long-term thinking, a deep understanding of structural vulnerabilities, and the creation of shared narratives between residents, experts, decision-makers, and local actors. Through the design of edge zones, the revival of commons goods, and the development of local production sectors, the landscape project opens a path toward what can be called a "flammability urbanism." In this process, fire becomes the driver of a proactive risk management strategies, fully integrated into public policies for urban planning and rural development [2]. This new governance places the resident as an active player in their own safety and gives peri-urban edges a renewed role as spaces for spatial and ecological innovation.

Figure 4. Multifunctional edges as activators of a new risk governance - TPFE ENSP Versailles-Marseille "The power of fire" © Jordan Szcrupak, 2014.



By inviting a collective rethinking of our relationship with fire, the landscape project initiates a forward-looking approach to territorial planning. It supports the convergence of public policies beyond traditional firefighting systems (like DFCI) and connects them through strategic planning tools at the local and regional scale. These tools help reduce vulnerabilities and promote multifunctional land uses in peri-urban interfaces, in service of resilient and creative territories. As an urban issue, adapting to climate change and developing a risk culture require new design imaginations. These challenges call on all urban actors, planners, designers, decision-makers, and residents, to engage in proactive strategies that reduce fire hazards and build resilience. This approach complements existing regulatory frameworks and emergency response systems, while also helping to restore fire to its rightful geographical scale, as a universal and defining feature of the pyro-landscapes.

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NEGOTIATING THE FUTURE: SCENARIOS FOR CLIMATE RESILIENT SLOVENIAN COAST

TOPIC: Guiding territories by changing the design of regional projects: tools for reinventing territories in situations of risk and environmental change

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Keywords: climate change, coast, landscape planning, evaluation, scenarios

Abstract
Processes resulting from the humans' interactions with nature have global, but territorially diverse impacts when they interact with locally specific natural and socio-economic features. To cope with associated challenges, societies need to design and implement sustainable responses, which are territorial specific and socially feasible. This contribution presents an approach and tools to provide such response. The approach is based on an IGC (international Geodesign cooperation) framework and tools and has been tested several times in academic situations as well as in practice of regional planning. The approach consists of interchange of scenario development and evaluation and using GIS support and negotiation process. The presentation will focus on the latest implementation that addresses the coastal region of Slovenia, challenged by climate change consequences such as floods due to sea level rise, droughts and forest fires. First, the "no response" scenario was prepared for 2035 and 2050 and for eight different spatial systems (land uses). This scenario includes further increasing density of development in the shoreline, such as tourism infrastructure, settlement and economic activities – particularly the port of Koper, followed by costly and ineffective flood protection against the sea level rise. In hinterlands, the scenario includes further abandonment of cultural landscape followed by forest overgrowth and increased risks of wildfires. This scenario was evaluated in reference to SDG's, internal level of conflict and national Spatial development strategy objectives. The evaluation results were used as inputs for developing an "active response" scenario along with the negotiations to resolve the conflicts among different land uses. This scenario proposes a set of different flood protection measures, including relocating some of the activities from the coastline and introducing natural flooding areas and wetlands. It also proposes new housing and industrial areas and cultural landscape measures in the hinterland. The back casting approach was used to designate the plan for 2035 along with the action plan for implementation. The resilience assessment showed that there will be less areas affected by floods and wildfires in this scenario as compared to trend.

I. Introduction

Nations around the world face a growing challenge to plan, manage and pay for infrastructure essential to address major demographic changes and weather events accompanying a changing climate. In 2018, at the instigation of the USA landscape and information experts Carl Steinitz, Brian Orland, and Tom Fisher, ninety global university teams agreed to collaborate to create scenario-driven designs for local-to-regional scale study areas to address future changes. The generic problem that the initiative aims to answer is: How do we organise and conduct the very beginning and strategic stages of designing for longer-term change in a large, multi-system, multi-client and contentious context, where our goal is concurrence and agreement? [2]. Since its beginning, each year around 150-member university teams in 50 countries participate in the International Geodesign Collaboration, or IGC in short. The University of Ljubljana has participated since its inception in 2018. The IGC approach is taught in the Studio in the first year of the Master's study of landscape architecture. The aim is to teach

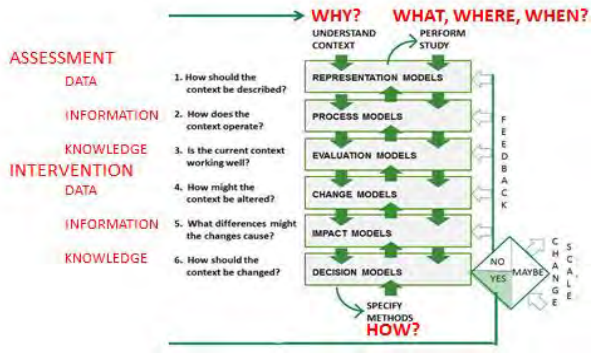
the students how to use scenario development and evaluation as a planning tool and argumentation for proposals. Over the years, a variety of scales and territories were addressed: from the nationwide spatial development strategy to the scale of a region (NUTS3) and the cross-border area of two adjacent cities in Slovenia and Italy. In this contribution, we present the last studio work, dealing with four municipalities on the Slovenian coast. The area is unique due to the presence of the sea, which is reflected in the distribution of activities – very dense on the coast and much less so in the hinterland. The Port of Koper has a strong economic importance and influences the development of transport infrastructure and economic zones. There is a strong, year-round tourist activity in the region and well-developed facilities. In addition, the region has some of the most fertile agricultural areas. Climate change is the main threat to the region due to the projected rise in sea level and increased fire risk, lack of drinking water and droughts. Additionally, heavy freight transit and strong touristification are potential threats for the region.

II. Materials and methods

The IGC strategy requires adherence to common scenarios and time frames, nomenclatures and processes, which enables the synthesis of the contributions from different countries and contexts [1]. The scenarios are designed for two timelines (2035 and 2050) and assume different levels of response to a set of identified driving forces, such as climate and demographic change. The trend ("no response") scenario is used to explore the effects of these extrapolated driving forces on spatial potentials and natural resources, and the "active response" scenario is used to set the targets and develop design solutions to optimise the outcome. The scenarios are evaluated in reference to UN's sustainable development goals and locally defined objectives to understand their global and local performance.

These IGC conventions are generally observed in our course. Through the years, our approach has developed into a more unique one and adapted to the needs of our study program and specifics of projects. These lead to explicit use of evaluation as a design tool, reversing order for developing the normative scenario with back casting to propose implementation measures, and partial synthesis in terms of environmental, societal, or economic aspects.

According to the Geodesign framework, which is the basis for the IGC approach, the whole planning process needs to be run several times (picture 1). The first run (scoping) is done as an analogous brainstorming, which gives the students an idea of what they are dealing with and what is the final product. The second run (methods) is skipped in the studio as it is done by the IGC team and teachers. Most of the time in the studio is devoted to the third run, the "real planning", with a lot of data and GIS support.



Picture 1. Framework for Geodesign and its three iterations [2].

The first two steps (presentation and process models) follow the conventional planning approaches. They consist of an area description, based on available historic and present data on area features and processes. Evaluation models are done in the form of a SWOT analysis for the area by collecting existing evaluations and references to the policy documents. Additionally, the spatial evaluation (suitability) models are prepared for the chosen land-use systems. These are: water (including infrastructure), green infrastructure, forests, agriculture, housing, institutions, industry, energy, tourism. Each student (or a pair) defines one land use system in terms of its elements and objectives.

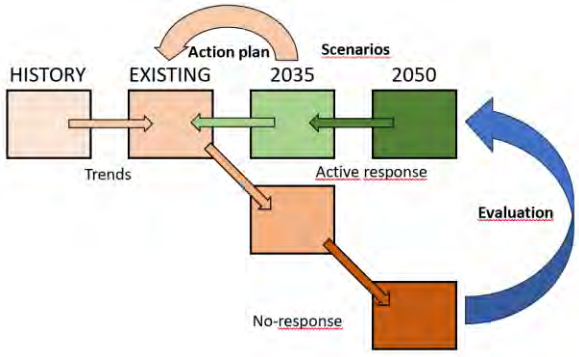
In the third step (change models) we apply the scenario approach. The first change model is "no response" and is based on extrapolations of most probable trends. Firstly, scenarios for each land use systems are prepared, and these are then synthesised into a common scenario. In case of conflicting projections, argumentation is used to choose the most probable outcome. The scenario is first prepared for 2035 and in the next step for 2050.

The fourth step is evaluation model: the no-response scenario is evaluated in reference to

three sets of objectives: (1) internal coherence; using an interrelation matrix in which the synergies and conflicts between systems are identified; (2) objectives of national planning strategy and (3) UN sustainability goals (SDGs). The evaluation is done first by each member of the team for their own system and then in a group discussion to calibrate the results.

The evaluation of no-response scenario is used as a starting point for the second change model. This is the so called "active response" scenario, which is used to set the goals for the area. This scenario is prepared first for the year 2050. After each team has prepared an "active response" scenario for their own system, the systems are grouped into three groups: "environmental" (green infrastructure, forests, agriculture, waters); "social" (housing, institutions) and "economy" (energy, industry). Transport is considered in both the economy and social groups. Each group synthesize and negotiates land use systems into a common scenario. The three scenarios are then compared and negotiated in pairs. The goal of the negotiation is to resolve the conflicts in a win-win manner or to find a better solution.

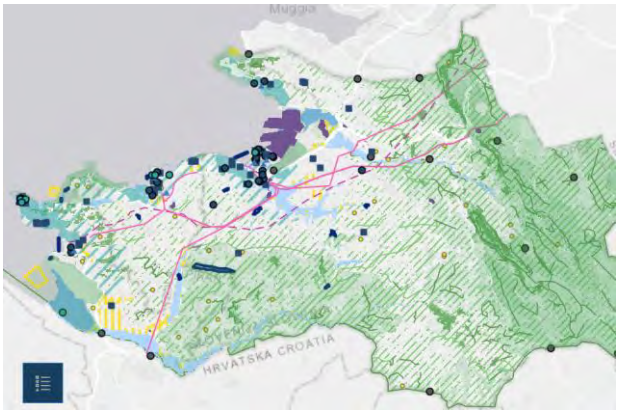
The resulting common active response scenario is again subjected to evaluation, showing if and where the scenario has improved in comparison to "no-response". Then the scenario is back cast to 2035. The last step is preparing the action plan, where each group must propose the implementation instruments which will enable us to achieve the planned changes by 2035.



Picture II: The work process in the studio

III. Results

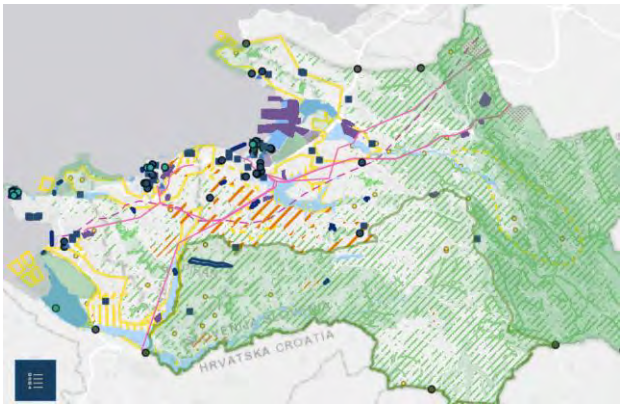
In the no-response scenario for 2050, the Coastal-Karst region is facing increased population density, especially in coastal cities where urbanisation is spreading. Increased traffic and a focus on individual transport are leading to higher levels of emissions in the atmosphere and congestion on the roads. Tourism is mainly active on the coast, which puts an additional strain on beaches and city roads. Staff shortages are causing the closure of some schools and health facilities, especially in the hinterland. Along with transport links, industry is expanding, so is the Port of Koper. Solar power plants are installed on most large roofs in industrial zones. New organic farms have been established, the area of irrigation systems on the one hand but also the overgrowth of agricultural land on the other has increased, while mariculture has been reduced by 50%. To protect against flooding, flood walls are built along the coast.



Picture III: No-response scenario

The scenario with active response, named »Terranova«, reacts proactively to identified challenges. Due to rising sea levels and increased flood risk, development is directed towards the hinterland, and tourism focuses on special resorts with less impact on the coast. Schools and intergenerational centres are being kept or newly opened in hinterlands, Marezige becomes a new urban hub with a health centre. The new transport infrastructure promotes public transport and meets the needs of the economy and the population. The Port of Koper is developing towards inland, where unused industrial zones are being filled and new ones are being created along the roads. Besides the solar power plants on the roofs of industrial buildings there are two photovoltaic installations with a capacity of 30 MW. Agriculture is transitioning to organic production,

and the number of fish farms, irrigation and drainage systems is increasing. Forest fire risk is prompting the expansion of protective forests to preserve biodiversity. Eco corridors and a new landscape park have been established to connect green areas and green spaces. The coastline is protected by flood control measures such as floodplains, islands and locks.



Picture IV: Active response, "Terranova" scenario

The evaluation of the impacts of scenarios was done first by land-use systems and in the next steps aggregated by groups (environment, society and economy) to help the interpretation and comparison. The comparison of both scenarios in terms of inter-system impacts shows that the overall cohesion increased in the Terranova scenario. Some conflicts aggravated though, and these are mainly the results of change in the redistribution of land use from coast to hinterlands. On the global scale, the Terranova scenario contributes noticeably more to achieving many of the SDGs in comparison to no action scenario. Contributions of Water and Transport systems improved most, and in terms of goals; the contribution towards Life on earth and Sustainable cities and communities increased most. In reference to the objectives on the national scale, the Terranova scenario does worse in terms of its contribution to spatial identity. Again, this can be explained by a changed concept of land use distribution and resulting image of the landscape on the coast as well as in the hinterlands. The scenarios differ most in their contribution towards the goal of resilience and adaptability, where Terranova does noticeably better. Each scenario addresses the uncertain consequences of climate change in a different way. Even no-response scenario must react to these, but it does so with technical measures such as flood walls. On the other hand, Terranova protects or newly provides floodplains along the coast as well as introduces islands and seawater locks to direct the water in these areas. Infrastructure for activities such as tourism, industry, and settlements are moving away from the coastal belt.

IV. Discussion

Participating in IGC adds a global perspective to projects by providing a set of global driving forces of change, innovations, and sustainable development goals (or SDG) evaluation framework. By studying and interpreting global change assumptions, we teach students to think of possible spatial consequences and future needs of their area. This helps them define the content of their plans and set the objectives. Global processes may provide a different context and impact the scenario design. Global population growth for example does not (yet) affect Slovenia, where the trends show stagnation of population. But a growing global population could put more pressure on natural resources and trigger more migration, which must be considered in scenarios. On the other hand, some planetary goals might even be contradictory with national goals. The Trillion Trees initiative, an aspiration to reforest the Earth is such an example – as majority of Slovenia is already forest the only available land to replant forest is agricultural, which conflicts the goal of national food security.

The key innovations in our IGC approach as compared to the original idea refer to the way the scenarios and evaluations are used and positioned within the project development. Using them interchanging (scenario – evaluation – new scenario – evaluation) helps to optimize the proposals. Not all things that happen in the no-response scenario are bad, and these need no specific action. While other changes that are either conflicting with other land uses or lead away from national and global objectives do need fixing. Back casting to 2035 and then to present enables to identify priorities and actions for timely implementation.

In the end, we see the IGC approach as one of major steps forward in pedagogy of spatial planning and related disciplines. It provides the groundwork for conducting increasingly complex studies, which equips students with the ability to think strategically and decisively in conditions of fundamental uncertainty in extensive spatial and distant temporal scales.

Acknowledgments
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EXPLORING THE LINK BETWEEN BLUE-GREEN SPATIAL PATTERNS AND DIURNAL TEMPERATURE BASED ON MACHINE LEARNING

TOPIC: Guiding territories by changing the design of regional projects: tools for reinventing territories in situations of risk and environmental change

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Keywords: Blue-green space, Land surface temperature, Diurnal variation, Spatial pattern, XGBoost-SHAP

Abstract

With global climate change and rapid urbanization, the urban heat island (UHI) effect significantly exacerbates the frequency and intensity of extreme heat events, posing a threat to sustainable urban development and public health. As an important component of nature-based solutions (NbS), blue-green space (BGS) has not yet been fully recognized for its morphology and pattern in regulating the thermal environment. Existing studies mainly focus on single landscape indicators, lack systematic analyses of the combination of morphospatial patterns (MSPA) and landscape patterns, and have insufficient knowledge of the response mechanisms of the diurnal thermal environment. To this end, this paper takes Nanjing as an example, constructs a comprehensive indicator system covering MSPA types and 12 landscape pattern indicators, and combines multiple linear regression (MLR), K-nearest neighbor (KNN), and XGBoost models to explore the nonlinear relationship between BGS pattern and diurnal land surface temperature (LST), and also uses SHAP method to quantify the marginal effects of the key variables and the interactions of the key variables using the SHAP method. The results show that the XGBoost model performs best in the prediction accuracy of diurnal LST.SHAP interpretation shows that the effect of the BGS pattern on LST exhibits significant nonlinear characteristics and temporal heterogeneity. During the daytime, the Core dominates the cooling effect, and its increasing size significantly reduces LST; the combination of high aggregation and medium contiguous has the best cooling effect. At night, the Core was transformed into a potential heat source due to the heat storage effect, and the cooling effect depended on the small-scale structure. The interaction analysis reveals that the combination of 'large Core+small patch, low fragmentation' enhances the cooling effect during the daytime. In contrast, the combination of 'small Islet+high CONTAG' significantly improves the cooling efficiency at night. This study comprehensively reveals the complex interactions between the spatial pattern of BGS and diurnal LST, which provides strong support for urban renewal. Based on the results of this study, future planning should focus on designing time-specific strategies, such as prioritizing the expansion of contiguous core zones and reducing fragmentation, enhancing aggregation and contagion through small micro-greenspaces and green corridors, enhancing night-time ventilation, and optimizing the structure of the water layout to mitigate diurnal heat stagnation.

Introduction

Global climate change and rapid urbanization have led to an increase in the frequency and intensity of extreme heat events, making urban heat island (UHI) effects a significant challenge for sustainable development and public health. The UHI effect exacerbates energy consumption, reduces comfort, and impacts urban infrastructure and ecosystems. Nature-based Solutions (NbS), especially blue-green spaces (BGS), are critical for alleviating UHI effects by enhancing transpiration cooling, shading, and ventilation, thereby improving urban microclimates.

Although previous studies have explored the relationship between blue-green spaces and thermal regulation, they often focus on landscape characteristics such as area and density. However, analyses based on a single pattern dimension fail to reflect the complex spatial environment of cities, and the temperature regulation mechanisms, especially in complex urban forms, have not been fully revealed. The actual impact of urban blue-green spaces on microclimate regulation depends not only on their macro distribution but also on their internal microform characteristics. Furthermore, research has largely overlooked the spatiotemporal heterogeneity of urban heat environments, where BGS exhibit different cooling effects during the day and night.

This study addresses these gaps by constructing and comparing multiple models (Multiple Linear Regression, K-nearest neighbors, and XGBoost) combined with SHAP methods to analyze the impact of BGS morphology on surface temperatures in Nanjing. The objectives of the study are: (1) to reveal the spatiotemporal distribution characteristics of daytime and nighttime surface temperatures in Nanjing, (2) to compare the fitting and explanatory capabilities of different models in the relationship between blue-green spaces and temperature, and (3) to use SHAP to quantify the importance, marginal effects, interactions, and temporal differences of various indicators. The study aims to deepen the understanding of urban heat environment regulation mechanisms and provide theoretical support and decision-making references for resilient city construction and spatial layout optimization.

Study area and data sources

Nanjing (31°14′-32°37′N, 118°22′-119°14′E) is located in the lower Yangtze River Delta alluvial plain, serving as the administrative center of Jiangsu Province and a key hub in the Yangtze River Delta urban agglomeration (Fig. 1). The city covers an area of over 6,500 km², with a resident population of nearly 10 million and an urbanization rate of 86.8%. Under the influence of the East Asian monsoon, Nanjing experiences a typical climate with cold winters and hot summers, with an annual average precipitation of approximately 1,090.4 mm. Meteorological observations indicate that the urban heat island effect in Nanjing leads to frequent extreme temperatures, with the highest historical temperature reaching 43°C, earning the city the nickname "one of the three furnaces" along with Chongqing and Wuhan. Due to the combined effects of the subtropical high-pressure system and urban surface properties, Nanjing experiences persistent high-temperature events during July and August, with the perceived temperature often exceeding 45°C. Furthermore, rapid economic development and continuous urban land expansion have exacerbated the urban environment, making it increasingly essential to improve the city's thermal environment through blue-green spaces as a nature-based solution.

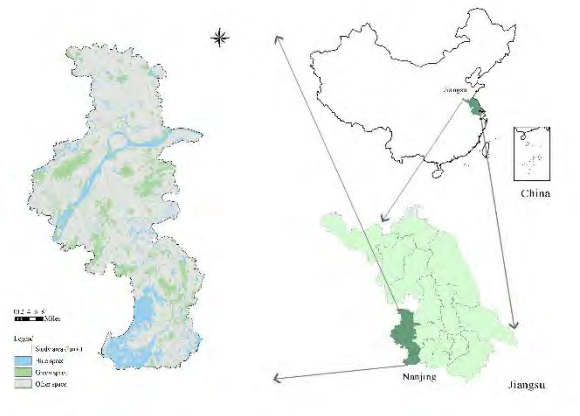


Figure 1. Location of the study area.

The data used in this study include surface temperature, land cover, NDVI, DEM, roads, buildings, and nighttime light data. Table 1 provides an overview of the data sources, resolution, and specific time periods.

Table 1. Date selection.

Data name	*Data source*	*Resolution*
ECOSTRESS Level-2	https://lpdaac.usgs.gov	70m

Landsat8 OLI/TIRS	http://www.gscloud.cn	30m
Land Cover	https://ers.cr.usgs.gov	10m
Normalized Difference Vegetation Index	http://www.gisrs.cn	30m
Digital Elevation Model	http://www.gscloud.cn	30m
Road	http://www.openstreetmap.org	-
Building	https://figshare.com	1m
Night Lights	https://eogdata.mines.edu/products/vnl	1km

Methods

This study focuses on the relationship between BGS patterns and urban daytime and nighttime temperatures at the grid scale. To ensure that most analysis units can adequately capture both external landscape patterns of BGS and internal morphological spatial patterns, this study selects a 1 km × 1 km grid as the basic analytical unit, balancing spatial coverage and data resolution compatibility. Firstly, daytime and nighttime surface temperatures in Nanjing were retrieved based on Landsat 8 OLI/TRIS imagery and ECOSTRESS Level-2 imagery, respectively, to calculate the spatiotemporal patterns of surface temperatures. In the second step, the study area was divided into blue-green spaces and non-blue-green spaces using land cover data, and potential influencing factors were used as control variables. Morphological spatial pattern index and landscape pattern index were calculated for each grid unit. To improve model efficiency and variable interpretability, Pearson correlation tests were conducted on all independent variables to exclude those with multicollinearity or redundant information. Three regression models, including Multiple Linear Regression, K-Nearest Neighbors, and XGBoost Regression, were introduced to model and compare the linear and nonlinear response relationships between BGS patterns and daytime and nighttime surface temperatures, further evaluating the performance of each model in terms of fitting accuracy and explanatory power. Finally, the XGBoost regression model, which performed best, combined with the SHAP explainable machine learning method, was used to analyze and explore the nonlinear response mechanisms and interaction effects between BGS spatial morphology and daytime and nighttime surface temperatures. The findings of this study provide scientific evidence and decision-making references for urban heat environment optimization, blue-green infrastructure configuration, and climate-adaptive urban spatial planning.

Results

Nanjing exhibits significant daytime and nighttime temperature heterogeneity, with a clear urban heat island effect (Fig. 2). The average daytime surface temperature reaches 51.18°C, with the highest temperature of 77.8°C in high-density areas. The heat island effect is most pronounced in the central and southern urban areas, where intense land development and high impermeable surface rates cause heat accumulation. At night, the surface temperature drops to 25.93°C, but the urban core area retains heat, forming a "day-night persistent heat island." Peripheral areas such as the northern and eastern regions, as well as areas along the Yangtze River, show relatively lower temperatures. The surface temperature distribution forms continuous high-temperature zones at road intersections, industrial parks, and dense residential areas, while lower temperatures are concentrated in the city's peripheral hills, waterfronts, and large green spaces like Purple Mountain, Xuanwu Lake, and the Yangtze River coastline. These green areas maintain lower temperatures and exhibit strong heat mitigation effects during both day and night. Grid-based processing (1 km × 1 km) smooths the temperature distribution, aiding comparison and analysis.

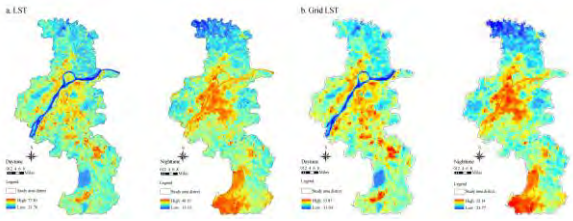


Figure 2. Land surface temperature spatial distribution map.

The blue-green spaces (BGS) in Nanjing display a spatial structure characterized by "north-south extension (Fig.3), central concentration, and linear penetration," with major blue spaces (rivers) and green ecological patches located in the urban periphery and hilly areas. The Yangtze River runs through the central urban area, forming an ecological corridor, with tributaries like the Qinhuai River also contributing to water and heat regulation. Green spaces in the northern and

southern hilly areas serve as key ecological buffers, while urban green spaces are more fragmented. MSPA analysis divides BGSs into seven types: Core, Edge, Bridge, Loop, Islet, Perforation, and Branch. Large Core patches, primarily in peripheral hills and water source areas, form the main cooling zones. In contrast, the central urban area features more fragmented blue-green spaces (Edge, Islet, and Perforation), limiting their cooling effect. Bridge and Branch patches act as ecological connectors, especially along the Yangtze River, while Loop patches have localized cooling potential in areas surrounding water bodies or mountains.

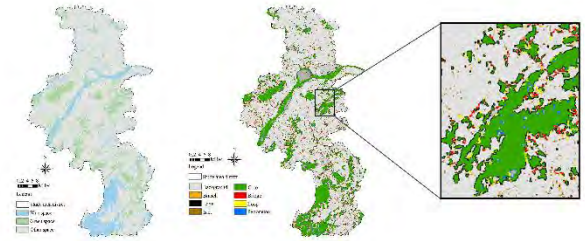


Figure 3. Distribution map of BGSs and MSPA in Nanjing.

Landscape pattern indices, calculated using a moving window method at a 1 km × 1 km grid scale, reveal significant structural heterogeneity and regional differentiation in BGSs (Fig.4). AI and PLAND are highest in peripheral hills and core urban areas, indicating a strong aggregation of BGS patches. COHESION values are high in the northern part of the city and around water bodies, reflecting strong connectivity, while ED, LSI, and NP show higher values in fragmented suburban areas. CONTAG and FRAC values indicate high boundary complexity, with CONTAG concentrated in high-value northern areas and FRAC scattered throughout the city. SHDI and SHEI correlate with diverse and well-distributed BGSs, particularly in the urban periphery and near rivers and lakes. LPI shows a strong influence of large patches in the city core, and AREA_MN highlights larger ecological patches in the northern and central areas.



Figure 4. The spatial distribution of key landscape pattern index.

Prior to model construction, a correlation screening analysis was conducted to ensure the independence of variables. Variables with high linear correlations were removed or combined to avoid redundancy and improve the robustness of the model inputs. Three modeling frameworks—MLR, KNN, and XGBoost—were compared for predicting land surface temperatures across daytime and nighttime periods (Fig. 5). XGBoost outperformed both MLR and KNN, with R^2 values of 0.77 during the day and 0.81 at night, alongside reduced prediction errors. It demonstrated significant robustness in handling nonlinear interactions and high-dimensional data.

Model	Daytime							
	Training set results				Test set results			
	R^2	MSE	MAE	RMSE	R^2	MSE	MAE	RMSE
MLR	0.59	5.97	1.90	2.44	-	-	-	-
KNN	0.74	3.77	1.48	1.94	0.68	4.74	1.64	2.18
XGBoost	0.88	1.75	1.01	1.32	0.77	3.39	1.39	1.84

Model	Nighttime							
	Training set results				Test set results			
	R^2	MSE	MAE	RMSE	R^2	MSE	MAE	RMSE
MLR	0.68	0.62	0.62	0.79	-	-	-	-
KNN	0.75	0.48	0.54	0.70	0.73	0.52	0.56	0.72
XGBoost	0.90	0.20	0.35	0.45	0.81	0.37	0.47	0.61

Figure 5. Comparison of three models.

To further explore the mechanisms through which urban blue-green space patterns regulate daytime and nighttime surface temperatures, this study employs the XGBoost model combined with SHAP methods to assess the relative contributions of various variables to surface temperature. In the analysis, built environment factors such as NDVI, road density, nighttime light intensity, and topography were excluded, focusing solely on

MSPA structural types and key landscape pattern indices to enhance the specificity of the results.

For daytime land surface temperature regulation (Fig. 6), the Core emerged as the most significant factor, with its SHAP values concentrated in the negative range, indicating that large-scale, contiguous blue-green spaces play a dominant role in cooling. AREA_MN follows in importance, with larger average patch sizes enhancing cooling functions such as transpiration, shading, and heat flux exchange. AI and Branch also showed negative contributions, with AI representing blue-green spaces with higher aggregation and sustained cooling effects, while the impact of Branch structures varied due to spatial differences. In contrast, edge or fragmented structures like Islets, Bridge, Loop, and Perforation had a more limited impact on LST during the day.

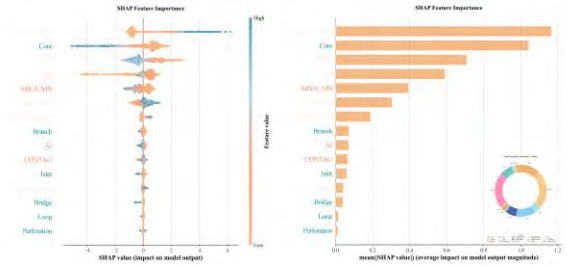


Figure 6. Relative contribution of variables to surface temperature (daytime).

The nighttime results showed significant temporal differences (Fig. 7), with Core's SHAP values shifting from negative during the day to positive at night, indicating that it releases heat accumulated during the day, leading to localized temperature increases, thus reducing its overall contribution to 10.8%. In contrast, the importance of AI increased at night, showing a negative contribution, which suggests that highly aggregated blue-green spaces also have cooling capacity during the night. The negative contribution of CONTAG increased significantly at night, indicating that higher spatial aggregation and connectivity aid in heat accumulation and release, thus enhancing thermal environment stability.

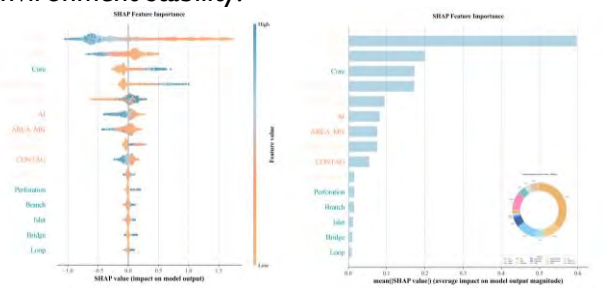


Figure 7. Relative contribution of variables to surface temperature (nighttime).

Figure 8 and 9 show the response characteristics of daytime and nighttime land surface temperatures to various blue-green space pattern indices. Daytime land surface temperature responded strongly to the Core area, with cooling effects becoming more significant as the Core area increased. In contrast, the cooling effects of Branches, Bridges, Islet, and other structures were relatively limited. Higher AI values enhanced daytime surface temperature cooling effects. Nighttime responses were more subdued, with the Core area's cooling effects weakening as the area increased, and the Perforation's cooling effect decreasing with increasing area. Overall, smaller patches and higher connectivity contributed to cooling at night, especially in small-islet and high-connectivity conditions.

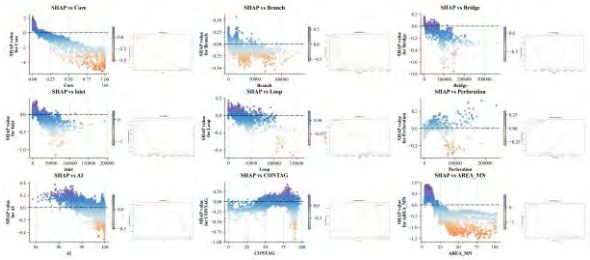


Figure 8. Response characteristics of daytime.

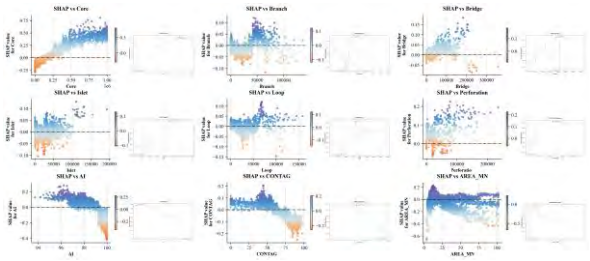


Figure 9. Response characteristics of nighttime.

The interaction effects between daytime and nighttime blue-green space pattern variables showed clear differences (Fig. 10, 11). Daytime temperature regulation relied more on the synergy between large-scale core areas and small-scale structures, emphasizing the importance of combining main structures with micro-scale features. At night, the regulation relied more on the characteristics and connectivity of small-scale units, with the influence of core area size diminished. These day-night differences suggest that urban blue-green space optimization should be tailored to the distinct temperature regulation mechanisms of day and night. During the day, the focus should be on maintaining the integrity of large-scale green spaces and multi-scale layouts, while at night, the emphasis should be on enhancing the connectivity and functional density of small-scale green spaces, forming a collaborative, all-weather, multi-scale urban heat environment regulation strategy.

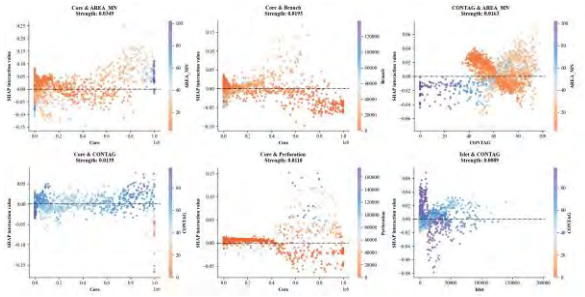


Figure 10. The interaction effects of main index of daytime.

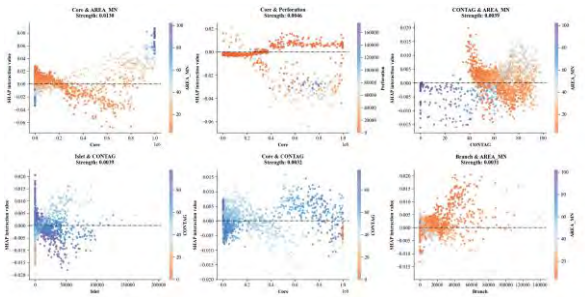


Figure 11. The interaction effects of main index of nighttime.

Discussion

This study compares the MLR, KNN, and XGBoost models, finding that XGBoost performs best in revealing the nonlinear relationships and interaction effects between blue-green spaces and surface temperature, particularly excelling in handling high-dimensional data and capturing nonlinear interactions compared to the other models. While the MLR model is simple and easy to interpret, it struggles to handle complex spatial relationships, resulting in lower prediction accuracy. The KNN model, although capable of processing nonlinear data, is significantly affected by the number of neighbors chosen and is less efficient in high-dimensional data. To improve model interpretability, this study incorporates the SHAP method, which identifies the key features and interactions influencing surface temperature.

In terms of urban planning, the study reveals the significant cooling effect of core area size on daytime surface temperature, especially with large-scale core blue-green spaces effectively mitigating the urban heat island effect by enhancing evapotranspiration. However, at night, the cooling effect of the core areas diminishes and may even result in heat release. High connectivity of blue-green spaces aids nighttime cooling and prevents heat retention. Based on this, it is recommended to expand blue-green core areas in high-density urban areas and enhance small-scale green space connectivity through greening efforts, forming an effective cooling network. Given the significant daytime and nighttime temperature differences in Nanjing, planning should consider the cooling needs at different times of the day to achieve an all-weather urban heat environment regulation.

The limitations of this study include the use of single-year remote sensing data, which does not capture the seasonal variations of the thermal environment. Future studies should incorporate multi-temporal data and enhance the analysis of the temperature regulation mechanisms of different scales of blue-green spaces to improve the dynamic applicability of the research and provide scientific support for optimizing urban thermal environments.

Conclusion

This study explores the complex coupling relationship between blue-green space patterns and urban daytime and nighttime surface temperatures, using Nanjing as a case study. A comprehensive index system that includes morphological spatial patterns and landscape indices was developed, and the effectiveness of MLR, KNN, and XGBoost models in capturing thermal environment response mechanisms was compared. The SHAP method was employed to quantify the non-linear effects and interactions of variables. The results indicate that XGBoost outperforms traditional models in capturing the non-linear characteristics and interaction effects of surface temperatures, especially showing stronger generalization ability in nighttime thermal environment modeling. Core, AREA_MN, and AI play significant roles in temperature regulation, but their effects show strong heterogeneity across time periods. Core has a dominant cooling effect during the day, but may become a heat source at night. High aggregation and moderate connectivity provide the best cooling effects during the day, while small patches combined with high connectivity are more effective at night. The study emphasizes the need for urban planning to focus on the systematic optimization of BGS structure to achieve all-weather thermal environment regulation, with significant implications for climate-adaptive urban planning.

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BEYOND ABANDONMENT, HINTERLANDS AS PLACES TO RECONSIDER THE POSTURE OF THE LANDSCAPE ARCHITECT IN MEDITERRANEAN RURAL REGIONS

TOPIC: Guiding territories by changing the design of regional projects: **tools for reinventing territories in situations of risk and environmental change**

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Keywords: hinterlands, territorial vulnerability, interfaces, qualitative approach, adaptive capacity

Abstract

Background. The Mediterranean hinterlands have undergone profound changes, which are reflected in the landscapes shaped by transitions, departures, and arrivals. This research focuses on these trajectories in Catalonia and Liguria, where forested landscapes overlay traces of a deep-rooted peasant heritage. These forests skim and cover such traces, but are also close to plots still cultivated, producing unexpected boundaries. The resulting landscapes embody vulnerability and uncertainty, calling for a prospective, grounded approach, where landscape architects should focus on ongoing processes rather than prediction. This research explores how those interfaces can be considered as strategic sites for guiding territorial projects in vulnerable hinterlands. Two hypotheses guide the study: 1) Hinterlands are at the forefront of upheavals that go beyond the local scale and stand as guardians of a broader territory. 2) The areas where agricultural practices meet forest landscapes are strategic places to engage territorial project dynamics from the hinterlands. **Methods.** A qualitative field approach combines exploratory walks, semi-structured interviews with local actors, and literature review on adaptive capacity in rural and vulnerable situations. Interviews are coded using mainly the Local Adaptive Capacity (LAC) framework and enriched by situated analysis. **Results.** Preliminary findings from the Bages region (Catalonia) reveal diverse trajectories regarding land stewardship and transmission processes. While some families maintain long-standing inheritance and adaptive practices, others face generational breaks, economic uncertainty, and insecure land tenure due to absentee ownership. These narratives expose tensions between continuity and rupture, highlighting local actors as witnesses and agents of change. Transmission patterns serve as indicators of broader relational dynamics shaping territorial vulnerability. Uncertainty and land tenure issues fragment local stewardship, yet these interfaces remain active sites of interaction and adaptation. In contrast to the view of abandonment as a mere decline, this research frames it as a relational and situated process, offering fertile ground for landscape action rooted in local knowledge and actor trajectories. **Conclusion.** While preliminary, these findings suggest that such interfaces may not merely represent residual margins but could instead constitute strategic places for landscape-oriented action. Early insights point to their potential as living, contested landscapes shaped by active local trajectories. Attentive to these dynamics, landscape architects could consider relational approaches that might inform future directions for action in vulnerable rural contexts.

1. Introduction

The Mediterranean hinterlands have experienced profound transformations over recent decades, including agricultural decline, land fragmentation, and reforestation, resulting in a clear shift from peasant to forested territories. However, the management of these private forests is fairly marginal: only 25% of forest owners in the northwestern Mediterranean have implemented management plans [1], rendering forests both a symptom of abandonment and a vector of vulnerability, especially regarding wildfire risk.
While forests have been viewed for a long time as a shared territorial identity in the mediterranean basin [2], and a focus of expert-based discourses on vulnerability and management, this paper shifts attention from the '*what*' to the '*who*': who lives here? Who acts? In the highly fragmented landownership of forests, characterized by many absentee owners and limited forest management, farmers emerge as key local actors: not as survivors of disappearing practices, but as active witnesses embedded within vulnerable landscapes.
This study is based on fieldwork in two Mediterranean regions — Bages in Catalonia and Levante Ligurian in Italy, and draws on the *territorialist* approach emphasizing situated knowledge as a basis for a territorial project [3] and qualitative methods [4-6].
From this perspective, the subtle yet active presence and testimonies of farmers provide a rich qualitative lens to understand the complex processes of landscape abandonment and vulnerability, defined here territorially as the capacity of the major issues to function and respond to crises [7]. The focus is on ongoing processes shaped by local actors rather than risk prediction.
This approach addresses a gap in literature on risk and territorial vulnerability, calling for grounded, situated approaches.

1.1 Hypothesis and objectives

This paper stems from a current thesis, exploring how forest-viticulture interfaces can become strategic sites for territorial projects in vulnerable areas of the Western Mediterranean.
The research is structured around two key hypotheses: 1) Mediterranean hinterlands act as frontlines within broader territories; 2) at the local scale, agriculture-forest interfaces might activate and guide territorial projects. Through fieldwork in Catalonia's Bages region, the Gulf of Tigullio, and Cinque Terre National Park in Liguria, the study examines how active local actors' trajectories can inform territorial action in vulnerable contexts.
The general objective is to assess the strategic potential of these interfaces. By adopting a qualitative approach focused on actors and their dynamics, the study aims to move beyond narratives of abandonment and recognize these complex spaces as generative places for emergence of territorial projects.
This paper reflects on the mobilization of a qualitative approach and explores how the rich, situated material produced can inform landscape action and grounding project thinking within these interfaces.

2. Methods

The general methodology is structured around three activities: 1) fieldwork to get to know the landscapes, their geography and toponomy; 2) interviews and discussions with identified stakeholders; 3) a literature review involving similar approaches and situations to the research, providing a broader context.
This paper focuses on the collection and analysis of interviews conducted in the Bages area. Research in Liguria is ongoing until August 2025, at the time of writing.

2.1. Study site

The Bages region was chosen because of the winegrowing heritage that long shaped the area's development, before undergoing a major forestry transition, leading to predominantly forested landscapes.



Figure 1. Location of the comarca of Bages in Catalonia

Nowadays, the configuration of wine-growing plots, isolated within forest landscapes, offers a variety of interface situations to explore. The area is also highly vulnerable to the risk of fire, which now occurs from March to October, and has become the focus of much research, notably at the Forest Science and Technology Centre of Catalonia (CTFC), alongside which this research

was conducted during the fieldwork phase. The last major fire occurred in 2022 in the western part of the region, revealing the many terraces, stone walls and *tines* (dry-stone structures used for grape storage and wine production) that bear witness to Bages' winegrowing heritage.



Figure 2. Illustration of the island configuration of vineyard plots in the Bages forest landscape. Castellfollit del Boix, June 2024.

2.2. Data collection

The interview guides were developed based on the thematic branches of the Local Adaptive Capacity (LAC) framework [8], which was adapted and enriched to reflect the specificities of the study areas. This framework was selected for its locally grounded analytical structure and its proven relevance in similar research contexts [4,8]. It explores the following dimensions: *Interactions among residents, Asset base, Innovation, Observation abilities to change, Ability to plan ahead, Access to scientific and technical knowledge, and Place-based knowledge*. The questions were slightly adjusted depending on the profile of each actor to better tailor the conversation and deepen the insights gathered.

Four main thematic axes structured the discussions:

1. social structure of the territory,
2. agricultural practices,
3. local and situated knowledge,
4. the relationship to forested landscapes.

The selection of interviewees was based on three criteria:

- residing within the study area;
- having an activity related to viticulture or territorial engagement;
- operating in proximity to forested areas.

The focus on viticulture gradually emerged through fieldwork and contacts, notably via collaboration with the FIRE-Wine project led by the CTFC, which looks at the role of winegrowing practices in fire risk management and was ongoing during the research period.

Table 1 summarizes interviewee profiles (n=11). Interviews (avg. 70 minutes) were conducted in situ, often while walking through work environments, creating a connection with the surrounding landscapes. In Bages, the questions were asked in Spanish, while interviewees were free to respond in either Spanish or Catalan. All interviews were recorded, transcribed, and analyzed as described in the next section.

Table 1. Profiles of interviewees in the Bages area

Profiles of interviewees	Nb. Interviews (Bages)
Cooperative winegrowers	2
Actor currently planning on starting up in winegrowing through transmission	1
Winegrowers in wineries	3
Geographer, involved in the territory	1
Researcher involved in wine culture heritage	1
Cooperative managers	2
Involved resident in sustainable tourism	1
Total	**11**

2.3. Analysis

The analysis is based on a qualitative reading of the interviews, aiming to shed light on the relational dynamics underlying the broader phenomenon of abandonment, preserving the heterogeneity and richness of the collected narratives to explore how such material can inform an attentive landscape approach.

Two complementary analytical frameworks guide this work, which is structured around successive coding phases applied to the interview transcripts:

1. the Local Adaptive Capacity (LAC) framework, which allows for the characterization of adaptive capacities identified through the interviews, according to previously mentioned branches;
2. the Ayache and Dumez approach [9], which involves multinominal coding based on the distinction between "*closest generalities"* (points of convergence across narratives, revealing transversal dynamics) and "*specific differences"* (subtle singularities that expose particular configuration).

This dual analytical movement helps to reflect the dynamic and situated nature of the narratives, without reducing them to fixed categories.
Table 2 presents an excerpt from the analysis of several quotations concerning a single phenomenon: **the transmission of vineyards**. The purpose of the analysis is to qualify how these testimonies shape and describe the phenomenon, to understand the underlying dynamics and consequences associated with it.

Table 2. Extract from the analysis table showing the progression from the quotation selected for the general "Transmission of vineyards" code, to the identification of processes and their relationship with the LAC analysis framework.

Interviewee's posture	Coded quote	Identified processes	Mobilized LAC dimension
Actor currently planning on starting up in winegrowing through transmission	"Last year we had a small vineyard that the pages (Catalan farmer) left us as a trial."	Relationship as a key factor in transmission processes	Innovation; Social networks; Ability to plan ahead
Cooperative winegrower	"Generational handover… Well, I don't have children, yeah. I don't really know what I'm going to do."	A lack of succession plan	Ability to plan ahead
Cooperative winegrower	"In fact, my grandfather did that. They would plant cherry trees and almond trees between the vines, because the minerals that one needs are not needed by the other."	Transmission provides access to substantial assets	Place-based knowledge; Innovation

3. Results

The results are preliminary and concern the interviews analyzed to date in the Bages area. This paper presents a typology of results from the qualitative approach, based on an example of the analysis of the phenomenon of "vineyard transmission". They are structured according to the identified issues.

3.1. *Transmission as a structuring process: between continuity and uncertainty*

LAC dimensions: Asset base, Ability to plan ahead, Place-based knowledge

The characterization of this phenomenon begins with a quote illustrating a familial model of transmission, where land and viticultural practices have been passed on through generations, signaling a strong *asset base* and a *capacity to plan ahead*, grounded in continuity:

> *"My father could bring 8 or 10 hectares, we kept planting until we had the 20 hectares we have today."*

Later, another winegrower explains:

> "*In fact, my grandfather did that: when they planted a vineyard, they would plant olive trees on the edge. And they were synergies that were really taken advantage of.*"

Beyond material inheritance, this testimony recalls the transmission of knowledge: subtle, intergenerational practices adapted to local conditions. This reflects a combination of *place-based knowledge* and *innovation* rooted in memory. However, this continuity appears threatened by recent economic and climatic instability:

> *"He's [his son] finishing engineering, and I don't think he wants to go into this. Especially after two years of drought, frost and hail. He hears me at dinnertime: 'well, this year I don't know how we're going to manage.' My wife's a teacher, good thing we've got my wife's income."*

This generational turning point shows how structural vulnerability (climate and income insecurity) erodes the ability to ensure succession. The *ability to plan ahead* is constrained by a perceived lack of future viability. Another actor highlights the absence of heirs and planning altogether, pointing to a shrinking *asset base* and a form of quiet withdrawal from *planning* processes:

> *"Generational handover… Well, I don't have children. I don't really know what I'm going to do. Up to now I haven't worried too much about it, there's no plan at the moment."*

3.2. Alternative Pathways and Their Obstacles

LAC dimensions: Innovation, Social networks, Access to institutional knowledge, Ability to plan ahead

Further encounters shown an experimental, non-familial transmission process, built through local cooperation:

> *"Last year we had a small vineyard that the pages left us as a trial."*

This testimony reflects *innovation* and use of *social networks* to pursue production through transmission. Yet, structural barriers quickly emerge:

> *"But the problem is, these big landowners still need to find the contract so we can actually see whether we can extend our time here."*

The lack of formal contracts with absentee landowners highlights an administrative obstacle that undermines continuity. This indicates a critical gap in *access to institutional knowledge* and a potential obstacle to plan ahead for a long-term period. More broadly, the ownership situation becomes a source of uncertainty, making the continuation of production highly dependent on distant actors with distinct priorities:

> "*Some landowners don't want to [make contracts], because they don't want to have any contracts in case they decide to sell one day.*"

3.3. Diverging Values impacting relationships among residents

LAC dimensions: Asset base, Social cohesion, Place-based knowledge

Some discussions revealed a disconnect in values between landowners and local agricultural actors:

> *"What their kids [kids of the land owner] were worried about was: "okay, we can give them [winegrowers] hand over the vineyards but on one condition: if someday I ever want to build a padel court."*

Agricultural land is an object of speculation, not of production or stewardship. This divergence directly affects *asset security* and weakens *social cohesion*.

> *"Most of them [winegrowers working with the cooperative] don't plan to continue with the vineyard, you know? Well, maybe they sell the vineyards — to whoever pays better, maybe the big players in Pla de Bages. They're always on the lookout for vineyards around here."*

This quote, coming from a cooperative manager, reflects the concentration of land by powerful actors, who operate at a distance from local practices and outside the logic of transmission. These actors are marginal to transmission processes.

Figure 3 attempts to map these relationships and configurations, connecting actor postures to the underlying dynamics of vineyard transmission, and providing the basis for a relational reading of the processes of transmission that resist binary interpretations.

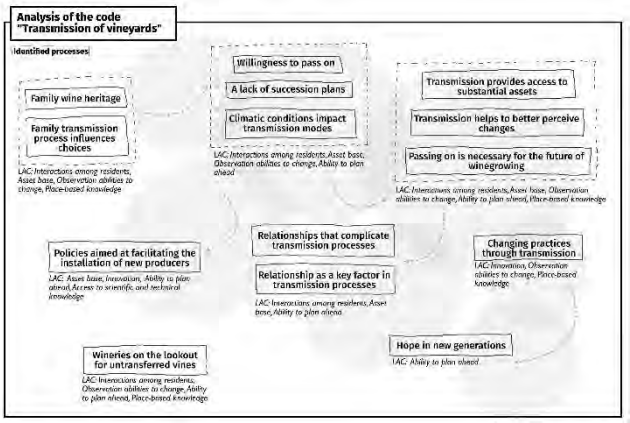


Figure 3. Exploratory map of connections between identified processes and LAC framework dimensions

This analysis highlights the close link between transmission processes and relationships. Marked by uncertainty, generational breaks, and land tenure tensions, the following section discusses how such dynamics may offer a foundation for landscape action—particularly when approached through the relational lens of the "generalities/differences" framework.

4. Discussion

4.1 Implications between relationships and vulnerability

The results show that vineyard transmission becomes an indicator of the relational dynamics shaping the territory.

These results, while varied, reveal general patterns, most notably, a limited capacity to plan ahead, often due to absent succession plans, both for vineyards and land plots. This limited foresight is a recurring theme across most interviews and relates directly to the *ability to plan ahead* within the LAC framework. Yet, these limitations stem from distinct underlying causes. For some, economic and climatic uncertainty undermines confidence in continuing the activity. For others, the absence of successors creates a perceived dead-end in land stewardship. Uncertainty thus emerges as a shared condition, though driven by different mechanisms—including unresolved succession and land tenure difficulties linked to absentee landowners.

These absentee owners, often geographically or culturally detached, appear external to transmission processes. Likewise, wineries operate outside transmission logics, benefitting instead from abandonment phases. In both cases, asymmetrical access to land and decision-making weakens territorial relationships. These findings echo previous research [4], which observed through expert's interviews that "*processes of rural abandonment and tertiarization of economies directly affect local interactions and relationships*."
However, while their study views these as outcomes, this research suggests the opposite movement: by focusing on "who transmits," relational dynamics appear as drivers of abandonment, highlighting a double movement relationships/abandonment. Focusing on the "who" allows local characterization of ongoing processes and constitute valuable material towards landscape action.

Another connection with literature further emphasizes the importance of social relations in vulnerable territories. They've already played a major role in wildfire risk management through the constitution of the Catalan ADFs (association for the defense of forests against fire): "*The origins of the ADFs can be traced back to the networks of mutual help and forest owner associations operating in the territory since the 1960s and 1970s. This type of collective action occurred largely among pagesos (Catalan farmers) and was particularly well-organized in Catalonia, where wildfire risk is very high.*" [10]

This interweaving of social relations and vulnerability also aligns with the concept of territorial vulnerability, which is based on "the solidarity between major issues and the territory […] leading to the mapping of 'major issues,' i.e., the key elements that enable an area as a whole to function, develop and cope with an emergency situation." [7]

4.2. From narrative mapping to landscape action

These findings call for a reframing of abandonment: not as a void, but as a process marked by intertwined individual paths and social dynamics, often shaped by constraints and latent opportunities. By bringing together these situated trajectories, the research aims to map a relational landscape, as theorized in this research [6] through the hypothesis of "*fermes-paysages"* (landscape farms), producing exploratory maps that "*allow orientation among the many ordinary experiences of farmers while revealing action paths at a broader scale.*"
The method used in this research does not aim for exhaustiveness or generalization, but rather to generate a narrative-based, situated understanding of vulnerability. In doing so, it creates a dialogue between what is "heard" and what is "observed", opening the possibility of creating an "*indirect discourse"* [5], a form of situated narrative reflexivity.
This qualitative and exploratory posture lays the groundwork for an attentive landscape approach, regarding the existing trajectories and interfaces, especially those between agriculture and forest. These interfaces, once characterized by the actors acting at their contact, provide a space to guide situated landscape action.

4.3. Limits and Perspectives

This communication focuses on the Catalan case and the analysis of one identified process. The results remain partial and will be further explored through comparative fieldwork in Liguria (ongoing until august 2025). Also, the limited size of the sample, as well as the focus on farmer profiles, makes it difficult to extend these results to other situations. Several avenues are identified for the continuation of the search, such as integrating additional actor profiles, linking qualitative analyses with the observed interfaces within the studied landscapes, and exploring the prospective implications of the relationship patterns identified.

5. Conclusion

This article explored the implication of a qualitative approach, from fieldwork to analysis, as part of the process to address the question: How agro-forestry interfaces in Mediterranean hinterlands can become strategic places for territorial project in contexts marked by abandonment and vulnerability? Through a situated approach, focused mainly on the trajectories and narratives of local winegrowers, the research identified transmission, uncertainty, and access to land as key dynamics structuring adaptive capacities. Using the LAC framework and the relational lens closest generalities/specific differences, the study revealed that abandonment is not a homogeneous retreat, but a process

woven through postures, trajectories, and their encounter.

The results' typology highlights a diversity of actors, individual and collective trajectories, places, moments of rupture or crystallization, and shared concerns. This fundamentally relational approach enables a deeper understanding of ongoing processes by situating actors within their context of action. It reveals specific dynamics that help characterize the broader phenomenon of abandonment observed in Bages, while also providing an interpretive framework for evaluating its current implications, especially when read through territorial approaches to vulnerability. These results reaffirm the importance of actor relationships in shaping territorial vulnerability, and open perspectives for landscape action as a situated and relational practice. By listening to the active protagonists of these interfaces, landscape architects can read these areas as living, contested and strategic places.

Acknowledgments
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UNRAVELLING TEXTILE TERRAINS: LANDSCAPE ARCHITECTURE AND THE HIDDEN GEOGRAPHIES OF FAST FASHION WASTE

TOPIC: Guiding territories by changing the design of regional projects: tools for reinventing territories in situations of risk and environmental change

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Keywords: textile waste landscapes, spatial representation, landscape architecture, fast fashion, environmental justice

Abstract
Fast fashion waste is a landscape issue. The global used clothing trade, driven by the overproduction of fast fashion in the Global North, is generating novel anthropogenic landscapes throughout the Global South. These landscapes, comprised of surplus discarded used clothing, are growing in scale along urban peripheries, on riverbanks, and in coastal zones, forming complex and chemically rich ecosystems among importing communities. Yet despite their ecological and infrastructural impact, these waste formations remain largely undocumented in spatial terms. This paper argues that these textile waste formations constitute an emergent landscape typology, and that their invisibility is both a technical and geopolitical condition that supports continually increasing export quantities of used clothing from the Global North with little regard for the impact the surplus of overconsumption does to importing communities.

This study explores how tools from the discipline of landscape architecture - specifically mapping, visualisation, and temporal analysis - can be applied to document, interpret, and spatially qualify emerging textile waste formations. Focusing on a case study in Old Fadama, Accra (Ghana), one of the largest used clothing import hubs globally, the research draws on collaborative work undertaken by researchers and postgraduate students at RMIT University. Working in a data-scarce environment, the study employs an integrated methodology combining Geographic Information Systems (GIS), photogrammetry, and triangulation of news and social media information to construct visual spatial narratives of accumulation and transformation of these urban sites over time.

Findings indicate that textile waste in Old Fadama has led to the development of sedimentary waste formations that alter local topographies and hydrological systems. These formations are dynamic, shaped by accumulation, erosion, and intentional burning. Their presence, however, remains largely absent from environmental assessments, planning documents, or public spatial datasets. This absence limits both public awareness and governance responses.

The study demonstrates how landscape architectural methods can operate as critical tools in data-poor contexts, synthesising fragmented information into coherent spatial representations. Beyond documentation, these methods support the recognition of textile terrains as legitimate spatial and ecological entities that warrant design, intervention, and regulatory attention. In addressing the spatial invisibility of fast fashion waste, this research contributes to ongoing discourse in landscape architecture, urban studies, and environmental justice. It proposes an expanded disciplinary role for

landscape architects, not only as designers of planned environments, but as advocates for emergent, damaged, and politically marginalised landscapes in the context of the climate crisis.

1. Introduction

Fast fashion waste is a landscape problem. Driven by the overproduction and marketed obsolescence of garments in the Global North, the accelerating global trade in used clothing is producing a novel and under-recognised landscape phenomenon as surplus unsellable clothing accumulates in cities across the Global South. The flow of garments into counties specialising in trade of used clothing now so far exceeds the capacity of local resale markets, waste infrastructure, and ecosystems that vast quantities of discarded clothing now amass at the margins of urban centres. Dumped on riverbanks, vacant land, and coastal edges, textiles form dense, chemically complex deposits of fibre, dyes, and plastics. These accumulations are reshaping the landscapes of import communities, producing novel environments with disastrous environmental, social and cultural consequences.

Yet despite their scale and material presence, these waste formations remain largely undocumented in spatial terms. They rarely appear in environmental assessments, planning documents, or geospatial datasets. Their invisibility is due in part to their recent and rapid emergence, but also to their typical location within informal or marginalised urban areas that have historically been excluded from formal spatial documentation. In many cases, their presence is further obscured by the geopolitical dynamics of transnational clothing trade, where waste exported under the guise of 'reuse' is systematically concealed from regulatory oversight.

This paper explores these textile waste formations, recognising them as a legitimate anthropogenic landscape typology produced by the intersection of fast fashion, global trade, and geopolitics. In response to their invisibility, this study explores how tools from the discipline of landscape architecture can be used to document and spatially qualify these landscapes in data-scarce contexts. Focusing on a case study in Old Fadama, Accra (Ghana), the research pursues three key objectives:

1. To document and spatially qualify emerging textile waste formations using landscape architectural tools and methods.
2. To assess the applicability of these methods in data-poor environments.
3. To contribute new spatial insights that support recognition and engagement with textile waste formations.

2. Background

The global used clothing trade has expanded rapidly over the past three decades, as fast-paced production cycles and market-driven obsolescence have increased the volume of garments purchased and discarded. While clothing donation is marketed as a circular or charitable practice, the export of unwanted used clothing increasingly functions as a mechanism for managing surplus waste, effectively displacing the environmental burden of overproduction and overconsumption onto countries across the Global South [1,2]. Donated used clothing quickly enters a for-profit transnational trade network, where it is baled, exported, and sold for resale in the Global South.

While portions of these imports are successfully resold in used-clothing markets across the world, large quantities are immediately discarded upon arrival due to oversupply, poor quality, or lack of local demand. In locations such as Kantamanto Market in Accra, one of the world's largest trading hubs for used clothing, an estimated 40% of imported used clothing is deemed unsellable shortly after arrival [3]. This imported material surplus far exceeds the absorptive capacities of local markets, waste infrastructures, and local ecosystems.

The environmental consequences of this system are severe. Discarded garments accumulate in open spaces available to importing communities including along riverbanks, wetlands, coastlines and along urban peripheries. These accumulations create chemically active, plastic-rich deposits that interfere with drainage, exacerbate flooding, and contribute to the contamination of soils and waterways [4]. Over time, these waste formations layer to form terrain-like conditions that are subject to erosion, sedimentation, burning, and seasonal movement. The slow violence of these landscapes [5] unfolds gradually, harming communities and ecologies of importing countries. Despite their physical presence and growing environmental impact, these formations remain largely invisible in terms of spatial data. They are rarely recorded in planning documents,

environmental assessments, or geospatial databases. Several factors contribute to this invisibility. Firstly, textile terrains are a recently emergent phenomenon, forming over the last two decades in response to the exponential growth of fast fashion. Second, they are typically located in informal urban areas that have historically lacked formal spatial documentation. Finally, it is possible that there are geopolitical incentives for keeping these accumulations out of sight, as visibility may challenge the sustainability narratives used to justify ongoing donation and used clothing export practices.

This research identifies these textile waste formations as a distinct landscape typology and argues that their spatial invisibility perpetuates ongoing environmental and geopolitical failure. To address this, the study investigates how landscape architectural methods can be deployed to make these formations visible, measurable, and actionable, particularly in contexts where conventional spatial data is limited or absent.

3. Materials and Methods

This study focused on documenting and spatially interpreting a key dumpsite in Old Fadama; an informal settlement located adjacent to Kantamanto Market and the Odaw River in Accra, Ghana. Over the last decade, the site receives continuous deposits of unsold and discarded garments from the market, in addition to other waste streams including e-waste and household refuse. Over time, these materials have accumulated into stratified, sedimentary layers, forming a dynamic textile-rich waste mound within the flood zone of the Odaw River. Rather than remaining static, the dumpsite is continually reshaped by human activity, hydrological flow, erosion, and fire.

Due to its informal and marginal status, there is a lack of formal data for the dumpsite at Old Fadama, presenting a highly challenging study environment. The site is largely absent from official spatial planning records, and no known environmental assessments have documented its material transformation. As a result, conventional methods of landscape documentation, such as formal surveys, planning overlays, or infrastructure records, were unavailable. To address these limitations, the study employed a hybrid methodology combining digital mapping, photogrammetry, temporal analysis, and Open Source Intelligence (OSINT) techniques to interpret and visualise the dumpsite at Old Fadama and its evolving context.

The case study was undertaken as part of an advanced design research seminar led by Dr Alice Lewis (RMIT) with support from James Melsom (UTS) within the Master of Landscape Architecture program at RMIT University. The work was conducted remotely, relying exclusively on secondary, publicly available data. This pedagogical integration enabled a studio-based inquiry model that tested how emerging professionals can engage with distant, complex, and data-scarce environmental challenges through visual and representational experimentation. Several discrete but overlapping techniques were necessary for this approach:

3.1 GIS Analysis and Site Mapping

Geographic Information Systems (GIS) formed the foundation for spatial interpretation. Open-access global basemaps and satellite imagery established spatial context, surface topography, and identification of visible concentrations of textile waste. Elevation and terrain data were sourced from publicly available Digital Terrain Models (DTMs), providing high-level insights into large scale topographic features and hydrological flows, and providing reference points and context for the further datasets. This approach was particularly important for the scoping of the project, large-scale analysis and identification of more detailed areas of study.

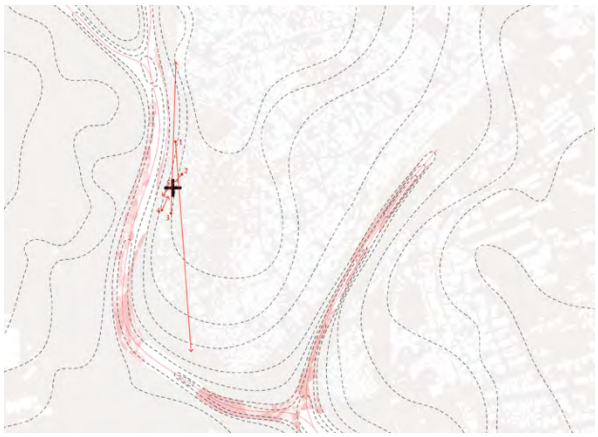


Figure 1. Initial high-level terrain exploration, conducted by Kunal Shah, TaiJung (Yvette) Wu and Zhirou Huang.

3.2 Photogrammetry and Remote Visual Data

To explore topography in more detail, photogrammetric techniques were applied to the individual video-frames of publicly available video footage from news and social media. Processed footage generated fragmented point-cloud models, allowing for an approximation of terrain, material height, distribution, and textile or waste-material build-up. Although less precise than ground-based surveys, this method enabled 3D visualisation in a physically and politically inaccessible site, as well as volumes to be accurately collected from specific moments in time.

3.3 Temporal Analysis

Historical satellite imagery from open archives was analysed to trace the evolution of the site over time. Attention was given to vegetation loss, shifts in the Odaw River, and the progressive expansion of the dumpsite. Seasonal variation was also considered, particularly in relation to flooding, which redistributes material, and intentional burning, which reshapes terrain form and composition. The nature and rate of landscape transformation could be inferred from these sources, as well as visual traces, wind direction, distance and spread of smoke pollution from the continuous burning of material on site.

3.4 Open-Source Intelligence (OSINT)

OSINT was critical to contextualising spatial findings. Information points were triangulated across NGO reports, local media coverage, citizen photography, and social media content to corroborate site-specific events, material flows, and socio-political dynamics. The information documented continuous and intense human land-use of these sites, as well as habitation by birds and agricultural animals. This process allowed for a more nuanced interpretation of the landscape formation and change, compensating for the absence of official monitoring.

Throughout the research, care was taken to acknowledge the ethical complexity of interpreting marginalised landscapes through remote visual methods. In the absence of local collaboration and ground-based data collection, these approaches should not be considered as singular or definitive representations. While spatial visualisations can bring visibility to overlooked geographies, they also risk abstraction or detachment from lived realities. This study seeks to advocate for representational practices that foreground presence without erasure, and legibility without simplification.

4. Analysis and Results

The spatial analysis of the dumpsite at Old Fadama reveals a distinctive terrain morphology shaped by material accumulation, hydrological disturbance, and informal land-use adaptation. While lacking formal classification, the site exhibits characteristics of an emergent anthropogenic landform: a waste-based topographic feature continuously reconstituted by deposition, inundation, erosion, human activity, habitat and fire.

4.1 Terrain Morphology

The textile waste accumulation in Old Fadama forms a mounded terrain situated on the eastern bank of the Odaw River, within a known floodplain. Satellite imagery suggests the formation spans approximately 60 to 80 metres at its widest point, occupying the full extent of open ground between the residential dwellings of Old Fadama and the river. The base of the site sits within a zone where the ground level drops approximately 5 metres from north to south. However, reports and photogrammetric explorations indicate that the waste mound rises an additional 10 to 15 metres above the highest natural ground level, suggesting a total height of up to 20 metres.

The form of the terrain is dynamic and continually shifting. Ongoing deposition of unsellable clothing, food market scraps, household refuse, and electronic waste adds to the accumulation, while erosion, water flow, and human activity continually rework its shape. River movement and seasonal rainfall have caused significant erosion on the western and southern flanks, producing steep, almost vertical slopes in places. In contrast, the northern and eastern sides exhibit a more gradual incline.

Human activity further contributes to the terrain's instability and transformation. Networks of waste-pickers and e-waste miners regularly sort through the accumulation, removing, displacing, and in some cases returning smelted or processed materials. Intentional burning to reduce the size of the pile is also common. Additionally, cattle owned by residents of Old Fadama graze on the organic matter deposited in the waste, disturbing its surface through movement and weight, occasionally triggering small-scale landslides.

The result is a terrain that is in constant flux. It is a constantly reforming landform shaped by intertwined flows of waste, water, fire, and labour.

Its evolving morphology challenges conventional definitions of dump sites and supports a more nuanced reading of the mound as a mobile, living terrain that registers the material, ecological, and social processes that shape it.

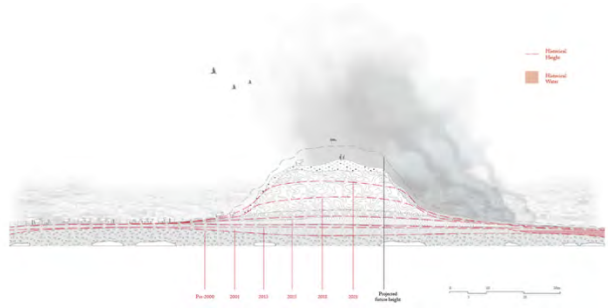


Figure 2. Exploring textile waste formation process since year 2000, by Kunal Shah, TaiJung (Yvette) Wu and Zhirou Huang.

4.2 Composition and Strata

Within this landform, emergent geologies composed of both synthetic and organic materials are forming. Based on satellite imagery and corroborating news reports, the dumpsite at Old Fadama appears to have begun developing around 2010. This timing coincides with the rapid population growth of the settlement and the closure of several of Accra's formal municipal dumpsites. While initial growth was gradual, the accumulation has accelerated over the past 6–7 years, mirroring global increases in the production and export of mass-produced fast fashion. In the absence of adequate waste management infrastructure or regulatory controls on the export of worn clothing, it is likely that this terrain will continue to grow, with erosion and flood events posing an increasing risk of textile debris entering nearby waterways and ultimately the ocean.

Analysis of photographic imagery and documented accounts suggests that the formation consists of alternating strata of textile fibres, compacted sand, plastics, electronic waste, decomposing organic matter, and soils. While these materials are often mixed on the surface, our research suggests that distinct layers appear over time. Shifts in municipal waste collection, changing import volumes, and seasonal fluctuations contribute to variations in composition, producing alternating phases dominated by electronic waste, textile influxes, or household refuse.

These strata represent a form of anthropogenic sedimentation in which clothing and debris integrate with natural substrates to create chemically complex, plastic-rich soils. The resulting material is water-resistant, highly flammable, and difficult to stabilise, increasing risks of fire, runoff, and long-term contamination. Rather than following typical geomorphological processes of deposition and erosion, these new geologies are shaped by global consumption patterns.

The presence of this layered, hybrid strata underscores the urgency of recognising textile waste formations as environmental entities with both immediate ecological consequences and long-term geological significance.

4.3 Temporal and Spatial Context Transformation

Temporal analysis of satellite imagery, triangulated with local news reports, indicates that a major flood mitigation and land reclamation project commenced around the year 2000. This project transformed the marshland east of the Odaw River into the land on which the informal settlement of Old Fadama now stands. During this time, vegetation cover declined significantly, and the river channel became increasingly engineered and constrained. As the settlement expanded over subsequent decades, so too did the adjacent dumpsite along the new riverbank. Despite its ongoing presence, Old Fadama continues to be characterised in policy discourse as a temporary or informal settlement. This framing has contributed to the absence of formal waste and drainage infrastructure [6], and recurring flooding events are exacerbated by blocked open drains, many of which are clogged with discarded clothing and solid waste. Establishing the spatial and temporal development of the dumpsite reveals an evolving relationship between waste, land use, and urban settlement. Like all landscapes, the evolving dumpsite at Old Fadama is shaped by broader environmental, social, and political systems. However, unlike Accra's formal municipal dumpsites, which are often listed in planning documents, geospatial datasets, or environmental management strategies, the textile waste accumulation at Old Fadama remains largely invisible.

This disjuncture highlights a critical gap between actual landscape transformation and formal spatial recognition. It also reflects a broader pattern in which marginalised or informal landscapes are systematically excluded from the spatial logics of

urban planning. Addressing this absence is not only essential for understanding the environmental risks associated with unmanaged waste, but also for recognising the lived realities of urban communities like Old Fadama, who contend with the material consequences of geopolitical waste displacement.



Figure 3. Mapping spatial and temporal context of site, by Kunal Shah, TaiJung (Yvette) Wu and Zhirou Huang.

4.4 Landscape Representations and Interpretive Gaps

The set of landscape architectural plans and sections developed through this investigation provide insight into the context, vertical stratification and surface form of this emergent, fluctuating landscape. These outputs, while exhibiting necessary approximation and interpolation, offer a crucial spatial narrative of material build-up that is missing from official records. By visualising site morphology and change over time, the work begins to fill a critical knowledge gap about the ecological consequences of textile waste accumulation in Ghana.

These findings reveal the infrastructural gaps and transnational trade governance failures that permit such landscapes to proliferate. The absence of spatial data or regulatory oversight directly facilitates the unchecked accumulation of waste in ecologically sensitive and marginalised areas. While the site is materially visible to its surrounding community, its invisibility in international public records reflects broader patterns of waste displacement whereby the costs of global consumer culture are absorbed by communities least equipped to manage them [7]. Recognising and documenting these landscapes is not simply an academic exercise, but a necessary step toward equitable environmental governance of transnational waste trade.

5. Discussion

The findings from this study highlight the critical role that spatial representation can play in making fast fashion's waste landscapes legible, actionable, and politically visible. Textile waste formations such as the dumpsite at Old Fadama exist because of global overconsumption and waste displacement. Their complete absence from planning documents, environmental registers, and global policy discourse reinforces their geographic and politically marginal status. By applying methods from landscape architecture, such as mapping, photogrammetry, and temporal visualisation, this research demonstrates how spatial tools can intervene in these global blind spots, producing representations that not only describe conditions but also advocate for change.

In this context, the distinct contribution of landscape architecture is in its capacity to combine technical spatial analysis with critical visual storytelling. As well as documenting these textile waste formations, the drawings developed in this study legitimise these dumpsites as complex anthropogenic landscapes, enmeshed in place, systems of trade, urbanisation, and environmental degradation. As such, landscape tools serve not only as instruments to represent, but to communicate the ways in which our waste is not as an incidental byproduct, but a force transforming landscapes across transnational boarders.

However, the approach also has limitations. Due to the remote nature of the study and the informal, politically sensitive status of the sites, on-the-ground data collection was not possible. The study's reliance on open-source, secondary data also necessitated careful triangulation and interpretation, however, still introduces a level of uncertainty, particularly in assessing subsurface composition and ecological impacts. While these constraints limited precision in some areas, they also underscore the value of hybrid, low-resource methods for working in data-poor contexts, especially where formal datasets are incomplete, outdated, or deliberately obfuscated. Political and economic constraints will often tend to obscure sites that are without a voice or agency, a circumstance that will always demand data collection improvisation, effort, and care on the part of researchers as well as the close collaboration with local actors.

This research complements and extends environmental science and urban studies by

introducing spatial and representational methods capable of capturing landscapes-in-formation that emerge outside planned or regulated systems. While environmental scientists may focus on contamination or material composition, and urban scholars on policy or informal settlement dynamics, landscape architecture brings a multi-scalar, visual, and material sensibility that makes emerging waste formations visible as part of broader urban and ecological systems.

Looking forward, the investigatory and representational approaches piloted here have potential applications in both policy and advocacy. By visualising and integrating these waste landscapes into spatial datasets, planners and decision-makers could better account for their risks and impacts. At an international level, these visualisations can also support debates on trade ethics, and the need for enforceable mechanisms that address not only production but the afterlives of fast fashion items. In short, this research positions spatial representation as a critical act: one that not only reveals neglected landscapes but enables active and equitable engagement with their futures.

6. Conclusion

Using landscape architectural tools to unravel the hidden geographies of fast fashion waste, this study has identified textile waste formations as an emergent landscape typology shaped by the global trade in used clothing and the systemic displacement of clothing waste. Formed through processes of accumulation, erosion, and sedimentation, these chemically complex landscapes carry significant environmental, infrastructural, and social consequences for communities across the Global South. Yet their absence from planning documents and spatial datasets reflects a broader failure to recognise these formations as landscapes worthy of analysis, care, or intervention.

By applying methods from landscape architecture this research demonstrates the role the discipline can play in visualising and politicising these anthropogenic landscapes, particularly in data-poor and distant contexts. These representations not only document evolving waste landscapes but also support their inclusion in environmental discourse and policy. As climate, consumption, and waste crises intensify, textile waste landscapes demand broader recognition from landscape professionals, planners, and policymakers alike. Making these landscapes visible is a first step toward holding the systems that produce them accountable and imagining more just and regenerative futures.

Acknowledgments

The authors acknowledge that the methods presented in this paper rely primarily on remote and secondary sources. In the absence of local collaboration and ground-based data collection, these approaches should not be considered as singular or definitive representations. Rather, the intent of this research is to contribute spatial visibility to overlooked environments and to support broader awareness of their existence and significance. The authors recognise the critical role of locally embedded organisations—particularly *The Revival* and *The OR Foundation*—whose ongoing work provides essential, grounded insights and community-led responses to the challenges addressed in this study.

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LANDSCAPE OF PERSISTENCE. CLIMATE CHANGE AND TECHNOLOGIES OF LONGUE DURÉE IN THE WATER LANDSCAPE OF SARDINIA.

TOPIC: Guiding territories - By changing the design of regional projects (energy landscapes, agroforestry, risks: Tools for reinventing territories in situations of risk and environmental change

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Keywords: rural landscape, climate change, water principles, architectural design, longue durée

Abstract
The article is part of the research activities of the Cagliari Department of Engineering and Architecture in support of landscape planning in the region of Sardinia. The research starts from a study of the climate change phenomena that constantly affect the regional territory. Sardinia can be considered a case of Mediterranean climate monitoring as it is in the centre of the western Mediterranean, with a high exposure to the extreme phenomena of drought and flood risk. The analysis of the forms of long-lasting landscapes can constitute an understanding of the principles that have generated and maintained them to date. The structure of the landscape is built by a fine-grained network of construction techniques that have enabled the landscape to maintain itself and sustain itself over time on the rhythms of the countryside, building models of self-sufficiency and circular economy specific to the individual sub-regions.
The research is based on two tools: an atlas of traditional technologies and a matrix of strategies for the recovery and enhancement of landscapes at risk. The first tool is articulated through a multi-scalar approach that addresses the scale of the landscape and that of construction techniques, focusing on the principles of water management. The second one proposes a matrix of intervention strategies related to the theme of climate change.

1. Introduction

The word persistence derives from the Latin “persistere”, meaning “to last a long time”. It is a complex word composed of the particle "per," which adds the idea of duration in an intensive manner, and "sistere", which means to stop and is obtained by doubling the verb “stare”. The etymological nature of this term alludes to endurance over time and represents the topic and the aim of this research, which studies the water landscapes of Sardinia.
Sardinia is the second largest Mediterranean island and is in the center of the western Mediterranean and is constantly marked by climatic fluctuations given by the intermittence between long droughts and sudden floods (Figure 1). The French historian and geographer Maurice Le Lannou, traveling to Sardinia in the early 1900s emphasized the vagaries of the Sardinian climate, referring to the constant variability and continuous alternation between opposing climatic phenomena [1].
The research is part of the DICAAR of Cagliari's research on the rural landscapes of Sardinia and explores issues related to the long-term exposure of landscapes to climate change by defining new transformation strategies.
The study of Sardinia's rural landscapes begins with the previously mentioned study “Pâtres et paysans de la Sardaigne” and briefly explored in the works of Pagano and Daniel on Rural Architecture in Italy. Osvaldo Baldacci explored this in greater depth in the 1950s, particularly regarding the theme of housing. In the 1980s, architect Fernando Clemente, designer of several villages under the agrarian reform program after the war, published the map of historic regions, which identified cultural, geographic, and political-institutional

invariants in the island's division into similar areas. In 2006 the Regional Landscape Plan was approved in Sardinia, the first Italian planning instrument to incorporate the dictates of the European Landscape Convention. Following this, the School of Architecture of Cagliari developed the Manuals for the Restoration of Historic Centers, which focused specifically on the relationship between settlement structures and landforms.

This research is in continuity with the morpho-typological study of landforms and landscapes and questions in particular the relationship with water and the ability of water to regulate the relationship with settlement and the rural landscape. In the Sardinian landscape, the separation between city and countryside is very difficult. Apart from a few historic royal cities, there is a dense network of small urban centers that forge close relationships with the countryside. Indeed, the rural landscape is governed by a historicized rule over time of the country as the place of habitation and the countryside as the place of production [2]. In this sense, the countryside is so closely linked to the forms of habitation as to constitute a unitary system. The relationship between alluvial land and dry land generates in an extremely precise way the forms of historic settlements that are located along the edge of the alluvial area to guard the more productive lands.

2. River systems

The research endeavor seeks to construct an interpretive framework that elucidates the hydrological characteristics of the island's river systems and their response to the phenomenon of climate change (Figure 2). The objective is to establish a methodological framework for investigating the concept of landscape multi-scalarity. This methodology is designed to facilitate a systematic examination of the spatial configurations that give rise to the landscape, emphasizing the constructive nature of these structures. The approach aims to elucidate the composition of the landscape, its relationship to soil morphology, and its structural dimensions, as well as the grain and texture of the constituent elements. The method proceeds through the selection of eight sample areas that cover a 20x20 km territorial transect. In some cases, this allows for the complete coverage of certain river basins, while in others, only the river mouth or middle valley is analyzed. It is divided into four specific parts:

- Recognition of the river district and settlement networks;
- The relationship between villages and the river;
- Identification of landscape forms;
- Construction technologies.

Starting from the first territorial scale, we identify the territorial structures generated by the relationship between villages and topography.



Figure 1. The rural landscape of "Meriagos", historical Sardinian form of silvopasture.



Figure 2. The rural landscape of "Meriagos", after the great fire of Montiferru in 2021.

Next, we proceed with the recognition of landscape forms that define the edge of relationship between urban center and water to understand the functioning of ecological systems and cycles of the long term. The landscape types are based on a heritage of traditional techniques that are extremely site-specific by defining elements that, while having the same formal structure, differ according to the location and nature of the stone elements of the sites. Multiscalarity is based on the relationship between site and construction techniques, on the circularity that the construction of traditional habitats brings with it, which lies in the interpretation of the resources present in the places and their use to create the best living conditions for the settled communities. The prehistoric and protohistoric architecture of the Nuragic period in the village of Romanzesu, in the territory of the municipality of Bitti in the northeast of the island, offers an extraordinary example of the opposition between historical continuity of forms and matter and discontinuity of climate, between great droughts and hydrogeological risk (Figure 3a-3b). At this site, a large amphitheater pool was placed in direct connection with a sacred well, probably constituting the most important public space of the settlement. There, the relationship between water and community was in an extreme state of proximity. The relationship between water and building technologies is not merely one of necessity; it is also intertwined with public practices and rituals. In these rituals, water takes on additional meanings that reinforce and accompany the social and collective dimensions proper to places of habitation[3].

3. Methodology

The research proceeds through the identification of eight sample areas that move away from the historical regions as defined in the regional historical handbook by anchoring more on the hydro-morphology of places and the relationships that urban centers have produced with spatial networks. The choice of districts is due, on the one hand, to the difficulty of the historical regions in territorially understanding the development of watercourses. On the other, the choice is due to the desire to capture the variations between the upstream and downstream systems in terms of relationships at the urban scale, slope relations, and construction techniques used.

The study of the river basin was then analyzed through a precise and always the same territorial cut-off of 20x20 km, elaborating a series of spatial maps that allow us to read firstly the hydromorphology of the territory, secondly the extension of the alluvial areas, and the highlighting of the areas at risk, the diachronic changes that the course of the river has undergone over time, and finally the overlapping of the networks that feed the agricultural plots and that relate directly to the productions.

This reconstruction facilitates the identification of figures and invariants of relationships between villages and rural landscapes, which are inscribed in the social and collective history of places. The identification of distinct landscape types has elucidated the ecological relationships between urban centers and the river, particularly regarding forms of agricultural production.



Figure 3a. The meeting basin of Romanzesu, Nuragic temple of XIV century B.C.



Figure 3b. The meeting basin in condition of full of water

Urban centers are thus categorized according to three factors:
- The distance to the watercourse;
- The relationship with the land;
- The various methods of production.

A detailed study of individual urban centers reveals their unique characteristics, which are linked to the specific features that define the relationship between public and private spaces. In the rural landscape of Sardinia, the centrality of the village is resolved through its relationship with water resources, its ability to procure water, prevent hydrogeological risk, and contain water within reservoirs, all while adhering to the traditions of rural life (Figure 4). The different river districts allow us to explore themes related to river mouth systems, upstream mountain systems, and midstream settlement networks. These landscapes are shaped by topography and forms of production, as well as the figures they generate. Water management principles, such as water capture, distribution and conservation, represent the link between different scales, connecting the landscape scale with that of specific technologies [4].

3. Water principles

The analysis of individual river districts allows for a deeper understanding of the relationships between the territorial structure and the construction techniques specific to the various areas. The principles of water management are recognizable constants that demonstrate continuity despite the overlap of different techniques. The ability to capture, collect, and distribute water is an element of continuity between traditional, modern, and contemporary techniques. In this case, the research focuses on premodern techniques that are traditional and based on a careful and parsimonious approach to water resources. These techniques are closely linked to local needs and the availability of resources and materials. The difficulty of analyzing water management principles in isolation, given their continuous integration and hybridization, led the research to study the techniques used to control water and land, and to measure how they function, their adherence to the principles, and their degree of modification. To accomplish this, an abacus of selected techniques was constructed according to the identified landscape types at the land scale, and the technologies were sorted according to their governing water management principles. The relationships with landscape morphotypes are deeply rooted in a technological substratum that tradition has preserved to the present day. In this substratum, humans exploit ancestral techniques for manipulating the land to make it productive and for constructing forms, as well as for refining construction techniques that shape rural spaces.

Technologies employed in rural settings can be studied and analyzed based on their capacity to create spaces, especially to understand the ongoing transformations affecting the rural landscape with multi-scale impacts The principles of water management constitute the invariants to which the techniques follow and which start from the study of the statics of the soil, the materials used and its hygroscopic and permeability properties.

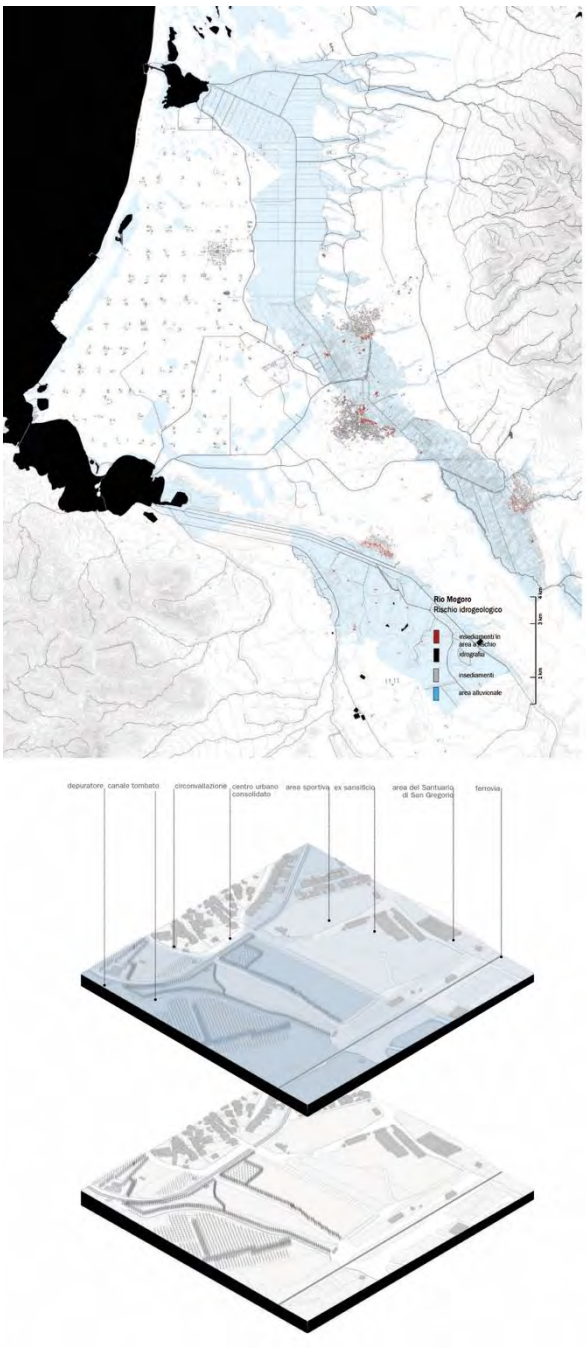


Figure 4. The relationship between the maps: the risk and the damages.

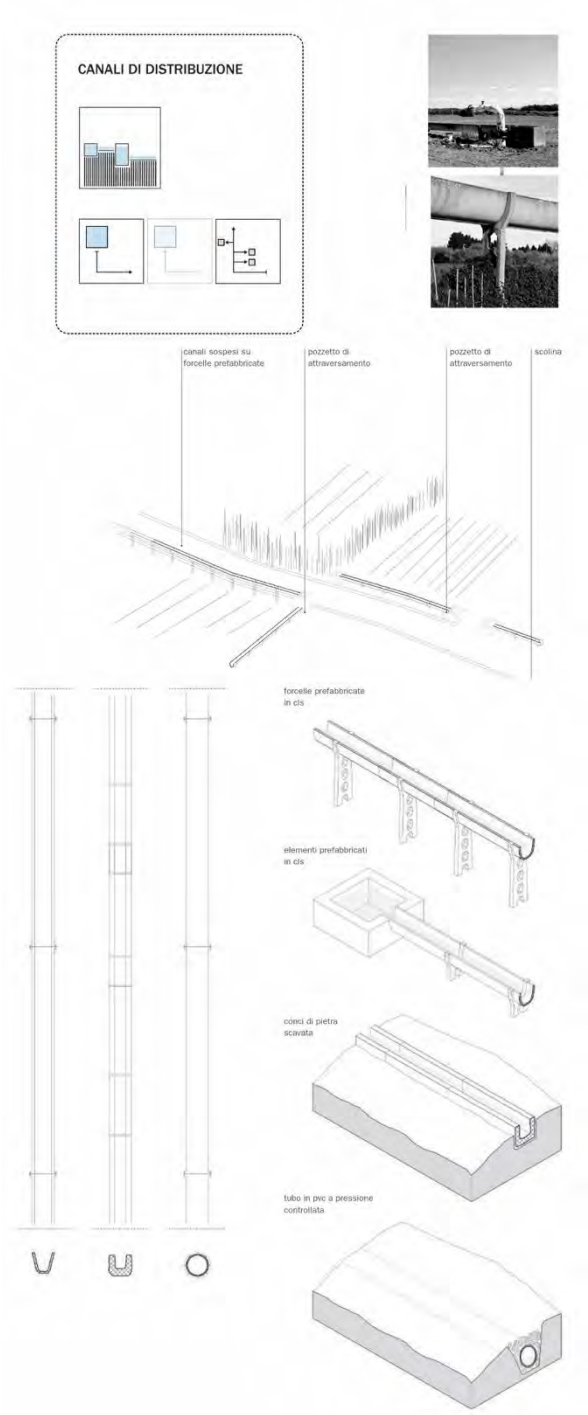


Figure 5. The different type of channel and the logic of water distribution

Exposure to prevailing winds, the sun, and the water cycle represent important resources, but also threats, for an architecture that manages daily life and is characterized as a settlement primarily dedicated to primary production or initial transformation.
The first of the principles of water management is that of conservation and the ability to retain and isolate a volume of water. Water harvesting is a primary activity and a necessary condition for settlement on a site. Water conservation is based on the ability to build water harvesting systems through the construction of surfaces or volumes with controlled permeability to allow accumulation. Terracing represents in this one of the most intelligent and widely used construction techniques, which allows topographically complex areas to be made productive. This is based on the massiveness of the wall and the resistance to horizontal thrusts coming from the ground and the downward flowing water. The ability to capture water corresponds to the capacity to draw water from a spring. This ability represents one of the founding acts in the history of settlement and has led to the development of a wide variety of construction techniques. Water abstraction systems require a source. In the case of direct abstraction from a river, this was historically achieved by building slackening chambers in the watercourse and creating a system of channels that capture moving water. In contrast, the well captures water from a static source. Distribution represents the ability to control moving water through systems that contain the flow and regulate the flow rate. The movement and flow of the fluid are guaranteed by the properties of the materials used and the impermeability of the surfaces and elements that allow the distribution of the water. The traditional channel can be rudimentary, from the furrow in the ground to the use of excavated ashlars (Figure 5). The use of discrete elements has favoured the possibility of replacing some with others of similar size built with different materials and techniques. The canal represents a technique that spans time, its characteristics remaining substantially unchanged to the present day.

4. Matrix of actions

The persistence of water management principles constitutes the theoretical foundation on which the projects are based, and which act on eight main river courses in the region:
- The Coghinas river
- The Cedrino river
- The river Temo
- The river Tirso
- The Rio Mogoro
- The Flumini Mannu
- The Rio Cixerri
- The Rio Flumendosa.

The projects are summarised within a matrix that attempts to systematise the research. The projects are based on three fundamental concepts
- interpretation of the principles of water management
- processuality of the intervention
- flexibility of the devices[5].

The principles of water management make it possible to connect traditional techniques and territorial systems in a multi-scalar manner, reinterpreting the positional criteria of villages and their transformations together with the technologies that generated them. The intervention based on a network must act through a clear process that aims at a complex environmental restoration and recovery, both in purely technological terms and in terms of returning spaces to communities. The coordinated study of the risk and multifunctional dynamics of the agro environment represents an interesting challenge to study the flexibility of the architectures and devices used. The minimum device, in fact, does not only become a technical element, but a support for flexibility, which avoids rigid and definitive solutions and, quoting Branzi, favours reversible, incomplete, imperfect devices, which allow the inhabited space to continuously adapt to new, unplanned and unplanned activities.

The project guidelines are summarized in an abacus-like matrix that indexes the project's critical issues, spaces, techniques, and actions. Building a "toolbox" for climate change planning becomes essential through a detailed illustration of the individual operations and their impact on the territory.

The combination of the different elements of the matrix constitutes the project control system for the different thematic areas. In this sense, we attempt to reflect specifically on each individual portion of the territory, proposing diversified approaches that are integrated within a single design logic, consistent with water management principles.

This is a series of approaches that designers can adopt with respect to water and site conditions; each design strategy combines one or more operational tools capable of measuring the change and activating a system for monitoring, enhancing, or otherwise affecting a resource. The broad spectrum of potential options underscores the capacity to tackle multifaceted issues from diverse perspectives, a necessity for any project. This flexibility is a crucial aspect for the success of any project. In contradistinction to other categories, it proves challenging to define a finite number of actions that must be evaluated on a case-by-case basis and that depend directly on the relationship between critical issues, locations, and spaces. Consequently, the categories encompassed within the matrix allude to broad themes that can be elaborated in detail during the design phase:

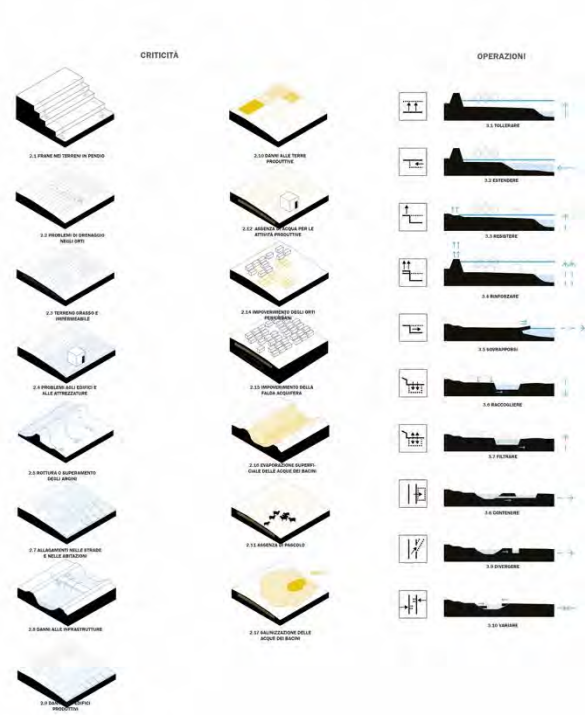


Figure 6a. The matrix of interventions analyses the relationship between climate change and forms of action.

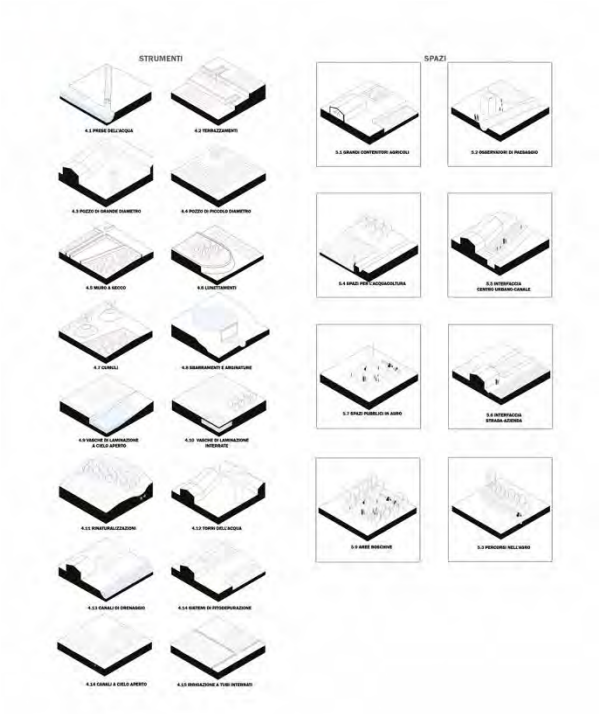


Figure 6b. The second part of the matrix shows the relationship between techniques and rural spaces.

- Tolerate
- Extend
- Overlap
- Resist
- Reinforce
- Diverge
- Contain
- Filter
- Vary
- Modify

The operational framework necessarily works together with a set of pre-ordained tools and is not to be thought of as the exclusive resolution of a given critical issue, but as a guide to the choice of tools for defining spaces. The relationship between actions and spaces can be read through the principles of water management, and thus towards a focus on the practices that tradition has put in place to resolve certain needs. Hardly a project can be solved with a single action, the ability to combine actions is an essential tool for the construction of quality spaces, and in this technology has the role of managing two fundamental nodes, namely the relationship with the water resource, reading its rhythms and modifications, and on the other hand understanding the degrees of modifiability of the soil, and the material relationships between the parts. To do this, the tools can structure and define actions through devices capable of activating the process. Articulating and managing nodes means refining the tools that control multiscalar transformations (Figure 6a-6b).

5. Persistences

The contemporary challenges posed by complexity necessitate the development and implementation of novel methodologies to address these issues. The cultural and scientific discourse on climate change has recently undergone a marked intensification, with a significant surge in the pursuit of novel eco-practices. These eco-practices are designed to respond more efficiently to the requisite performance criteria, using eco-materials and eco-techniques that optimise the conservation of resources. Furthermore, these eco-techniques encompass the use of certain coefficients to enhance the regulation of the relationship between form and surface of a building. In contrast to this productivist approach, the objective is to furnish an operational and meta-designing tool, which endeavours to demonstrate how the principles of historical-traditional techniques can continue to serve as valid tools on which to graft contemporary architectural design. Land use, water consumption and energy consumption are critical elements of the contemporary world that place architects before an important ethical responsibility, starting with the construction of architecture and landscape [6]. The analysis and reinterpretation of historical landscapes and their forms of persistence has the potential to inform a conscious project on the existing. The focus is not on a mathematical formula, but rather on demonstrating the character of innovation that has been preserved and maintained over time. The objective is to interpret this innovation using contemporary tools to construct a new sense of responsibility.

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LANDSCAPE AND ECONOMY: THE VICIOUS CYCLE - AN INFERNAL COUPLE PUTTING HUMANITY'S FUTURE AT STAKE

TOPIC: Guiding territories by changing the design of regional projects: tools for reinventing territories in situations of risk and environmental change

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Abstract

Economy and landscape have been closely intertwined since the dawn of humanity, but this has not been well researched. The discipline of landscape economics is relatively new. In fact, landscape transformation is driven by economic development, and economic investment adds value (negative or positive) to the landscape. In this sense, the investment in the "artificialisation" of the landscape area depends a lot on how the return on investment and the business model are developed. As our current business model is carbon intensive, based on burning fossil fuels and coal derivatives, it automatically and inevitably leads to intense and irreversible pressure on land, climate and environment through the creation of grey infrastructure, buildings, roads and more. Within this business model, the originally high landscape values become irrelevant as soon as they are artificialised, and landscape interventions are often relegated to the role of "beauty maker". The current degrowth debate is only one aspect of this new awareness and demonstrate the wicked problems which humanity is facing currently.
For example, EU28 land consumption reached 539 km2/year between 2012 and 2018. The main drivers over the period 2000-2018 were industrial and commercial land use, as well as the expansion of residential areas and construction sites (EEA 2019). Europe's urbanisation rate is expected to increase from 74% today to around 84% in 2050 (EU 2020). The EU population is ageing dramatically and is projected to fall to just 4.1% of the world total by the end of the century. On the other hand, migration has become increasingly important to sustain the economy (EPRS 2019). At the same time, urbanisation goes hand in hand with the growing socio-economic benefits that many Europeans have only recently been able to enjoy: better housing, more job opportunities and a better quality of life.

Urban and peri-urban land is scarce, so battles over land use and ownership are in full swing. In and around cities, we need space for climate adaptation, water retention, biodiversity, affordable housing, sustainable transport, social integration, food production - with a forward-looking approach that considers the ideas and needs of future generations that we cannot foresee or predict today. These wicked sustainability challenges have already proven intractable to business-as-usual solutions, especially in the short-term context of political elections and sectoral policies.

It is time to think “landscape first” and change the business model of urban and peri-urban land use. This paper explores the current debate on the landscape economy, identifies possible new ways of changing the paradigm, and shows how this approach could be implemented in relation to other business models, in particular the degrowth landscape model. Our Erasmus project TELOS[1] developed this approach.

1. Introduction

This article discusses a general trend that can be observed all over the world, not only in European landscapes. It elaborates on the pressing problems of our daily lives and how systems thinking can solve the challenges facing humanity. Every day, landscapes are being transformed – we talk about the 'artificialisation of natural soils', 'urbanisation and urban sprawl', 'urban creation' and even 'landscape creation'. Every day, we observe land being considered a 'cheap resource' for urban extensions, new projects and infrastructure. There is also a general acknowledgement that new infrastructure (e.g. roads and bridges) can 'create' jobs and economic growth, which is economically nonsensical, and that this infrastructure needs to be funded to fuel additional growth. Consequently, landscape transformations are driven by economic development, and economic investment adds positive or negative value to the landscape, influencing the return on investment.

It is also true that our current business model is based on the intensive use of carbon sources and minerals derived from the burning of fossil fuels and coal, which will lead to unbelievable costs for humanity. This is putting intense and irreversible pressure on land, the climate and the environment. I would describe the connection between landscapes as resources and economic development as a vicious cycle.

2. The relationship Landscape & Economy

2.1 Why are we talking about landscape economy?

The landscape economy is the interconnected relationship between economic activities and the natural and human-made environment. It encompasses how economic factors influence, and are influenced by, the landscape, including natural resources, infrastructure and human settlements. It also considers the economic value of landscapes, taking into account both tangible aspects, such as resource extraction, and intangible aspects, such as aesthetics and recreation. The landscape economy focuses on the availability and management of natural resources (such as minerals, forests and water), which are crucial for many economic activities and shape the landscape. It also applies to different economic sectors, such as agriculture, mining, manufacturing and tourism, which create distinct landscape patterns. Roads, buildings and other infrastructure are essential for economic activity, but they also transform the landscape. Landscapes have economic value in terms of resource extraction and through cultural, recreational and aesthetic benefits.

Consider tourism, for example. A beautiful landscape can attract tourists, which boosts the local economy through hotels, restaurants and related businesses. In agriculture, farming practices shape the landscape, and the type of farming (e.g. intensive vs. organic) can have different environmental impacts. Regarding urban development, the way cities and towns are built and expand affects the surrounding landscape and its resources.

The landscape economy is therefore not restricted to any specific discipline. We all live and work in and with landscapes, and we do so through an economic system. The landscape economy must be understood as a means of defining the boundaries, elements and dynamics of a system within a specific territorial context. The study of landscape economy draws on various disciplines, including economics, geography, ecology and urban planning, to understand the complex relationships between economic activities and the environment.

The Planetary Boundaries Framework highlights the increasing risks posed by human activity to nine critical global processes that regulate the stability and resilience of the Earth[2] (Stockholm Resilience Centre, 2023). By excavating this intense relationship between landscape and economy, we are heading in the wrong direction with regard to managing our planetary boundaries.

2.2 European Cities and their economic development

The new European Commission 2025 identifies cities as the economic engines of the European Union, responsible for 85% of GDP and 75% of employment. Cities are dynamic and competitive places where innovation and technological advancement happen due to the proximity of stakeholders and multidisciplinary interaction. However, cities are also responsible for around 80% of global greenhouse gas emissions. They are therefore key contributors to climate change and increasingly affected by its negative impacts, such as heat island effects. The sectors reported to be most impacted by climate change in urban areas are water, buildings, health and transport.

2.3 Landscape as an Economic Framework

The term 'landscape' is used in many different contexts and can therefore be interpreted in various ways. To understand the process, we must follow the definition set out in the Council of Europe's Landscape Convention[3]: 'Landscape means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors' (ELC, 2000, Article 1). These areas

can be natural, rural, urban or peri-urban. They include land, inland water and marine areas. This definition encompasses landscapes that may be considered exceptional, as well as everyday or degraded landscapes (ELC, 2000, Article 2). Public spaces, recreation areas, parks, roads, streets, brownfield sites, forests, rivers, coastlines and agricultural land are all considered part of the landscape. Therefore, the concept includes the city as a whole. Indeed, a city is merely a specific type of landscape. It is important to recognise that the concept of landscape implies an understanding of how elements are interconnected. A landscape is a system in which natural and human elements are constantly present and interacting with each other. Therefore, landscape encompasses both the concrete natural and human elements of which it is composed. It is also the interpretation of these elements, both individually and collectively. As described by Ipsen[4] (2006), landscape concepts evolve at the intersection of nature, human land use, and the social and cultural values of society.
People judge objects, such as landscapes, according to a specific and interrelated set of values, known as a 'value system'. This value system forms the basis of our preferences and judgements and thus determines individual preferences of understanding of landscape quality. In fact, the system of quality criteria should reflect the collective value system of the groups in society for which it is intended. The quality of the landscape must be optimised. Only then can the development of a landscape be guided in a way that serves society's needs.

The key reference of a regenerative economy is landscape carrying capacity. The transgression of the planetary boundaries on a global scale is the sum of all local and regional landscape capacity transgressions. Landscapes are where we source our food, energy, raw materials, water and other consumables, and where much of our waste ends up. Therefore, we can conclude that any landscape has only a limited carrying capacity. Human-centred functions operate within this capacity. However, future landscape capacity will be further reduced by the effects of global driving forces, such as climate change, biodiversity decline and pollution.

Entering the concept of frugal innovation. Despite research indicating unavoidable and devastating futures for societies worldwide, collective and radical systems change is limited in its global application. Rather than our leaders spearheading collective action between multiple actors, across paradigms and at various levels, we fall back on quick techno-fixes. We look for ways to edit and improve our existing systems, finding new, innovative ways to reduce our reliance on resources. Enter sustainability transitions. Ecological protection meets new economic prosperity meets revamped social justice. Over the past decade, growing urgency in this interdisciplinary field has given rise to numerous new strategies for addressing the challenges of our modern world[5] (Swiling, 2019). The circular economy shows great promise in reducing our dependence on resources, renewable energies could transform the way we power our lives, and changing social practices could help save polar bears, one bamboo toothbrush at a time. We have become adept at identifying the misdeeds of the not-so-distant past: extractive industries, fossil fuels, overconsumption, fast fashion, the ultra-rich and their private jets, tax evaders, and so on.

As discussed in relation to the work of Timothée Parrique, frugality and sobriety are concepts that emphasise living with less and being mindful of resource consumption, often within the context of degrowth and societal transformation. Parrique's work, particularly his book "Ralentir ou périr, L'économie de la décroissance"[6] (Slow Down or Perish: The Degrowth Economy), advocates shifting away from a growth-dependent economy towards a more sustainable and equitable society.

In this context, frugality involves reducing consumption and waste, making conscious choices about what is truly needed and finding satisfaction in simpler living. Frugality can also be connected to the broader concept of degrowth, which challenges the idea that economic growth is necessary or even desirable, particularly given ecological and social limitations. Consequently, frugality should not come at the expense of social or ecological justice. It's about finding a sense of 'enoughness' — a balance between meeting needs and avoiding excess. Sobriety, on the other hand, can be interpreted as a state of moderation and self-restraint, particularly with regard to consumption and desires. It's about being mindful of one's impact and avoiding overconsumption and consequently challenging the 'myth of growth' and critically examining the cultural and economic systems that promote endless consumption.
The key argument is that the current economic system, which is based on endless growth, is unsustainable in the face of ecological limits. A degrowth economy, based on frugality and sobriety, could be fairer and more equitable, tackling issues of poverty and inequality. Therefore, we need to re-evaluate

what constitutes a 'good life', moving beyond material possessions and embracing simpler, more meaningful ways of living.

3. Landscape Economy and Systems Thinking

As explained above, landscape is a container for various natural and human systems. It provides these systems with context and territoriality. These systems then become observable in terms of their physical and structural impact, as well as their responsibility and accountability. This helps us navigate the complexities of sustainable development. In this sense, landscape is not just a theoretical concept, but also a practical method.

Landscapes can be understood as dynamic assemblages shaped by diverse human and non-human actors. This brings us close to an important theoretical direction of systems-thinking: actor-network theory (ANT), developed by sociologists such as Michel Callon, Madeleine Akrich, Bruno Latour and John Law[7]. ANT encourages us to view landscapes not just as physical spaces, but as networks of interacting entities, including environmental elements such as soil, water, flora and fauna, as well as social elements such as communities, organisations, industries and policies. Recognising these as interconnected enables planners, designers and other stakeholders to consider a broader range of perspectives and dependencies, thereby increasing the likelihood of achieving holistic, sustainable outcomes and innovation towards regenerative systems.
A systemic approach seems particularly necessary when addressing the so-called 'wicked problems' of our time. Designing and leading the transition from the present state to a regenerative landscape economy involves tackling multiple such problems. Rittel and Webber described the characteristics of such problems in their seminal 1974 article, 'Dilemmas in a General Theory of Planning'[8]

According to this crucial article, we can understand wicked problems by considering the following ten main characteristics:

1. There is no clear definition of a 'wicked problem'. Wicked problems have no stopping rule. There is only a constant process of understanding.
2. Solutions to wicked problems are not true or false.
3. Solutions to wicked problems are not true or false, but good or bad.
4. There is no immediate or ultimate test for solutions to wicked problems.
5. Every solution to a wicked problem is a 'one-shot operation', because there is no opportunity to learn through trial and error; every attempt is significant.
6. Wicked problems do not have a finite set of solutions, nor is there a well-described set of possible operations that can be incorporated into a plan.
7. Every wicked problem is essentially unique.
8. Every wicked problem can be considered a symptom of another problem.
9. A discrepancy representing a wicked problem can be explained in numerous ways. The chosen explanation determines the nature of the resolution.
10. The planner has no right to be wrong. The aim is not to find the truth, but to improve the characteristics of the world in which people live. (Ellen Fetzer, Didier Vancutsem - TELOS Project – *Landscape Economy*)



Figure 1. TELOS Brainstorming process systems-thinking

We can therefore conclude that each wicked problem is a system in its own right, which is why a systems-based approach is required to address them.

4. Conclusion

In conclusion, we can state the following: the economy is a key factor in our decision-making. It influences both what we choose as individuals and broader societal trends. As the world becomes more complicated, the economy is the main aspect that causes big changes in the way things are. From how we develop cities, landscapes to how we make rural areas better, money is the thing that decides

how we interact with and change our environments. The wicked problems of our humanity business model need to be addressed by using sobriety and frugality principles – circular landscape economy should be the "Landscape First" approach.

To really understand these changes, we need to see the landscape as a system made up of different natural, social and economic parts that are always changing. This is because it helps us understand the important connections that shape our landscapes and economies. As people become more interested in sustainability and the environment, the relationship between the economy and the landscape is more important than ever.

We also need to make sure that future landscape architects are ready for these changing challenges. We can help the next generation of professionals to design landscapes that are economically sustainable, resilient and ecologically sound. This is important if we want to create landscapes that show how our economies and environments are connected.

The Landscape Economy topic has been developed within the EU funded project TELOS: Towards a European Landscape Economy for a Sustainable Urban Development (https://telos.hfwu.de/index.php?title=Main_Page) in 2024; objectives of the Erasmus project were to develop the first Landscape Economy curriculum by which learners can deeply immerse in the theories, dialectics and methodologies associated with these emerging concepts; to build capacity among university teachers, enabling them to successfully implement interdisciplinary and transformative learning settings; to build up key competences for sustainable urban development; to create and share knowledge, by documenting TELOS methodology as an open educational resource and to disseminate the TELOS curriculum and methodology as widely as possible.



Figure 2. TELOS – Erasmus Project

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IFLA 2025

GUIDING TREE MIGRATION FOR CLIMATE CRISIS ADAPTATION: NATIVE AND ADAPTIVE TREE PLANTING IN RURAL TERRITORIES

TOPIC: Guiding territories by changing the design of regional projects: tools for reinventing territories in situations of risk and environmental change

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Keywords: planting, tree migration, climate adaptation, human assistance, native species

Abstract

Loss of trees, woodlands, and larger forests is a growing local and worldwide issue. The multiple climate benefits of trees are widely known, ranging from air quality improvement and temperature reduction to carbon sequestration. In response to urban tree loss and to address climate justice, Landscape Architects have collaborated with urban communities and leaders to increase the number of city trees for greener streets and parks and recently to add small woodlands to new local parks to ameliorate climate and biodiversity pressures. In parallel actions, rural areas of the territory with established woodlands require professional and community attention to conservation, management and even enlargement to expand native trees and shrubs. This paper shares territorial tree planting at two sites to augment woodlands and increase tree and allée plantings.

In response to the climate and biodiversity emergencies, adaptive management of tree plantings requires human assistance to accelerate natural tree species migration by selecting dependable local native trees and to advance testing of potentially adaptable species from beyond the local range. This additional planting seeks to test enhanced resilience to climate changes. As specific native species decline, due to historic or current pests, diseases or from severe weather exacerbated by climate stress, human agency in tree planting offers an opportunity to augment the species palette more quickly than these more distant native trees can migrate on their own.

In this paper tree planting projects on a conserved historic property and a privately owned landscape offer updates on adapting new tree plantings in response to the interrelated climate and biodiversity crises. Tree selection and planting responds to these crises in the project examples at two territorial locations in Vermont, USA, a relatively rural state with low population densities.

Vermont is located in the northeastern or New England portion of the United States and has a land area includes 9,616 square miles (24,906 square kilometers). Pinpointing the location on Planet Earth, the latitude of Vermont, USA is 44.000000, and the longitude is -72.699997 and global positioning system (GPS) coordinates of 44° 0' 0.0000" N and 72° 41' 59.9892" W.

From 1999 to present, Heritage Landscapes and Broad Reach Farm carried out planting projects in Charlotte and Shelburne, Vermont, of the northeastern United States, planting dependable local native trees and initiating human assisted tree migration testing of specific native species with a good likelihood of success. Several migrated species are observed as performing well in the early years after planting.

While these projects are relatively recent, preliminary findings offer hope for augmenting shrinking native tree planting palettes that thoughtfully respond to current pressures by shaping projects with durable native trees from the region and augmenting new plantings with potentially resilient native trees from farther away.

Abenaki peoples of several tribal groups are recognized as the indigenous peoples of Vermont that remain today while other tribes also populated these lands through the past 10,000 years. The authors recognize that we inhabit the traditional lands of those former and living peoples and offer their respect.

Context and Location

Water features demarcate two boundaries of the state of Vermont with the Connecticut River forming the eastern border with the state of New Hampshire and Lake Champlain extending along much of the western margin with New York State. The international border with Quebec, Canada defines the northern edge and the border with the Commonwealth of Massachusetts forms the southern margin. Five physiographic regions define the hills and valleys of Vermont with 1) Green Mountains, which are part of the Appalachian Range; 2) Champlain Lowlands; 3) Northeastern Highlands; 4) Taconic Mountains; and 5) Vermont Piedmont. Statistics characterize the diverse topography and geology of Vermont. About 7,100 miles (11,426 km) of rivers flow through the landscape, often feeding more than 800 lakes of varied sizes, while deciduous and coniferous forests cover much of the generally north-south oriented mountain ranges.

The tree planting, climate adaptation projects addressed in this paper take place in the Champlain Lowlands region. Over the past 20 years, in parallel with other regions, the United States Department of Agriculture (USDA) plant hardiness zones map for Vermont has changed, shifting the Champlain Lowlands from zone 4b to zone 5a and b, for a gain of up to 15 degrees Fahrenheit (9.4 C).[1] This shift is accompanied by a change in frost free date that is 19 days earlier in the spring. These updated schedules express recent climate changes to annual weather patterns. In addition, frequency of extreme weather events in this region of the northeastern USA is increasing with greater incidents of high winds, heavy fast rainfall, floods, extreme heat, drought, and more.

While historical data demonstrates trees migrated as North American glacial ice receded, 12,000 years ago, tree range expansion required hundreds of years to achieve broader distribution. Documentation of anthropogenic long-distance distribution of selected tree species during this time reveals a role of people in plant colonization.[2] The rapid timeline of contemporary climate change mandates that humans assist selected native trees to expand their range as climate change and biodiversity loss accelerate. With increasing disease and pest vectors eliminating previously dependable native trees from planting selections, resilient adaptable native trees from milder climate areas can regenerate and augment the needed tree canopy enrichment. Progress in human-assisted, climate-adaptation-led tree plantings is possible when a conceptual approach to adaptation is defined through active planting projects that select potentially resilient native trees species from both within and beyond the local region.

Forest Tree Migration

Human agency can overcome land use barriers for tree migration over disconnected pathways and corridors fragmented by human settlements, industries, farms and other intensive land uses as well as mitigate barriers of pollution and land degradation. Each blockage to movement presents an issue that must be addressed at the project site and locally.

Consideration of the climate change effects on trees recognizes that individual tree species respond differently. Alexandra Kosiba, author of "Future Climate-Adapted Tree Species," notes that native trees in some locations will decline, while others adapt due to the multiple vectors of weather vagaries, pests and pathogens.[3] As the climate continues to shift, the woodland communities will change. With accelerated loss of species, can gaps be filled and woodlands expanded by incorporating new species? Tree populations are constantly on the move, but with rapid change, they cannot adapt quickly enough. The replacement and new tree selection process considers, as one factor, habitat range contraction to the warming side and expansion to the cooling side, which in Vermont would generally produce less range to the south and more to the north.

Many questions require attention to target human agency in managing trees, woodlands and forests

into a climate adapted future. Emphasis on the health of trees and woodland communities raises a question about the abilities of a woodland to adapt its species composition without assistance. Evidence indicates that trees from farther south in the USA cannot move far enough and fast enough through wildlife, air and water movement of nuts and seeds. Trees must be aided by humans to advance quickly.

For the northeast region of the USA, foresters define four groups of native trees: 1. trees with habitat ranges farther to the north; 2. trees centered in this habitat range; 3. trees with ranges further south; 4. Trees native to the warmer Mid-Atlantic US region that do not extend into this range today.[3] Groups 2, 3 and 4 offer potential climate adaptative trees to be trialed and observed.

Vermont Trees and Climate Adaptation

Investigating the potential response of trees to Vermont climate change employed study of the USDA Climate Change Atlas tree tables for this small but diverse state landscape, reveals probability projections for 91 trees.[4] Three locally rare native trees: bitternut hickory (Carya cordiformis): silver maple (Acer saccharinum); and white oak (Quercus alba) were included in plantings discussed in this paper.

The Vermont chart shows 23 trees judged as highly adaptable to climate vagaries with seven considered as migrants to new habitat used in the example planting projects to include:

- hackberry (Celtis occidentalis)
- common persimmon (Diospyros virginiana)
- honeylocust (Gleditsia triacanthos)
- yellow-poplar or tulip tree (Liriodendron tulipifera)
- Osage-orange (Maclura pomifera)
- blackgum, tupelo (Nyssa sylvatica)
- northern pin oak (Quercus ellipsoidalis)

Six more migrant trees, indicated at lower levels of adaptability in moving to new habitat, were also chosen for testing, to include:

- pawpaw (Asimina triloba)
- pignut hickory (Carya glabra)
- eastern redbud (Cercis canadensis)
- flowering dogwood (Cornus florida)
- sweetgum (Liquidambar styraciflua)
- sassafras (Sassafras albidum)

In addition, some currently present native trees, noted as medium and low climate adaptability still held a place in planting lists based on the authors' experience and observations across this region.

Project Approach

Learning from climate change adaptation in woodland and tree management literature and practices, the example projects considered future-adapted tree species based on native species and current hardiness climate range in relation to the project sites in the Champlain Lowlands. Project teams also factored in all known disease and pest vectors to reduce vulnerability. Relevant additional factors included young native tree availability, cost per tree and the carbon footprint of transportation.

The native tree groups noted earlier provided a focus for the climate adaptable tree selection process. These included potential trees: centered in this range with wide areas warmer (south) and cooler (north) - Group 2; ranging both here and warmer areas farther south, often of limited local abundance - Group 3; and trees currently located further south but potentially adaptable to on-site conditions of climate shift - Group 4. Plantings sought to augment native trees in woodland expansions, tree rows along drives, a new silvo-pasture grove, as well as individual trees and clusters in open areas. Each project employed a predominance of hardy native trees thriving around or near the planting sites while climate adaptable trees augmented that list.

Historic documentation and on-site observations informed project development, tree selection, site design and implementation. Study of chronological mapping and aerial images provided a basis for an historical understanding of trees present and lost. Parallel observations of the vigor of native tree species on the project sites initiated the development of potential trees lists. Native trees centered in this climate zone but rare locally offered variety to augment new plantings.

These efforts also acknowledged recent extreme weather events, rising average temperature and native tree pests and pathogens. Trees from this region and farther south with active pests and diseases were not planted in these projects. For example, native oak species have relatively large ranges. However, the red oak group, currently experiencing several stresses from pests and

diseases, was substituted with the less susceptible white oak group species including white oak (Quercus alba), bur oak (Quercus macrocarpa), and Swamp white oak (Quercus bicolor) on planting lists.

The trees species with typical growing ranges to the south, generally inhabiting warmer areas, were selected for migration north in trial plantings. These trees, commonly found in the US Mid-Atlantic region were planted to test the potential of Vermont's Champlain Lowlands as suitable habitat.

New Trees for Shelburne Farms

At Shelburne Farms, a 1,400 acre (5.7 km) National Landmark historic property, the project team initiated topical research, historic documentation and a landscape planning overview report. As an ironic aspect of preservation in historic living landscapes, new plantings need to adapt to changes in the environment rather than simply replace historic trees, allées or groves. Over 25 years, Charlotte, Vermont and Norwalk, Connecticut based Heritage Landscapes LLC, Landscape Architects and Planners, of have documented the 1800s-1940s landscape, identified vegetation change, prepared restoration plans and carried out projects to plant new trees. For example, comparing the 1942 aerial photograph to the existing trees remaining yielded an inventory itemizing 243 historic trees present and 89 current ones, a loss of 63 percent over 66 years (Figure 1).

Historical plantings along drives favored a monoculture of American elm (Ulmus americana), which Dutch Elm Disease (DED) decimated in the late 1960s and early 1970s. With few elms remaining, a 2004 Landscape Stewardship Plan recommended planting disease resistant elms in specific historic locations.[5] In 2008 the current entry trees, of invasive Norway maple (Acer platanoides), were removed as 22 disease resistant Princeton elm nativars, a selection from Princeton University that survived the blight, were planted in their historic locations. These young elm trees were well cared for but wild elm regeneration in the adjacent woods infected the closest new trees with DED by 2016 as they reached about 15 years of age, the same age that native trees succumb to DED. Disease resistant elms remain susceptible if infections are nearby. Immediate discussion focused on selection for replacement and choose native sycamore (Platanus occidentalis). Heritage Landscapes directed new plantings alternating with remaining Princeton elms, in 2019. Climate vagaries, in particular wet spring weather, have tested the vigor of the new sycamore allée with these 22 trees struggling over six years. After three replacements in spring, the allee of sycamore finally appear to be thriving in the summer 2025.

DED also devasted the Elm Swamp and white ash (Fraxinus pennsylvanica) naturally repopulated the area during the late 20th century. With the recent threat of invasive emerald ash borer (EAB) nearby, Shelburne Farms planted a group of 18 native and migrant climate adaptive trees at and near Elm Swamp in 2022. By 2025, the migrant tupelo (Nyssa sylvativa) and tulip tree (Liriodendron tulipfera) as well as the native but rare silver maple (Acer saccharinum) exhibit strong growth.

An award-winning Brown Swiss cattle herd, that yields excellent milk for cheddar cheese, pasture at Shelburne Farms as one component of sustainable agriculture. To enhance resilient land management and animal husbandry, planting pasture-adapted shade trees combats rising temperatures with partial shade. Pasturing within forty percent part shade benefits the grazing animals by lowering temperatures and improving forage, while carbon is sequestered in the soil and vegetation. Shelburne Farms carried out the silvo-pasture demonstration in 2023 as a climate action initiative for animal health.

This shaded pasture employed 40 trees that could thrive in a relatively wet site, adapt to grazing and provide open shade. Trees for pasture adaptation included red maple (Acer rubrum), smooth alder (Alnus serrulata), black locust (Robinia pseudoacacia), thornless honey locust (Gledistsia triacanthos inermis), river birch (Betula nigra), American linden (Tilia americana) and quaking aspen (Populus tremuloides). The honey locust, not found in this region, is migrant from slightly warmer areas nearby. Smooth alder, quaking aspen and river birch are widespread and generally adaptable, but not common at Shelburne Farms.

The Marshall Woods planting in 2024 and 2025 adds a three-acre (12,140 m^2) woodland in a pasture carved out of earlier woodland. The species list drew on the surrounding forest and added infrequent native and migrant southern species. Shelburne Farms planted some 300 new trees and woodland understory shrubs as the initial steps towards creating Marshall Woods.

The evidence amassing as these projects mature offers useful details of both failures and successes

in adapting this historic public property to the climate and biodiversity crises.

New Trees for Broad Reach Farm

Positioned on Lake Road under one mile from the shore of Lake Champaign, Broad Reach Farm, is a property of fields and woodlands covering 144 acres (58.25 He) owned and managed by two of the authors. Planting experiments at this location have included the testing of individual trees and woodland reforestation using trees with native ranges further south and trees native to the warmer Mid-Atlantic region that do not extend into the northeast today.

The trial planting in 2000 of two native trees from farther south: tulip tree (Liriodendron tulipfera); and redbud (Cercis canadensis) initiated a test of shifting species from southern hardiness zones at Broad Reach Farm. In early years both plantings failed to thrive; however, they have demonstrated faster growth rates and exhibited improved health since 2015.

Trial planting at this project site has continued for 25 years with native trees, nativars (selected cultivars of native trees), and trees that are non-native to the USA yet non-invasive. Some 2,500 trees have been planted over these years of variable sizes and survival rates. This summary focuses on native trees and tree migration.

Since 2000, planting of new tree and shrub species has tested the boundaries of hardiness zones with migrant plants from warmer areas and with native not found here. Trials involved multiple native species not associated with the Champlain Lowlands region including:

- White fir (Abies concolor)
- pawpaw (Asimina triloba)
- American chestnut (Castanea dentata)
- fringe tree (Chionanthus virginicus)
- yellowwood (Cladrastis kentukea)
- flowering dogwood (Cornus florida)
- downy hawthorn (Crataegus mollis)
- common persimmon (Diospyros virginiana)
- Osage-orange (Maclura pomifera)
- Douglas-fir (Pseudotsuga menziesii)
- chestnut oak (Quercus montana)
- willow oak (Quercus phellos)
- sassafras (Sassafras albidum)
- giant sequoia (Sequoiadendron giganteum)
- bald cypress (Taxodium distichum).

Other planted species include those growing elsewhere in the Champlain Lowlands but not currently growing near the project site:

- balsam fir (Abies balsamea)
- silver maple (Acer saccharinum)
- northern hackberry (Celtis occidentalis)
- cockspur hawthorn (Crataegus crusgalli)
- quaking aspen (Populus tremuloides)
- American elm (DED-resistant selections) (Ulmus americana ‘Valley Forge’ ‘Princeton’)

Of this list, the majority of trees proved adaptive to environmental conditions of Broad Reach Farm (BRF) and demonstrate vigor. Several species including sassafras, sequoia, and pawpaw, required multiple consecutive plantings before surviving through winter dormancy and into the second growing season. All plantings of willow oak, a potential climate migrant, have failed. The American elm DED nativar thrived for over ten years gaining size to a 12 inch (30.5 cm) DBH before succumbing to DED.

In 2024, planning for a large woodland expansion began at Broad Reach Farm. The area selected was the southeast corner of an existing hayfield that had not been exposed to any fertilizers or other soil modifiers for over 25 years. The field contained one large bur oak (Quercus macrocarpa) with a diameter at breast height of over 50 inches (127 cm). The adjacent wooded margin of the area consisted of heavy understory growth of invasive shrub species, primarily European buckthorn (Rhamnus cathartica) and Japanese honeysuckle (Lonicera japaonica) and also good stands of native grey dogwood (Cornus racemosa), with a canopy of predominately white and green ash (Fraxinus americana and F. pennsylvanica), and a few Eastern white pine (Pinus strobus), American elm (Ulmus americana), and black cherry (Prunus serotina).

Reforestation began with the removal of the invasive shrubs and the harvest of declining ash trees due to EAB infestation. Elm and cherry trees were retained. The BRF owners also evaluated the water table and took soil samples to analyze soil acidity or alkalinity, nutrients and composition during project planning. Results indicated that soils had a high clay content with a slight alkalinity and a very high late winter and spring water table.

The woodland planting reinforced native species found on or near the site, including:

- red maple (Acer rubrum),
- silver maple (Acer saccharinum)
- shadblow serviceberry (Amelanchier canadensis)
- Allegheny serviceberry (Amelanchier laevis)
- paper bark birch (Betula papyrifera)
- downy hawthorn (Crataegus mollis)
- hop hornbeam (Ostrya virginiana)
- quacking aspen (Populous tremuloides)
- American sycamore (Platanus occidentalis)
- swamp white oak (Quercus bicolor)
- bur oak (Quercus macrocarpa),
- American linden (Tillia americana).

Testing of climate adaptation for uncommon or non-local species included:

- balsam fir (Abies balsamea)
- bitternut hickory (Carya cordiformis)
- pignut hickory (Carya glabra)
- northern catalpa (Catalpa speciosa)
- common hackberry (Celtis occidentalis)
- redbud (Cercis canadensis)
- cockspur hawthorn (Crataegus crusgalli)
- sweet gum (Liquidamber styraciflua)
- tulip tree (Liriodendron tulipifera).
- sawtooth oak (Quercus muhlenbergi
- pin oak (Quercus palustris)

BRF owners sketched a layout of the trees on an aerial photo. They used it as a guide to lay out the tree locations in the field, adjusting as needed to match visible micro site conditions. The plant list included four to six specimens of each local natives, but just two or three of the native trees from warmer areas. There were 75 bare root trees with 1.00 to 1.75 in (2.5 to 4.5 cm) caliper, a few ball and burlap trees, and about 150 small whips and seedlings ranging from one to four feet (30 to 122 cm) tall.

The planting work began in mid-April of 2025. The high clay content became very evident as digging proceeded. Many of the holes filled to various levels with ground water. The situation triggered further layout refinement based on diverse species responses to the temporary inundation of the root zone.

Initial results show that the migrating species that are not now typically found in the region are doing well, while a few of the local natives demonstrate struggle and reduced vigor. This situation may be an issue of high ground water. Observations will continue as these newly planted trees settle in and grow through 2025. Deer proof fencing will be installed in the fall to protect trunks from antler rub and young branch tip eating and will also exclude rodents that can damage tree bark.

Conclusion

The demand for human assisted tree planting, including adaptation and migration, increases as the climate and biodiversity crises deepen. These efforts continue a longstanding practice of anthropogenic tree dispersal within the context of evolving ecologies. These projects provide useful evidence of carefully developed selection processes and initial outcomes to share learnings and advance this important work.



Figure 1. 1942 aerial photograph annotated with tree trunk dots shows 243 trees at that date, while parallel field study in 2008 identified only 89 remaining trees. Diagram by Heritage Landscapes.



Figure 2. Aerial photograph showing phase 1 Marshall Woods planting. Google Earth Pro, 2024-10-27, Eye Alt. 500m.



Figure 3.
View of woodland extension area at Broad Reach Farm with ash trunks in piles and planting in process, April 2025.

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Broad Reach Farm owners offer gratitude, respect and stewardship for the diverse landscape they share with more than human life.

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Emerging Landscape Architecture Pedagogies from the Global South: Addressing Climate Change in times of resilience

TOPIC: Guiding territories by changing the design of regional projects: tools for reinventing territories in situations of risk and environmental change

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Abstract

How can the integration of active learning methodologies in Landscape Architecture training address the challenges of climate change in vulnerable amphibian ecosystems in the Global South from an experiential perspective? This research explores the application of pedagogical strategies that merge ecological design, green infrastructure, and nature-based solutions within higher education. The study focuses on the Mallorquín swamp, an aquatic ecosystem modified by anthropogenic intervention in the Colombian Caribbean northern region. The degradation, pollution, and loss of biodiversity in mangrove forests require educational approaches that combine direct experience and critical reflection in the training of architects committed to sustainability and ecological resilience. Theoretical and empirical evidence shows that traditional teaching methods do not adequately respond to the complexity of climate change, which has led to the adoption of experiential learning practices, facilitating a comprehensive understanding of natural processes and fostering critical and creative thinking in urban and landscape architecture. During one academic semester, a qualitative study was conducted with undergraduate students in urban and landscape design, integrating experiential learning, service-learning, and project-based learning, creating spaces for direct interaction with communities and the environment. Participants conducted field observations, created visual narratives, and speculative urban scenarios, allowing them to identify territorial variables and define ecological restoration strategies by analyzing water dynamics and their influence on the configuration of the biocultural landscape. These activities fostered an understanding of local cultural identity linked to mangrove diversity, an essential element in the formation of guiding landscapes capable of responding to current and future environmental demands. The results indicate that immersive educational experiences in real-life contexts and the application of active learning methodologies strengthen competencies in environmental awareness, sustainable development, and skills to address the challenges of climate adaptation in amphibian ecosystems. It was found that contextual learning and direct contact with ecological reality enable the development of well-founded and coherent proposals, integrating the restoration of natural processes and the revaluation of local cultural identity. Furthermore, the training experience increased students' commitment to mangrove conservation, suggesting that the inclusion of environmental education in landscape architecture is crucial for building resilient and sustainable communities in the Colombian Caribbean. In conclusion, the findings highlight the importance of rethinking pedagogical models in the training of landscape architects, promoting an education that combines theory and practice in real-life settings. The integration of active learning methodologies and collaborative approaches is an effective tool for articulated responses to climate change, promoting the restoration of biocultural landscapes and the creation of sustainable cities. These methodological contributions have implications for the evolution of architectural teaching, guiding proposals in the fields of urban and landscape design, and offering perspectives that strengthen the commitment to biodiversity protection.

1. Introduction

The incessant impacts of climate change in the global south especially affect wetland and mangrove ecosystems where the alteration of hydrological and urban dynamics increasingly intensify habitat degradation (Watson, 2020)[1]. In the lower basin of the Magdalena River in the city of Barranquilla in the Colombian Caribbean, the Mallorquín swamp, with approximately 6.5 km2 and 1 mt deep, refuge of 4 species of mangroves (*Conocarpus erectus, Avicenia germinans, Laguncularia racemosa, and Rhizophora mangle)*, about +1929 species of birds, 45 ichthyic species, 8 species of reptiles, 7 species of mammals, 2 communities of inhabitants (La Playa and Las Flores), however, has been exposed to loss of its biodiversity due to urban sprawl, soil erosion due to contamination, and geomorphological transformations of the estuary system of the Rio Grande delta, affecting the eco-social dynamics of the territory and its relationship with nature. How do we address these challenges through diverse educational pedagogies? These vulnerable ecosystems demand that Landscape Architecture training in the Caribbean must transcend the traditional unidirectional models and foster cultural-place-based learning, and oriented towards climate resilience.

Experiential Learning (EL) and Project-Based Learning (PBL) re-emerged as effective pedagogical approaches in architectural education, merging theory and practice (Pak & Smet, 2022)[4]. These, immerse students in real contexts of ecological challenges, promoting awareness and action; also, Service-Learning (ApS) engages them in community restoration (Luo & Hsu, 2018)[3], while project-based assignments cultivate critical and creative thinking (Wróblewska & Okraszewska, 2020)[2]. Complementarily, Nature-Based Solutions (NBS) integrated with local cultural knowledge (LK) and ecological restoration strategies enable empowerment of biocultural landscapes and resilient territory management in highly vulnerable communities.

Despite global interest in structural changes in academic curricula, conventional teaching methodologies based on one-way transmission knowledge remain inadequate to address the multidimensional challenges of climate change in complex ecosystems (Stupar et al. 2017)[5]. This study investigates: ***How can active learning methodologies in Landscape Architecture training empower students to address climate challenges in vulnerable amphibian and mangrove ecosystems in the Caribbean?*** Therefore, the main objective is to analyze the characteristics of teaching methodologies used by a professor who addresses climate change to educate students in aware of the global crisis. Specifically, seeks to a) document pedagogical strategies used by a teacher in a semester course in the Mallorquín swamp; b) identify the development of climate competencies; and c) record the cultural-ecological commitment in the context of the community.

By showcasing how active place-based and culture-based methodologies foster climate competencies, this study contributes to strengthening the transformation of teaching methodologies in the Global South, informing academia and policymakers about the integration of field experiences and community engagement that train designers in climate and ecological literacy.

2. Materials and Methods

2.1 Research Methodology and Design.
This research employed a qualitative approach with a single-case study design to analyze active learning methodologies in Landscape Architecture education. The study was conducted over two sessions of a 16-week academic semester in an Urban and Landscape Design undergraduate program in the Colombian Caribbean. This methodology was chosen to capture the complexity and depth of pedagogical processes in real-world, place-based learning environments. As Pak and Smet (2022)[4] suggest, case studies provide crucial insight into how educational interventions unfold in specific ecological and cultural contexts.

2.2 Participants and context.
The object of study is a proffessor with a Master's degree in Sustainable Architecture and Landscape Design, who is in charge of the Urban and Landscape Design core studio course of the 6th semester of undergraduate architecture at a private school, where the Mallorquín swamp was chosen as the site of intervention, a coastal lagoon ecosystem (~2.5 km²) on the Colombian Caribbean region, once a lush amphibian and mangrove habitat, now experiencing environmental degradation and ecosystem loss due to anthropogenic factors, which have weakened its ecological resilience. Also, out of 14 students, 3 were selected for their academic performance and sustainability background. The course chosen as the object of the case study had

an intensity of 6 hours per week, and it was decided to select module II/IV, where topics of climate, landscape and nature-based solutions were developed.

2.3 Pedagogical Intervention and Data collection.
Over the 16-week semester, students took part in two 2-hour field immersion sessions at the lagoon site, providing direct experiential engagement with the local environment. They also participated in two service-learning workshops with community stakeholders, facilitating knowledge exchange and grounding the learning experience in real-world service. In parallel, a project-based assignment tasked student teams with developing design proposals for climate resilience at the site, synthesizing insights from the field immersions and workshops. Multiple qualitative data sources were collected for analysis. Three semi-structured interviews were conducted with the course instructor and two student representatives to gather in-depth reflections on the learning experience. Additionally, two non-participant observations (one field session and one workshop) documented student engagement and group dynamics.

2.4 Data Analysis.
Data were analyzed using thematic coding procedures based on Díaz (2009)[8] framework. An initial phase of open coding identified emergent categories related to pedagogy, skill development, and environmental awareness. Axial coding was used to establish relationships between these categories, with particular attention to how students integrated ecological and cultural knowledge into their design thinking. Trustworthiness was ensured through triangulation of interviews, observations, and student work. These measures contributed to the credibility and confirmability of the findings.

3. Results

3.1 Emerging Pedagogical Strategies.
For observation 1, the findings indicate that the professor employs various teaching-learning strategies to understand and generate solutions to climate change in her subject, closely connected to the Project-Based Learning (PBL) methodology specific to the architecture studio. Additionally, the main strategies from the categories studied that are most relevant and characterize her practice are *the connection to real-life contexts, guided exploration, project-based learning, fostering critical thinking (ideas), and Socratic discussion*, which emerge as the five most widely implemented strategies in the observation.
Similarly, based on observation 1, the analysis of macrocategories that group the most relevant categories in the study of strategies implemented by the professor reveals that the professor's implemented methodologies are characterized by and oriented toward *classroom participation and collaboration; the connection between knowledge, concepts, theory, and experience; the focus on design, ecosystems, landscape, and climate sustainability; The encouragement of analysis, critical discussion, and visual communication; critical thinking based on communication dynamics; and the processes and promotion of academic planning.*

For observation 2, the findings indicate that the professor employs various teaching-learning strategies, continuing to connect the Project-Based Learning (PBL) methodology specific to the architecture studio. Similarly, the main strategies from the categories studied that most closely characterize her practice are *the dynamics of the Architecture, Urbanism, and Landscape Studio, feedback-based assessment, interaction to expand responses to questions, guided discussion, and Socratic discussion, emerging* as the five most widely implemented strategies in the observation.
Additionally, in observation 2, the findings from the macro-category analyses indicate that the professor's methodologies are characterized by and oriented toward *fostering practical action in teams (based on the project, representation, and active collaboration); monitoring and feedback of the learning process; and promoting reasoning, critical thinking, and creative problem-solving; to questions, debate, and reflective analysis; to the implementation of sustainability theories in urban contexts in their course; and to the processes and promotion of academic planning in the classroom.*

Based on the triangulation of data from the observations, the findings indicate that the instructor's methodology is characterized largely by the ***Integration and Contextualization of Knowledge (IC)***, with specific strategies such as linking real-life contexts, explaining disciplinary topics related to climate and landscape, linking knowledge and course learning objectives, as well as the use of everyday shared knowledge and transdisciplinary climate and ecosystem knowledge. In addition, ***Formative Assessment and Comprehensive Feedback (FCF)*** is used with specific strategies such as Feedback-based Assessment, interaction to expand responses to questions, positive constructive feedback, hetero-

assessment, the use of rubrics, self-assessment, and peer-assessment.

3.1.1. Methodological Strategies for Climate Change - Teacher Interview.
Based on the strategies analyzed in the teacher interview, these findings indicate that the teacher articulates various methodologies that facilitate the understanding of climate change knowledge. First, the teacher establishes a ***Prior Conceptual Foundation (PF)*** to ensure that students understand the climate foundations before the field experience. Then, she implements ***Experiential Learning (EL)***, organizing field trips to the study site, such as the La Playa district, during two key moments: the drought and the flooding, to verify water dynamics with the students, who build their knowledge from their experience. To this educational experience, she adds ***Contextual Learning (CL)***, which integrates the physical, social, and environmental surroundings into the analysis and development of the current project. Likewise, it introduces ***Ecological and Landscape Learning (ELL)***, with a vital focus on natural variables such as temperature, humidity, soil, and water, and their relationship to urban design. Finally, it promotes ***Collaborative Interdisciplinary Learning (CIL)*** by forming groups of students with specialist roles in different areas such as mobility, ecology and landscape, social aspects, and others, to enrich the solution to complex problems such as climate change. In this framework, the intentionality is evident in the emphasis on articulating theory, practice, and collaboration, which reinforces the understanding of climate phenomena and stimulates the generation of resilient design proposals. The proposed academic framework is shown below: **Multimodal Approach: (PF→EL→CL→ELL→CIL)**

3.1.2. Competencies used in the course - Teacher Interview.
Based on the competencies studied in the teacher interview, the findings from the analyses indicate that the teacher establishes her intention by developing four competencies that support an understanding of climate change and promote solution ideas. The **Projective competency** guides students to incorporate basic ecosystem cycles into the urban design of residents' public spaces, focusing on climate and contextual vegetation. She then promotes the **Environmental Awareness competency** by evaluating the use of Nature-Based Solutions and stimulating a vision of the city as an integral part of the ecosystem, based on a rubric that values sustainability. She also integrates the **Critical Reflective competency** through feedback loops that invite questioning how the climatic dynamics of water affect soil, vegetation, and built spaces. Finally, she promotes the **Social Awareness competency** through field trips and horizontal dialogues with the local community, strengthening residents' recognition of actors and shared knowledge. These competencies reveal an intentionality that articulates theory, experience, and collaboration to consolidate meaningful learning outcomes and create resilient urban design solutions in the face of climate change.

3.1.3. Relevant methodologies perceived by students - Student interviews.
The analysis of teaching-learning methodologies in these findings from student interviews indicates that the **Nature-Based Solutions (NBS)** strategy was the most effective in fostering reflection on the climate change crisis in a local context such as the district of La Playa, being mentioned repeatedly by the three students at various levels of performance and project development. Similarly, contextualization through field trips and real-life case studies *(Linking Real-Life Contexts and Transdisciplinary Integration)* strengthened students' climate and situational awareness. The pedagogical dynamics of *Group Discussion* and *Rhetorical Questions* fostered ***Critical Dialogue (CDI)***, while the continuous assessment rubric enhanced metacognition and self-assessment of learning in environmental and climate education. These patterns, encompassed in the macrocategories of ***Climate Education Mainstreaming (CEM), Integration and Contextualization of Knowledge (IC), Interaction and Critical Discussion (ICD)***, and ***Continuous Learning Assessment (CLA)***, demonstrate a pedagogical approach validated by students that combines active, collaborative, and formative strategies to effectively integrate environmental education to address climate change in the course studio, developed by the teacher in the Caribbean.

3.1.4. Cognitive Climate Changes - Student Interview.
Based on the study of the cognitive changes perceived by the students in the interview, the findings of the analyses indicate that the students demonstrate significant transformations across different dimensions. On the one hand, Student 1 makes particular progress in *thinking and designing*, developing a comprehensive ecological awareness

and regenerative proposals in his design practice. Student 2 excels first in *reflecting*, becoming aware of real-life problems, and then in *take action*, incorporating natural cycles by reviewing the use of specific rubrics. Finally, Student 3 demonstrates a practical component in *remembering and taking action*, implementing nature-based strategies. For all, the combination of methodologies such as ***Climate Education Mainstreaming, Critical Interaction and Discussion, and formative assessments*** were crucial in measuring these cognitive changes, demonstrating a multidimensional formative impact that strengthens both the conceptual understanding of environmental education and the active application of solutions to address climate change in the Caribbean at the local level.

As these strategies and methodologies were implemented during the sessions, observations and practical tasks, students engaged in ecological fieldwork, focusing on mangrove ecosystems and their spatial dynamics. Field immersion activities included seedling identification, planting exercises, and georeferencing mangrove cover loss. These activities allowed students to critically reflect on the impacts of urban encroachment on amphibian biodiversity. The service-learning component involved two participatory workshops co-developed with local fishing communities. Students collaborated with residents to design replanting and habitat restoration schemes incorporating traditional ecological knowledge. This community-based restoration dynamic aligned with Grant's advocacy for inclusive environmental education that fosters civic responsibility and shared ecological stewardship. Project-based learning was operationalized through the development of speculative landscape and urban design scenarios. Student-led proposals combined field data with design thinking to produce conceptual plans for restoring amphibian habitats, managing stormwater, and reconnecting ecological corridors. Emphasis was placed on adaptive solutions sensitive to both ecological and cultural parameters. Students proposed design interventions such as raised vegetated buffers, seasonal water gardens, and floating walkways that responded to fluctuating hydrological patterns. These outcomes reflected Wróblewska and Okraszewska's (2020) project-based adaptation frameworks, synthesizing interdisciplinary methods to address climate resilience in a vulnerable biocultural landscape

4. Discussion

This study's discussion situates its pedagogical findings within leading frameworks of contemporary landscape architecture and urban design education. It highlights a shift toward experiential, contextual, and community-engaged learning, echoing Doherty (2024)[10] advocacy for "learning through the landscape" via immersive fieldwork emphasis on bodily engagement in ecological restoration. The integration of problem-based, service-learning, and project-based methodologies aligns with calls from Luo and Hsu (2018)[3] and Grant (2020)[7] for real-world problem-solving and community involvement, as well as Vera and Sordi (2021)[9] strategies for adapting vulnerable Latin American territories to climate change.

Students' incorporation of local and indigenous ecological knowledge exemplifies Watson (2020)[1] concept of "vernacular intelligence," demonstrating how biocultural design processes can ground proposals in regional narratives. The studio's sustainability-centered pedagogy confirms Stupar et al.'s (2017)[5] argument for curricula that treat sustainability as lived practice rather than abstract theory. Moreover, the use of interdisciplinary project-based learning in climate adaptation mirrors findings from Wróblewska and Okraszewska (2020)[2], showing that climate-challenged regions benefit from speculative urban-ecological scenarios that bridge ecological theory and actionable strategy.

Curricular implications include the embedding of mandatory field modules to develop ecological literacy and systemic thinking; the adoption of interdisciplinary service-learning to foster civic responsibility and co-production of knowledge (Grant, 2020; Luo & Hsu, 2018)[7,3]; the articulation of competency-based outcomes—climate literacy, ecological design thinking, and community engagement (Pak & Smet, 2022)[4]; and the structural integration of nature-based solutions across core courses rather than as electives.
This study contributes to the discourse on climate resilience education in the Global South by providing a model for situated, practice-driven pedagogy. In the Colombian Caribbean—particularly in Barranquilla and the surrounding Mallorquín Swamp—amphibian ecosystems and mangrove forests face acute threats from deforestation, urban expansion, and ecological fragmentation. These vulnerabilities are

compounded by loss of RAMSAR-designated wetland protections and unchecked urban sprawl.

Within this context, the study shows that place-based experiential pedagogy can foster resilience education that is both ecologically grounded and culturally resonant. By emphasizing the symbolic and functional role of the Magdalena River and its interconnection with the ciénaga, students learned to value water as a dynamic cultural and ecological asset.

Moreover, the model has scalability potential in resource-constrained tropical settings across the Colombian Caribbean. It demonstrates that even in low-infrastructure academic environments, high-impact learning can be achieved through strategic integration of fieldwork and community partnerships.
The approach is also transferable (with some limitations) to other amphibian wetlands and coastal systems across Latin America. Ecosystems in Cartagena, Santa Marta, and the broader Caribbean coastline share similar social-ecological dynamics, making this pedagogical framework relevant across contexts.

5. Conclusion

In response to our initial research question, the active teaching methodologies to address climate change found in the teacher's course are characterized by a multimodal approach, situated contextualization, combining active collaborative strategies and formative assessment. Active methodologies promote critical co-construction of knowledge. Contextualized learning with case studies and field trips enhances meaningful climate literacy. Multimodal approach **(PF→EL→CL→ELL→CIL)** ensures and focuses students on climate literacy and strong climate competencies. Develops ecosystem, environmental and critical thinking competencies, preparing architects for resilient urban solutions. Empirical evidence supports UNESCO recommendations to mainstream climate education in higher education.

In limitations, a single case study with 14 students may limit transferability of results to other educational contexts, but the experience can be generalized. Colombian Caribbean geographic context could differ from other regions, restricting full applicability of didactic strategies. Dependence on local technological resources and variable infrastructure could influence the diversity of didactic means used.

As suggestions and applications, implement curricular scalability in adapting the pedagogical sequence **(PF→EL→CL→ELL→CIL)** to mainstream climate education according to SDGs in other university workshops; implement professional programs in active methodologies and advanced climate technologies to sustain pedagogical practices, and foster collaboration between architecture, environmental engineering and social sciences for transdisciplinary educational projects.

It is recommended to promote curricular flexibility and allow the design of pedagogical sequences (such as the one presented by the teacher) as a natural thread for climate education, promote continuous teacher training with intensive workshops on active methodologies and digital and analog climate visualizations, and strengthen ties with local communities through on-site classes and dialogue with public actors for contextualized learning. Finally, the study advocates a paradigm shift toward biocultural pedagogy that bridges theory and practice through real-world engagement.

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Sustainable Water Management and Irrigation Practices in the Face of Climate Change*: anthropological perspective*

TOPIC: Guiding territories by changing the design of regional projects: tools for reinventing territories in situations of risk and environmental change

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Keywords: Water, Governance, Climate Change, Development Policies, Societies/Environment

Abstract
The social history of the mountain communities of the Arrière-Pays Niçois and the High Atlas of Morocco is marked by an ancient hydraulic heritage. For centuries, irrigators, once organized in traditional institutions (Castas, Universitas, watering societies, Jmâas) and now in syndical associations or AUEAs (agricultural water users' associations), have never ceased to maintain complex relationships with their environment, constantly restructuring their local modes of water governance as part of a social, hydraulic and territorial organization. These Mediterranean mountain countries, which have been able to preserve to this day the major features of ancestral irrigation water management, are distinguished by the omnipresent concomitance of two state and community logics that are difficult to reconcile in reality. As a result, the limitations of universalizing and rationalizing models have led us to imagine other management methods, favoring the local scale as a vector for sustainable development. In the process of integrated water resource management, aspects relating to the use of water, and above all to the individual and collective use of the resource, seem to us to be essential if we are to appreciate the current challenges of more equitable and sustainable management. In the new context of climate change and overexploitation of natural resources, and in order to meet the agri-food needs of a growing population, the management and appropriation of water remains a strategic challenge for state and community players. In the case of the Amizmiz and Ourika valleys, how can the development of gravity-fed irrigation canals and the presence of agricultural practices help to combat flooding and fires? For decades, agricultural abandonment in the hinterland of Nice, due to a lack of real political will to promote water-efficient organic farming, has led to ecological vulnerability and increased exposure to natural disasters. Indeed, the Roquebillière floods and landslides of 1926 and the recent storms of storm Alex are evidence of a new, complex ecological context.

Text

1.1. My research focuses on Sustainable Water Management and Irrigation Practices in the Face of Climate Change in two Mediterranean areas: the South-East of France (the Roya, Vésubie and Tinée valleys) and an arid region of South of Morocco, more precisely the valleys of Ourika, located both in the small and medium hydraulic and the large hydraulic of the Haouz of Marrakech, and Amizmiz. The social history of mountain communities of the Nice hinterland and those of the High Atlas of Morocco is marked by a very old hydraulic heritage. For centuries, communities have been mobilized for the establishment of hydraulic infrastructures, through the establishment of social rules and practices considered reliable and adapted to the constraints of the natural environment. In the new configurations of climate change and overexploitation of natural resources and to meet the agri-food needs of a growing population, water, its management, and its appropriation remains a strategic issue for state and community actors. Faced with the failure of the first water policies and the degradation of the environment, the realization of technical adjustments is hardly enough to ensure the sustainability of a "physical" and "social" system (Ostrom, 1992) [1] which has been largely managed by local institutions little known by the public

services. The plains have experienced intensive State intervention in hydro-agricultural development, planning new rules for sharing and distributing the resource, rules often ill-suited to the complexity of micro-local contexts. The limits experienced by public policies have led to the imagining of other management methods by promoting the local scale as a vector of sustainable development. In this context of vulnerability marked by drought / fire (southern shore of the Mediterranean) and / or floods (northern shore of the Mediterranean), thinking about new, resilient approaches are at the heart of recent development policies. In this perspective, the European Green Pact policy [2] emphasizes the primacy of the climate (reduction of net greenhouse gas emissions, balance between economic growth and the use of natural resources including water, integration of the various actors in the development process) in a kind of interconnectivity [3] (waterscapes, Molle, 2012) between Society, Economy and Environment.

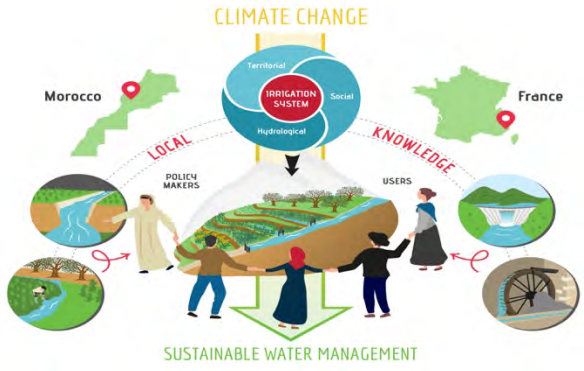


Figure 1. Diagram of my research project created as part of the FIAS/Mak'it program during my research stay in Montpellier between 2022 and 2023 [4].

1.2. Therefore, one of the major objectives of this research is to rethink the evolution of sustainable water management in a context of climate change. How local communities perceive their environment and adapt to changes and / or disruptions due to the processes of interaction with agricultural development policies. How does ownership of this common heritage provide social, political, and economic power. In these contexts of small-scale irrigation[5](Funnel, 1994), which was disadvantaged by the first hydraulic policies, could the adoption of organic agriculture such as permaculture aimed at creating a balanced ecosystem contribute to the enhancement of these territories and promoting the local economy. In a context of climate vulnerability, how to reconcile between the development of irrigated agriculture of high profitable added value but requiring water and the new environmental issues which remain at the heart of the concerns of water stakeholders? How the human sciences, in particular anthropology and the exact sciences, understand the relations between Man and his social and natural environment. My study, which constitutes a bridge between social sciences and fundamental sciences, fits into several lines of research.

1.3. Since the 1950s, several anthropological and sociological studies have paid particular attention to the interrelationships between Man and Nature (Philippe Descola, Latour, Tim Ingold…) and to this Nature / Culture dichotomy. Yet this situation has long remained dissocialized, emptied of its social and cultural substance. Faced with accelerating changes due to the climate emergency and due to its holistic and comparative approach as well as the originality of its ethnographic tradition [6] (Beau and Larrière,2018), the human and social sciences are beginning to invest the socio-environmental question in its comprehensiveness. It makes it possible to explain and analyze changes at several scales and to deconstruct the complex relationships between society and the environment. From this perspective, water as a "total social fact" [7] (Mauss, 1950) becomes both a social and ecological object that fits into a form of networks linking humans and non-humans [8] (Latour, 2006; Philippe Descola, 2005). The current challenges of water uses are of interest to the human and social sciences just as much as traditional questions. Recent work by Aubriot, Wateau, Riaux and Casciarri, perceive water as an anthropological object. Water as a multi-scalar common good is embedded in forms of social organization and in different scales of management. This is how my research fits into the theoretical and methodological framework of anthropology of water. The dilemma of this anthropology is not only the apprehension of social and cultural practices around water management, but above all to relate these social practices to the technical inventions which the local community uses to build its socio-territory. -hydraulic. If the social management of irrigation water is a social construct, it is also a technical construct. The interaction between these two elements ensures the sustainability and functioning of the irrigated system. François Sigaut and Robert Cresswell [9] consider that this technical fact is treated differently in the anthropological field than in the technical field of engineers whose system of thought deals with each question they ask themselves in terms of a concrete problem to be solved without, generally, considering the social dimensions in which they fit. In the management and social organization adapted

to the irrigated system, technical aspects are interwoven, and in the technique social dimensions are revealed. The rules of social and technical management are modifiable, negotiable, and renewable by the various actors following the change (Ostrom, 1992). This allows a system to be defined and distinguished from another. To cope with global warming, how the development of territories by canals and the presence of agricultural practices allows (in the case of the Amizmiz and Ourika valleys) and would allow in the context of Nice to fight against floods and fires.





Figure 2.3.4 **https://france.comersis.com/carte-epci-communes.php?dpt=06/** the Vésubie riverbed after storm Alex, fieldwork February 2021, Hind Sabri/ the Roya riverbed (village of Tende) after storm Alex, Oct 2020

1.3. For decades, the agricultural decline in the Nice hinterland has created ecological vulnerability by increasing its exposure to natural disasters. Indeed, the floods and landslides of Roquebillière of 1926 and the recent bad weather of the storm Alex are the witnesses of a new complex ecological context. The latter requires scientific and interdisciplinary reflection on new methods of prevention and resilience risks due to multi-hazards. To fight against these climatic hazards in the Marrakech Safi region including the Ourika valley, several research programs such as "ARIMA" were recently developed by scientists from Cadi Ayad University in Marrakech in collaboration with state operators or even ORMVAH (Haouz Regional Office for Agricultural Development) and ABHT (Hydraulic Basin Agency of Tensift) and with donors such as the European Union and other NGOs who are increasingly aware of the environmental issue.

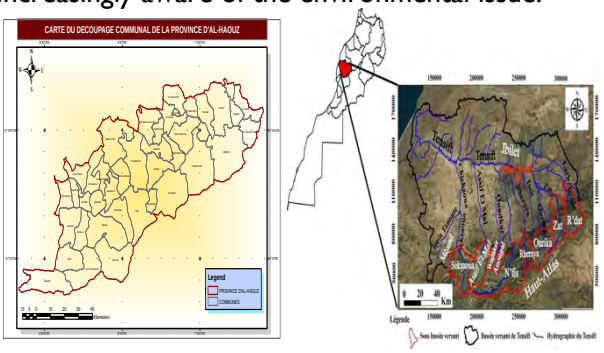


Figure 5.6 ORMVAH (Haouz Regional Office for Agricultural Development)/ Modélisation hydrologique du bassin versant de l'oued Rheraya et sa contribution à la recharge de la nappe du Haouz (bassin du Tensift, Maroc)**, Oct 2018, Hajhouji Youssef, https://www.researchgate.net/figure/Bassin-versant-de-Tensift_fig1_336796242**

1.4 This study of the evolution of collective water organization systems is justified by the plurality of complexities of micro-local specificities, the diversity of social and technical methods of water and the omnipresent concomitance of two state and community logics which are difficult to reconcile in reality. In interaction with the global framework of water management, the evolution of development policies at the local mountain scale and that of community irrigation systems requires a thorough study of the relationships maintained between Man and his Middle. Over the centuries, and in a context of partial scarcity, ownership of irrigation water has been the main issue for the various local, regional, national, and supranational players. The relationships, either conflictual or contractual, maintained between the local communities and the administration around its management, will be the common thread in this study. In addition, and by following the evolution of the principles of integrated water resources management in Morocco and France, we can see the common orientation of the various actors, including the State, towards a concerted approach in order to preserve water. which remains not only an economic, social and political issue par

excellence, but also an environmental issue crucial to ecological balance[10] (H.Sabri, 2018).

1.5. *A priori* in France, contracts adapted to the complexities of each micro-local environment and drawn up within the framework of the SDAGEs (master plan for water development and management) and SAGE (water development and management plan) at the scale of the hydrographic basins, including that of the Rhône-Méditerranée-Corse basin, make it possible to highlight the new uses of irrigation water and the gravity network in different management scales. This network contributes to the balance of ecosystems by securing the water flows of rivers to ensure equitable management of the resource. Apart from the first water law in France of 1898, the laws of 1964, 1992, the European Framework Directive of 2000 and that of 2006 clarify the heritage scope of water which takes the status of a fragile heritage which must be safeguarded, and which deploy new concerted approaches beyond a centralizing political vision that sees water as an inexhaustible resource.



Figure 7. The flour mill and the watering canal of the Tour sur Tinée, fieldwork February 2021, Hind Sabri

1.6. As for the Moroccan context, the examination of state discourses relating to water policies seems important to us for a better understanding of irrigated systems. These discourses linked to agricultural practices through the deployment of strategies at the local level possibly envisage a certain respect for the principles of self-management of irrigation networks by the communities of irrigators.



Figure 8.9.10 fieldwork in the Anougal-Amizmiz valley, 2012/ fieldwork in Aghmat-Ourika March 2023, Hind Sabri

The discrepancy between discourse and reality, revealed by in-depth fieldwork, will allow us to conceive of the issues linked to the management and appropriation of the resource. The evolution of water policies, the relationships between communities and administrative services and between Man / Environment, the deployment of state logic and community logic are questions that we want to address during this research work. From this perspective, water constitutes the basis of a permanent dialectic between several elements, allowing the social, political, and economic system to be conceived as a whole.

1.7. The communities, and particularly those of the high mountains, identify themselves by the collective appropriation of water and the management of gravity-fed irrigation networks within the precise institutional framework of the Jmaa or watering societies, which is constantly acquiring a broad local legitimacy. It is only through the self-management of irrigation networks and the establishment of collective rules that are often flexible that the communities of irrigators manage to ensure their agri-food self-sufficiency and through this the sustainability and social cohesion of the social groups.

The community's rules have often proven to be reliable in a complicated ecological environment shaped either by limited water resources or by land scarcity that limits local agriculture to unprofitable subsistence farming. To overcome the constraints

of the environment, the irrigators deploy strategies through the acceptance of technical innovation and the modernization of hydro-agricultural systems while adapting them to their so-called traditional social modalities ensuring their sustainability. The collective organization is embedded in the water governance systems which are particularly based on a process of negotiation, integration, concertation, responsibilities, consensus and permanent adaptability of the different actors ensuring the good functioning of the irrigated systems and thus the social cohesion of the communities.

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FACILITATING UKRAINE'S AGRICULTURAL LANDSCAPE

Guiding territories by changing the design of regional projects: Tools for reinventing territories in situations of risk and environmental change

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Keywords: Cultural landscape, Regeneration, Climate, Land degradation, Agriculture

Abstract
Ukraine is known for its productive soil, Chernozem, which covers approximately 60% of the country and accounts for 25% of the world's storage. Until 2022, Ukraine was the world's biggest exporter of sunflower oil, and was a major exporter of maize and wheat. [1]. However, the Russian invasion dramatically reduced the volume of exports, which critically affected the global food supply.

One of the reasons for this downfall is that the invasion released significant contaminants into the soil due to military operations and the destruction of infrastructure. As of December 2024, 23,03% of the whole territory of Ukraine was at high risk of damage and pollution [2]. Such contamination reduces soil fertility, poses a risk of spreading hazardous substances through agricultural products, and has serious consequences for both human and ecosystem health. Considering also the agricultural heritage of Ukrainians, this represents not only an attack on the soil but also on the cultural landscape.

This paper applies methods such as system-oriented design and research by design to the specific context of Ukraine's Poltava region, and employs visual narratives through maps and diagrams. The region's environmental history - both past and present - serves as a foundation for exploring potential future scenarios. By examining the dynamics of living systems, these scenarios demonstrate the potential consequences of severe soil contamination and help to identify both desirable and undesirable futures. Focusing on the most desirable future scenario, the study addresses design strategies for soil remediation and their integration into the cultural landscape, laying the groundwork for a long-term environmental and social rehabilitation pathway.

1. Introduction

Ukraine is widely known for its productive soil, Chernozem, thanks to which it has the ability to produce large amounts of agricultural food products. Until 2022, Ukraine accounted for up to 2.7% of global production share, and was ranked the largest global exporter of the sunflower oil. From 2011 to 2022, Ukraine was also the fifth global producer of maize and the ninth global producer of wheat. With the full scale invasion in Ukraine, the agriculture food production and export declined significantly [3].

Food supply and territories, where food is coming from, are often treated as politically driven resources. Consequently, crucial environmental factors such as soil health and biodiversity, along with social aspects like people's health, mental well-being, their connection to their homeland, traditions, and cultural landscapes, tend to be overlooked.

This oversight contrasts with the deep historical and cultural connection that Ukrainians have maintained with their agricultural landscapes. Historically, the daily lives of Ukrainians have been closely tied to agricultural fields, which are shaped by thousands of years of farming practices that aligned with natural biorhythms. Numerous festive traditions connected with soil and harvest, remain well-known today. For instance, Obzhynky is a ritual that marks the end of the harvest. Usually, during the celebration, the final sheaf, Didukh, is knitted and decorated with ribbons and wreaths. It is later placed in the corner of the house on Christmas Eve [4]. Ukrainian harvest related traditions are a reminder of the importance of agriculture fields in people's lives and a symbol of gratitude for the gifts of nature.

According to the Unesco World Heritage Convention cultural landscapes represent the "works of man or the combined works of nature and man" [5]. In this context, Ukrainian agricultural fields with its long-standing practice of human-nature relationship, exemplify a cultural landscape. Thus, the full scale invasion in Ukraine, threatens not only food security, but also the Ukrainian cultural heritage.

The paper discusses the consequences of undesirable future scenarios while focusing on potential desirable outcomes, particularly strategies for regenerating soil to promote agricultural productivity and environmental health. It examines these issues through the lens of Ukraine's cultural landscape, all within the ongoing climate crisis.

In this paper, the author seeks to highlight the importance of agricultural land in Ukraine not only as a vital source for food production but also as a significant natural and cultural asset. The paper provides an analysis of possible future scenarios and offers potential ways to better integrate agricultural fields into the post-war lifestyle.

2. Ukraine in the context of the global food supply

To explore the value of Ukraine's agricultural land, it is essential to explore its unique soil composition. A prime example is the widespread presence of Chernozem (black earth), renowned for its exceptional fertility. Chernozem covers approximately 60% of its territory and contains around 25% of the world’s reserves of this soil type. This natural asset is fundamental to Ukraine’s agricultural productivity and food security, playing a critical role not only within the country but also across Europe and global markets.

Until the full-scale invasion in Ukraine, the country was producing 29.1% of the global sunflower oil, and exporting 44% of the global sunflower oil [1]. Following the full-scale invasion of Ukraine from 2022 to 2024, the country experienced an 81% decline in sunflower oil exports.
Between 2022 and 2024, maize production declined by 21%, while wheat production dropped by 30.3% [6].

Such a reduction in the quantity of food products and infrastructure issues caused by military events disrupted the supply chain of all the aforementioned export commodities. These disruptions had a significant impact on the global food market, leading to food shortages and price hikes [3].

3. Effect of war in Ukraine on its Chernozem

A broader understanding of these supply chain disruptions also requires consideration of the underlying agricultural conditions within Ukraine. In particular, the state of the soil plays a critical role in shaping the country's agricultural productivity and resilience.

According to surveys during the period 1957–61, original soil maps of Ukraine depict 222 agro-industrial soil groups and thousands of individual mapping units [7]. The last comprehensive soil monitoring in Ukraine took place from 2016 to 2020, during which only 21.7% of all agricultural land was surveyed. Considering the urgent purpose of the first assessment of the effects of the war on the soil of Ukraine, Dmytruk et al. modeled the soil pattern. In this way, a predictive soil map of Ukraine was created and the soils were categorized into 14 distinct soil groups, with relatively common responses to the impacts of war [7].

Military actions led to such types of soil degradation as compaction, pollution, loss of nutrients, and biodiversity. The formation of craters and pits in demining areas is also among the negative consequences of military actions. However, the most potentially hazardous forms of soil degradation include contamination from explosives and weapons components, chemical pollution, burning, and physical destruction. In order to understand the scale of the catastrophe, a detailed soil survey is essential. However, ongoing military actions make such surveys of most agricultural fields in Ukraine impossible at this time. Thus, these forms of soil degradation have only been examined only pointwise. Meantime, the ability to remediate soil depends not only on soil type and chosen remediation intervention but also on explosive processes that result in soil pollution and weather conditions at the moment of the explosion.

In the absence of such a survey, the term *potentially contaminated territories* remains the officially used term. These territories include areas where military operations took place, zones affected by missile landing, drone explosion, burning equipment, as well as potentially mined regions. According to the latest data, from December 21, 2024, the area of Ukrainian territories that may be potentially contaminated with explosive remnants of the war is 139,000 km² or 23,03 % of the whole territory of Ukraine [2]. Moreover, degraded soil can have a broader environmental impact since it disrupts ecosystem processes and compromises the overall health of surrounding areas. *Figure 1*

4. Possible futures of the agricultural field

Given the scale of contamination, effective restoration efforts must extend beyond isolated interventions. Addressing this complexity requires a comprehensive approach that considers interdependencies and evolving conditions.

In a complex situation such as ecosystem restoration during and after the war, it is essential to consider the relational connections and the long-term consequences of actions. This paper is employing system-oriented design, which is especially suited to addressing complex and

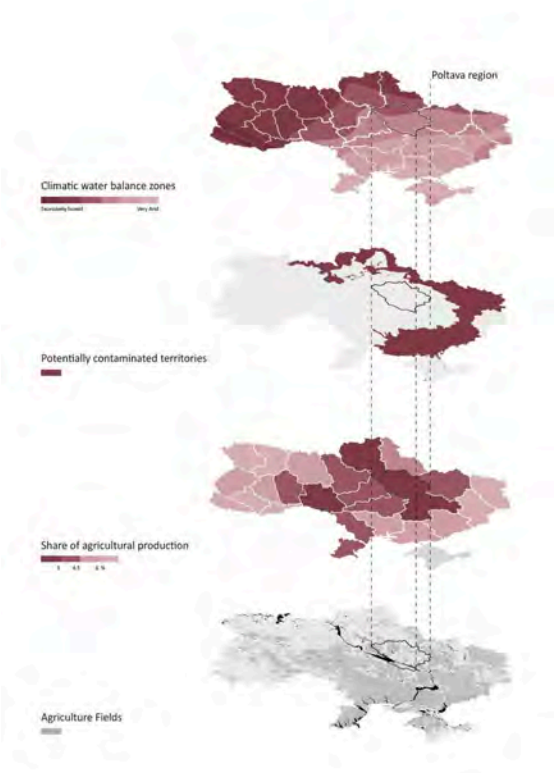


Figure 1. Map analysis of Ukraine

dynamic real-world issues. This is the primary methodology for drafting future scenarios. Using a research-by-design approach, the paper offers a generalized vision of possible futures until the year 2050, while testing the system through prototyping and transgressing limitations of the current situation [8]. Figure 2, 3

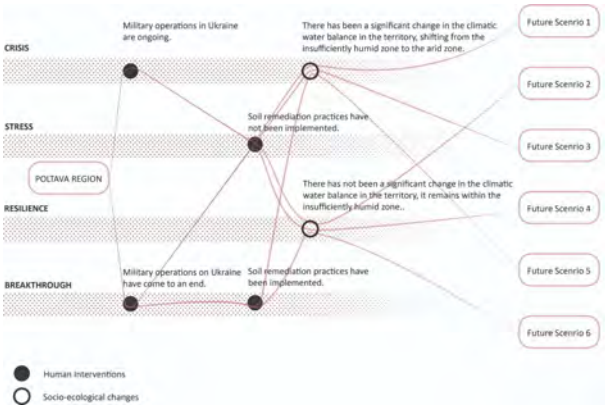


Figure 2. Future scenarios diagram

This study focuses on the region of Poltava due to its productivity. In particular, it had the highest share of agricultural production in the country in 2021 [7]. In 1990 Poltava was situated in three climatic water balance zones at the same time, but due to shift of zones, nowadays it is situated in two climatic water balance zones. Based on forecasts from the State Water Resources Agency of Ukraine, it also has a significant risk of its shift. Based on a predictive soil map of Ukraine, the Poltava region has Haplic chernozem - black earths with a very thick, black, friable, humus-rich topsoil exhibiting well-developed granular structure and neutral reaction [7]. In the absence of data on soil contamination, however, the study site is conceptualized as a composite landscape that represents the fields currently located in the Poltava region within the insufficiently humid zone.

Such scenarios are not descriptive, but generative knowledge, as they do not merely interpret the existing conditions but aim to design change [8]. While being inside the design process as a reflective practitioner, I define Possible Future 1 as the most undesirable future and Possible Future 6 as the most desirable future. In the following, the author will describe both undesirable and desirable futures, guiding through such event steps as continuing and ending military actions on the territory of Ukraine, soil management practices



Figure 3. Description of future scenarios

that might be implemented or not, and significant or not significant change in the climatic water balance of the region, in detail.

Undesirable future:
Soil degradation accelerates. With no restoration or protection efforts, humus levels continue to decline sharply, and biological activity in the soil is about to collapse. Underground water contaminated by heavy metals, fuel residues, and toxic fragments rises, feeding back into soil toxicity. Widespread contamination from military pollutants not only breaks down nutrient cycling systems but also makes some large areas unsafe in agricultural terms.

The transition from an insufficiently humid climatic zone to an arid one drastically alters the region's climate profile. Some crops fail entirely during severe droughts. Farming becomes a high-risk and economically unviable activity, and grain production in the Poltava region declines dramatically. Agricultural livelihoods start to disappear, prompting waves of migration from rural areas. Attachment to the land weakens, and cultural stewardship traditions fade.

As aridity expands, the ecosystem begins to collapse. While natural forest seeding is visible in some marginal lands, advancing aridification and poor soil conditions prevent successful establishment. Frequent wildfires in the remaining forests release additional carbon. Persistent emissions from military activities and infrastructure destruction prevent any meaningful progress on emissions reduction. Wetlands dry out, contributing to carbon emissions. Vegetative cooling is reduced, and desertification patches appear, which reduces habitat diversity. Steppe species are displaced or disappear. Water-dependent species, including amphibians, fish, and pollinators, face extinction locally. Ecosystem services such as pollination and water purification break down. The landscape becomes alien and threatening - dry, dusty, unsafe.

Dust storms become more common, reducing visibility and worsening air quality. It is continuously poor, especially during dry, windy seasons. Particulate matter and chemical residues in the air lead to chronic respiratory and heat-related illnesses among the local population. There are risks of expansion of arid-adapted species such as rodents or mosquitoes, which might increase the risks of diseases that they spread, respectively.
Clean water becomes scarce, contributing to disease spread and reduced hygiene. Nature no longer offers relief or healing. Living conditions deteriorate. Access to clean air and clean water becomes a daily concern. Mental health crisis deepens, fueled by social isolation and despair.

Desirable future:
Post-war peace, phytoremediation practices, and regenerative farming lead to robust recovery of soil structure, organic matter, microbial life, and nutrient cycling regeneration. Bioremediation restores even severely polluted lands over time. Stable rainfall patterns support the efficient use of organic amendments, composting, and rotational systems. Grain production returns to 80–90% of pre-war levels, and some agriculture fields see improvements in food quality and resilience due to healthy soils.

Stable precipitation enables carbon sequestration through restored soils and vegetation. With moisture conditions maintained, forest patches, wetlands, and steppe habitats recover well. Biodiversity expands steadily. Pollinators, birds, amphibians, and freshwater species return in greater numbers. Agroforestry and biodiversity-friendly landscapes support both farming and wildlife. Forest and wetland restoration projects reduce surface temperatures, store carbon, and moderate local climate. Wind erosion is rare. Sustainable transport and new renewable energy technologies are common in farming, while overall CO2 emissions in the region decline.

Natural buffers reduce agrochemical drift. With clean rural air, fewer emissions, and less particulate pollution, air quality in the region is significantly improved. Recovering landscapes

creates hopeful, grounded communities. Nature becomes a part of daily life - recreation, celebration of traditions, and education flourish. Mental health improves with access to diverse natural environments and the possibility of social gathering. Both rural and urban populations are stabilizing, with growing numbers of young people expressing interest in ecological living and engaging in environmental stewardship. Additionally, the mental and spiritual connection to the land renews long-term resilience.

5. Design strategies for a desirable future

The development of future scenarios enables the anticipation of events, the formulation of design strategies, and the identification of potential interventions required to achieve desired outcomes. Among these, phytoremediation through vegetation and, possibly, microbial bioremediation represent key approaches. The soil in this case should first be analyzed in terms of its pollutants and contamination level. Soil microbial bioremediation, however, has been never used for soil recovering from military-induced damage before. To ensure success, such a method should be validated under conditions that are similar to the actual site before being used on a full scale.

A critical distinction must be made based on whether the cultivated vegetation is intended for entry into the food industry. When crops are grown for consumption, sunflower is a recommended option due to its capacity to effectively accumulate heavy metals in its biomass, excluding the seeds, which remain suitable for consumption. Notably, the sunflower also holds significant symbolic value in Ukrainian culture, representing resilience and national identity. For non-food applications, miscanthus may serve as an alternative, due to its well-documented capabilities in soil remediation and biomass production.

In this context, phytoremediation leads to ecological restoration. However, ecological restoration focuses on returning the site to its original ecosystem state, and it doesn't take into account possible future environmental changes due to climate change. For restoration to be “future-oriented”, I will use the term rehabilitation [9]. This form of rehabilitation is intended to be combined with regenerative farming practices such as no-till from the very beginning, and leaving plant roots in the ground after harvest, following a certain period of phytoremediation processes.

The suggested design strategies recognize that the restoration challenge cannot rely on a single type of intervention, but can include a flexible set of approaches suited for longer-term challenges. Site monitoring and iterative learning would be essential in order to modify interventions due to the soil-root system dynamics or potentially unpredictable problems.

After ecological recovery and fostering environmental awareness within the community, selected sites of rehabilitated fields can be reimagined as contemporary public spaces. These spaces should be developed in alignment with the principles of ecological design - emphasizing biodiversity, sustainability, and minimal environmental impact - while also drawing inspiration from local cultural traditions and landscape heritage. By integrating natural elements with culturally meaningful symbols, such interventions can create inclusive and reflective environments. Beyond providing areas for recreation and social gathering, these spaces have the potential to strengthen place attachment and facilitate the reestablishment of environmental stewardship practice rooted in collective memory, situational correspondence and responsibility.

6. Discussion

The multidimensional nature of the issue calls for multidisciplinary collaboration involving experts such as ecologists, soil scientists, farmers, and other relevant specialists. Future research will require more comprehensive analyses, as this study is limited by the current lack of detailed data on soil contamination. Moreover, the diversity of climatic water balance zones across Ukraine

presents additional challenges. Subsequent study may also incorporate expert and stakeholder interviews, to provide more contextual insight and support scenario development.

7. Conclusion

This study aims to illustrate the systemic nature of agricultural landscape degradation in Ukraine and to highlight its potential environmental and social consequences. The author acknowledges the conceptual and exploratory nature of the work. The proposal to integrate agricultural fields more into everyday recreational activities seeks not only to strengthen a sense of belonging but also to foster environmental stewardship among younger generations, an essential component in mitigating the impacts of climate change.

By incorporating the notion of cultural landscapes, the study adds an additional layer of complexity and demonstrates the potential role of landscape architects in addressing this multidimensional issue.

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ESTUARISM: A CRITICAL FRAMEWORK FOR DESIGNING ADAPTIVE COASTAL LANDSCAPES IN NORTHERN SPAIN

TOPIC: Guiding territories by changing the design of regional projects: tools for reinventing territories in situations of risk and environmental change

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Keywords: estuary, coastal resilience, adaptive design, Cantabrian coast, ecosystem services

Abstract
Hydrating, feeding, producing, and oxygenating - estuaries are vital landscapes capable of engendering life. Positioned at the thresholds of diverse lands and waters, they represent non-binary ecosystems, creating environments that sustain biodiversity and support human activity. Yet, under growing climatic friction, they demand a new approach—one that moves beyond anthropocentric development towards an entangled coexistence with nature. Under this premise, the presentation introduces the concept of Estuarism, a critical framework for designing adaptive and tactical interventions in coastal landscapes, taking the Nalón river estuary in northern Spain, as a case study. It belongs to the polynuclear bioregion of Asturias, which is home to a variety of species, including the migratory eel from the Sargasso Sea. It is a site of converging flows, both human and non-human, which has undergone significant degradation due to the aggressive extractive activity of coal mining and its subsequent post-industrial reconversion. Estuarism embraces climate form over a carbon form. This specific site could serve as a model for other coastal estuaries, prompting the following question: How might coastal landscapes be designed enhancing trans-species communities and becoming resilient to environmental change?

To answer this question, the methodology employs a comparative mapping approach to deploy design strategies for estuarine regeneration. It examines the twenty-six estuaries along the Cantabrian coast from Galicia to the Basque Country. Each estuary is analyzed and organized in a circular way according to its proportion of ecosystem services related to water, oxygen, food, industry and culture. A set of tactical interventions, drawn as an atlas of regenerative elements, is then proposed as a tool for engaging in co-design processes. The combination of elements depends on the needs of each estuary. It embraces complexity rather than imposing control by moving from actions against nature to actions with nature. The methodology is both diagnostic and prescriptive: it first establishes a baseline knowledge of estuarine conditions along the Cantabrian coast and then extrapolates key strategies.

The transformation project of the Nalón estuary demonstrates how Estuarism can serve as a critical framework for designing adaptive coastal landscapes that move beyond extractive practices. Its proposed transformation involves a three-fold approach: 1) Relocating activities and regenerating ecosystems – expanding ecotones and reversing extractive practices; 2) Improving connections and softening boundaries—reviving commercial ground floors, regenerating abandoned buildings, and linking them to estuarine activity; 3) Implementing experimental interventions—introducing climate-responsive infrastructures and fostering ecological economies by repurposing materials such as the eucalyptus timber. From regenerative tourism to adaptive aquaculture, new sectors of the blue economy emerge, such as

maintenance rituals, and traditions rooted in care practices. Through this approach the estuary evolves into a prototype for entangled coexistence. Ultimately, Estuarism envisions estuaries as dynamic and evolving ecosystems—where landscape, architecture, and biodiversity are interwoven into a living fabric of adaptation.

1. Estuary as nonbinary landscape

Estuaries are capable of hydrating, feeding, producing and oxygenating. They are capable of engendering life. At the thresholds of diverse lands and waters, they act as complex ecosystems that ensure the maintenance of life. They are non-binary landscapes, between sea and river, mountain and pasture, urban and rural, hosting productive and recreational activities, seasonal and planetary rhythms, the human and the non-human.

Estuarine landscapes represent complex socio-ecological systems that are increasingly vulnerable to the combined pressures of climate change and human activity. Effective regeneration strategies must embrace the multifunctionality of these environments, recognizing their ecological, cultural, and economic values (Bolliger et al., 2011). Planning for coastal resilience requires innovative approaches that balance stability and transformation, navigating uncertainties inherent to dynamic coastal systems (Allan, 2012; Rölfer, Celliers, & Abson, 2022). As García (2022) highlights, resilient coastal landscapes undergo continuous metamorphosis, adapting to shifting climatic regimes that demand integrative governance and collaborative action. This perspective aligns with Latour's (2017) call to rethink human-nature relations within the new climatic order, emphasizing the need to manufacture landscapes that coexist with planetary processes rather than oppose them. Together, these frameworks provide a foundation for exploring regenerative pathways in estuarine environments that foster both ecological integrity and socio-cultural resilience.

The Nalón estuary is one of these fertile environments that are repeated along the Cantabrian coast, with different variations but sharing a great commonality. Therefore, its intervention must be approached from a holistic perspective, capable of transcending disciplinary barriers, subjects and scales, going beyond urbanism, landscape and architecture. We need a form of knowledge that embraces this entanglement. We need to think in terms of "Estuarism" to understand how we will coexist in this assemblage of high climatic friction, how we will be living from water, or in Asturian language "Vivir de l'agua".

2. Methodology for Adaptative Estuarism

The study begins with a detailed focus on the Nalón estuary and subsequently broadens its scope to include all landscapes exhibiting similar characteristics. This investigation identifies 25 additional estuaries along the Cantabrian coast of northern Spain, spanning from the Basque Country through Cantabria and Asturias to Galicia. The orography, geology, and climate across this trans-provincial region contribute to the formation of these estuarine landscapes.

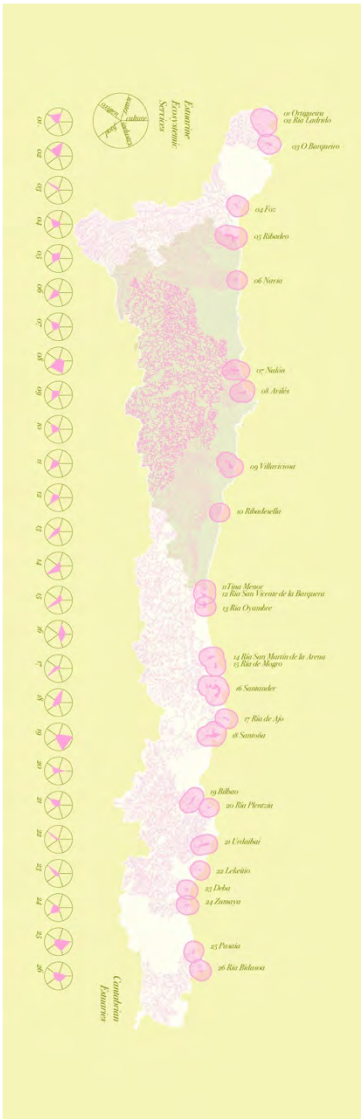


Figure 1. Cantabrian estuaries analysis.

To enable meaningful comparison and facilitate cross-learning, a study zone is delineated using a 10-kilometer buffer around each estuary. Land use data is then analyzed using the CORINE Land Cover tool, which classifies current land uses according to various categories. For this research, these categories are consolidated into five key classes linked to ecosystem service provision in each region: water for all aquatic areas, oxygen for forested zones, food for surfaces dedicated to food production or plant-based products, industry for productive industrial sectors, and culture for inhabited or populated areas within the territory.
Based on the percentage of land allocated to each category, a star diagram is generated to facilitate comparison. This allows for the reorganization of the estuaries into a comparative cartography, an "Estuarism Atlas." Through this approach, landscapes are grouped according to shared characteristics and functional affinities rather than geographic proximity or administrative boundaries.

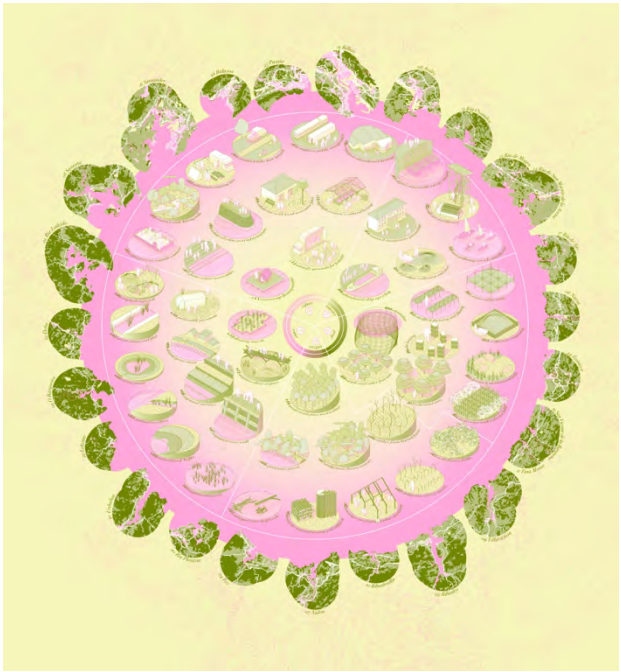


Figure 2. Estuarism Atlas.

Following this reclassification, the estuarine landscapes are examined in greater detail to identify successful strategies that enhance or balance ecosystem services. By learning from existing practices, effective actions can be transferred between estuaries, fostering adaptive and context-sensitive management.

Finally, these insights are compiled into a comprehensive circular document where the estuaries metaphorically discharge into a common "pink sea," organized according to their predominant ecosystem services. Within it, actions are categorized according to the five established ecosystem service groups. This document is intended to serve as a co-design tool for envisioning desirable futures for these estuaries and as a platform for negotiation among local, institutional, and more-than-human stakeholders.

3 Resilient Estuarism in Nalón River

The Nalón estuary is the habitat of a polinuclear bioregion formed by three cities - Aviles, Gijón and Oviedo. In Nalón, not only human flows converge, moving on foot on the road to Santiago or by plane. But of multiple species such as the famous eel, coming from the Sargasso Sea or migratory birds that make their stop on their journey from Africa to the Arctic. After applying the previous research to this specific case, five lines of action emerge.

3.1 Expanding Ecotones (oxygen)

The anthropic barriers that articulate the territory have produced great fragmentation in the ecosystems and serious consequences for biological communities. Therefore, we focus on amplifying and adding complexity to the transitional areas, the ecotones, identifying their ecological value, their wide biodiversity and their cultural importance. Smoother limits allow higher interaction and higher complexity of more than human processes.

3.2 Nourishing industries (industry)

Another strategy to progressively dilute the water-land and urban-nature boundaries, strongly materialized in the territory by decades of extractive industries, is to implement an economic model based on maintenance and research as a practice of care. We propose livelihoods grounded on regenerative industries, which instead of providing only human-centered services advance a new form of recovery from tourism to estuarism.

3.3 Sewing Loops (water)

Improving the connection between the towns of L'Arena and San Esteban is essential to enhance mutual synergies. A "chalana" boat in the harbor and a cable ferry between the new regenerative industries connect the two riversides without the need for costly infrastructure, allowing the passage of boats. The new bike lane, pedestrian streets, along with existing trails, weave a network of public spaces into the waterfront landscape.

3.4 Restructuring Flows (culture)

Making room for biodiversity means less car-oriented planning. We need to widen the edges for allowing moments of friction with water, being able to absorb disturbances. Reorganizing the roads, reducing the two-way traffic to the minimum, and optimizing park and ride lots, we can regain better thresholds for the entanglement of diverse flow lines including non- humans. The natural heritage will be weaven with the architectural heritage, reactivating comercial groundfloors and abandoned buildings by linking them to the estuary activity. It is intended to change to a regenerative tourism that actively participates in the recovery of the ecosystem. These strategies can generate new jobs based on the maintenance of the estuarine habitats, bringing new maintenance rituals, festivals and traditions based on these care practices, and retain working population the whole year round.

3.5 Upcycling Forests (productive)

Among the actions suggested for the regeneration of local ecosystems, we propose the gradual eradication of eucalyptus monoculture, which is dedicated to the polluting paper industry, in favor of the reintroduction of native species in a biodiverse forest. Eucalyptus timber can be used for construction if the logs' natural drying time is increased and they are sawn in a radial pattern, which avoids twisting. We designed a series of estuarism pavilions built with wood from existing Nalón eucalyptus plantations. These reversible structures will act as catalysts for the regeneration processes, as well as visualize their ongoing progress.

4 Tactical Estuarism

Next, we focus on a scale of specific, identifiable, and measurable interventions. The strategies for the Nalón estuary are presented through three distinct scenarios. To guide their implementation, we propose a phased approach based on temporal scale and priority: first, relocate activities to enable ecosystem regeneration; second, enhance connectivity, upgrade infrastructure, and soften rigid boundaries; and finally, initiate experimental interventions and foster research initiatives. The following actions emerge from the atlas of elements developed through the comparative analysis of estuaries presented in the first section.

4.1 Scenario 1: *Puerto Chico* breakwater

This site presents a highly anthropized coastal landscape, historically characterized by a hard edge facing the Cantabrian Sea, an environment frequently exposed to strong storms. A small port once occupied the area, now infilled and replaced by a swimming pool and a large surface parking lot. In the first phase, activities are strategically relocated to reduce ecological pressure on sensitive areas. The existing parking lot is repurposed to accommodate the soccer field previously situated near the marshes in La Xunquera, thereby freeing up space for ecological restoration. The expansive blind wall of the swimming pool is adapted to support seating stands, integrating recreational infrastructure with the existing built fabric. A dedicated service area for caravans is also introduced, providing water and electricity supply, picnic areas, and shaded spaces using pergolas constructed from eucalyptus wood harvested from the Llama Beach forest plantations.

The second phase focuses on softening the rigid coastal boundary through ecological engineering. The concrete dike is modified by recessing its upper layer, enabling the creation of a terraced, vegetated surface that can accommodate riparian plant species and temporarily retain floodwaters during extreme weather events. Excavated material is reused on-site to generate subtle topographic relief over the former parking area, facilitating the establishment of native halophytic cliff species and mimicking the geomorphology of adjacent coastal habitats.

In the third phase, experimental interventions are introduced to promote habitat creation and renewable energy generation. A "life-developing wall" is installed, functioning as a vertical substrate for algae growth and ecological colonization along the dike. Additionally, mechanical devices are positioned to harness the kinetic energy of waves and tides for electricity production. A research center is established on-site to monitor these experimental systems and evaluate their ecological and technical performance over time.

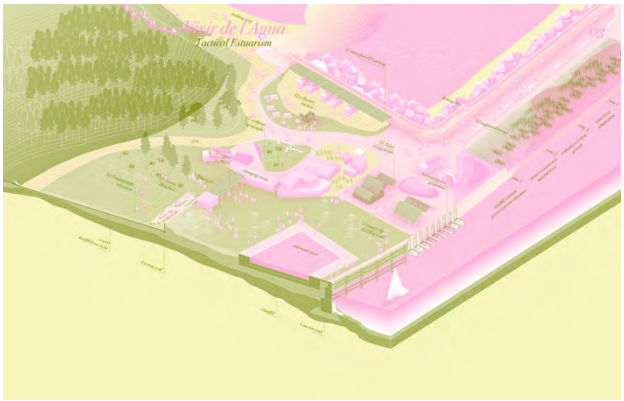


Figure 3. Puerto Chico Breakwater.

4.2. Scenario 2: *Xunquera* lagoon

This area has a long-standing historical association with the coal mining industry. Former shipyards were transformed into heavily polluting scrapyards that occupied former marshland, resulting in significant degradation of local biodiversity. Currently, the site is occupied by yacht clubs and warehouses, reflecting a shift in land use while continuing to impact the ecological fabric of the region.

On the first stage of implementation, the intervention addresses the reorganization of land uses and ecological restoration through the softening of boundaries and the expansion of ecotones between the industrial zone and the naturalized marshes. The relocation of the soccer field to Puerto Chico releases critical space for the extension of wetland habitats and enables the formation of a more resilient and ecologically functional edge. Existing physical barriers, including waste and impermeable walls, are removed to reestablish hydrological and ecological continuity. Soil decompaction strategies are implemented to restore infiltration capacity and support the regeneration of native plant communities. Controlled public access is introduced through the creation of low-impact pedestrian and cycling paths, designed to minimize disturbance while enabling environmental education and passive recreation. At the threshold between urban and ecological zones, a buffer strip of alluvial forest is established. This landscape element, representative of the region's native ecosystems, mitigates flooding, stabilizes soils, and serves as a visual and acoustic screen for the benefit of the marshland's fauna

For the next stage, the project proposes a strategic reconfiguration of connections, public facilities, and edge conditions to foster ecological restoration and enhance socio-environmental integration. Waterfront spaces are reprogrammed to accommodate small-scale, water-oriented enterprises, while the existing launching ramp is adapted to support low-carbon aquatic activities such as kayaking. A portion of the ramp is terraced to enable safe public access for bathing, integrating recreational use with the site's natural dynamics. Cross-river connectivity is significantly improved through the introduction of a user-operated cable ferry, offering an accessible and low-impact mobility solution. The existing dike is partially deconstructed. Its upper stone layer removed to facilitate a more porous and adaptive interface that increases flood resilience while softening the boundary between land and water. Additionally, a bird observatory and interpretive trail are integrated along a pre-existing path, and former electric poles are retained as habitat structures to support avian nesting, reinforcing biodiversity within the site's evolving ecological framework.

During the third stage, the project introduces experimental interventions and supports on-site ecological research to inform adaptive management strategies. A controlled grazing system using "xalda" sheep, a local breed, is established as a method for managing invasive plant species, exploring the role of traditional agricultural practices in contemporary ecological restoration. A vertical "life-developing wall" is installed to facilitate the growth of algae and biofilm, contributing to habitat complexity and water quality enhancement. Additional measures include a phytoremediation zone, floating platforms planted with marsh vegetation, and designated spaces for small-scale aquaculture. To support the monitoring and evaluation of these interventions, a research facility is integrated into the site. Adjacent to this, an enclosed space is constructed to promote environmental education and public engagement. Both structures are built using sustainably sourced eucalyptus wood from the nearby Llama Beach forest, emphasizing the use of local materials and low-impact construction techniques.

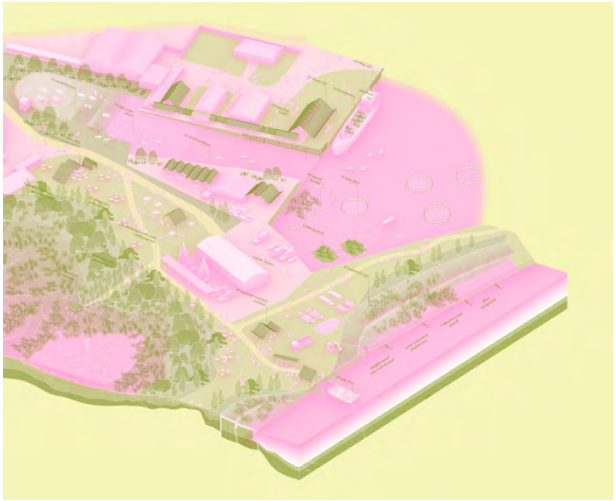


Figure 4. Xunquera Lagoon.

4.3. Scenario 3: *La Llama* beach.

Historically utilized by the inhabitants of San Juan de la Arena for bathing and elver fishing, this area features a distinctive ecotone comprised of marshes and swampy alder groves, which the project proposes to expand.

In the first phase, activities are relocated and ecological regeneration initiated by acquiring the

eucalyptus plantation adjacent to the marshes to extend the wetland ecosystem. A small section of the eucalyptus stand is designated as a testing ground for restoration efforts. The transition zone between the accessible recreational area and the naturalized marshes is enhanced through the expansion of ecotones and the creation of pedestrian pathways that provide controlled access to the marshes as well as connectivity to La Llama Beach. River-deposited logs are collected and repurposed, together with their shavings, to construct a natural playground.

The second phase focuses on strengthening connections and developing infrastructure. First, the connectivity with La Xunquera is improved by the installation of a user-operated cable ferry, enhancing access and mobility. The eucalyptus trees are harvested and dried for use in constructing small-scale facilities, such as a gathering space for local fishermen. To promote vegetation growth, holes are introduced into the compacted gravel substrate of the site.

The third phase involves experimental interventions and research initiatives. A small passage is constructed to facilitate observation of the "anguleros" platforms, supporting ongoing ecological monitoring. A naturalized vertical wall is installed to encourage algae proliferation, contributing to habitat complexity and water quality. Additionally, a managed grazing strip utilizing "xalda" sheep is implemented as a biological control method for invasive plant species.

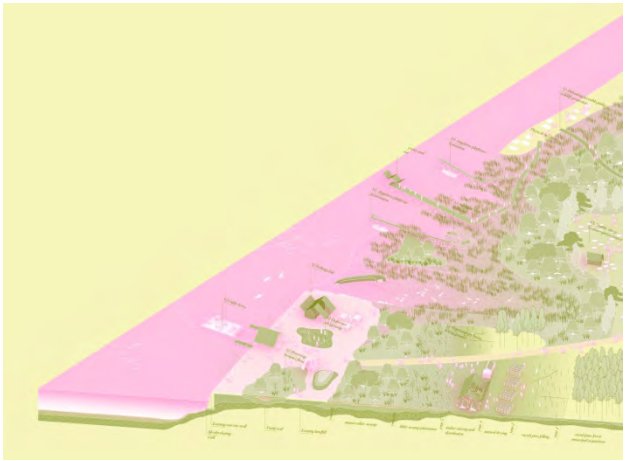


Figure 5. La llama Beach

5. Conclusions

This paper has introduced the concept of "estuarism" as a critical framework for analyzing and subsequently regenerating estuarine landscapes along the Cantabrian coast. This approach challenges administrative boundaries and redraws regions based on their landscape behavior.

Additionally, the methodology of critical cartography was presented as a comparative analytical tool aimed at designing regenerative landscape strategies.

Following this, an atlas of potential interventions was showcased, intended to balance or enhance the various ecosystem services of each estuary. This catalog serves as a negotiation tool involving multiple stakeholders, both human and non-human.

The methodology was then applied to a case study of the Nalón River estuary, resulting in five strategic lines for adaptive estuarism: Expanding Ecotones, Nourishing Industries, Sewing Loops, Restructuring Flows, and Upcycling Forests.

Finally, in the context of tactical estuarism, a temporal dimension was introduced by proposing overlapping, phased implementation strategies focused on three critical sites within the landscape.

Future research could explore extrapolating this methodology to estuarine landscapes in other geographical regions. Another potential avenue for investigation involves applying this approach to regenerative landscape strategies through the comparative analysis of critical cartographies in other landscape typologies.

Acknowledgments

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A FIRE SMART LANDSCAPE: TO DEFINE NEW COLLABORATIONS WITH AGRICULTURE

TOPIC: Guiding territories by changing the design of regional projects (energy landscapes, agroforestry, risks): tools for reinventing territories in situation of risk and environmental change

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Keywords: landscape management, rural landscape, wildfire, Europe, agriculture

Abstract
The management of landscapes is an important topic in western Europe because of the growing density and continuity of the metropolis. The banalization of the landscapes linked to urban sprawl has been denounced since the 1960s. Little by little rural landscapes have become a heritage to protect. They illustrate the shared values and the identities of many territories for inhabitants even if these values do not reflect productive agricultural realities. The incomprehension between urban or neo rural societies and farmers has been explained in sociology research (Hervieu & Purseigle).
The European Landscape Convention (2000) has developed some tools to define and to support the evolution of landscapes while the existing range of systems of protection has been growing. But global climate change and the growing frequency of extreme events, such as wildfires, oblige us to reconsider and diversify strategies. How can our landscape values be protected? How could their resiliency be managed? How could their physical transformations (mechanization, diffusion of agroecological and agroforestry models, mortality of plants and forests…) be dealt with?
These challenges are shared by the sector of agriculture as they face important losses and reduction of profits while the number of its active population is constantly decreasing. On the other hand, the idea of a farmer as a "gardener of our landscape" which is shared in politics and the media, expresses the reality of the ecosystemic services that agriculture provides (beauty, security, biodiversity, water quality…). Because of the fragility of the whole system, we need to build new ways to collaborate.
Fire Wine and *Fire Product* brands have been created to enhance the role of agriculture in wildfire risk management. Its ambition is to create a network to improve processes and to share experiences that could be defined in some cases as good practices.

Introduction

Since the 1960s, rural abandonment has increased, as have the concentration and specialization of farms. In Europe, this phenomenon has accelerated as a result of the Common Agricultural Policy (CAP) and widespread urbanization. The banalization of landscapes, developed first of all in peri-urban areas, gave rise to national landscape laws and then to the European Landscape Convention (ELC, 2000), which defends the right to a quality environment. At the same time, the mechanization of agricultural tasks and land consolidation have led to a simplification of farmland landscapes. These observable trends reflect changes in our lifestyles and the detachment of a predominantly urban society from the dynamics of the land. In addition, changes to the CAP (1992), market globalization and its economic reality, have deepened

the misunderstanding between society's expectations and the farming world. Are farmers ready to take on the role of 'landscape gardener'? However, models for recognizing the agricultural landscape as a living heritage are multiplying: it has been included in the various UNESCO labels (Cultural Landscapes, Geopark, Biosphere reserve), it is at the heart of the FAO's SIPAM model, not to mention national models. Yves Luginbuhl (1991) and Hervieu and Purseigle (2013, 2022) [1] have explained the global lack of interest among farmers. In that context, fire risk management introduces a new understanding of landscape management. As it is necessary to maintain agriculture in strategic areas to low down forest fuels and the risk of extreme fire, it can be an opportunity to create new cooperations between private and public sectors and to reconsider landscape management as the central thematic of territories management.



Figure 1. Wine landscape of Bages, in the inside of Catalonia: dry stone terraces, forest of *Pinus halapensis* (abandoned terraces), Montserrat mountain. *Source: Soazig Darnay*

1.1. European rural landscape: a deep transformation

Urban sprawl is consuming land at an accelerated rate as populations migrate from urban areas to suburban fringes. Leapfrog development patterns are characterized by the juxtaposition of patches of open land with built-up areas, resulting in the fragmentation of the landscape and the dissemination of a standardized model of housing and industrial architecture. This phenomenon has been shown to contribute to the loss of natural ecosystems and biodiversity, the spread of contamination, agriculture land abandonment, and the banalization of the landscape. The phenomenon of homogenization and trivialization has been denounced in Europe since the 1960s. This led to the establishment of legislation (in France, the 1993 Landscape Law) and the ELC. Concurrently, there has been an observable trend of standardization of landscapes by architecture designed for tourist purposes, even when the architecture is of a high caliber. For instance, in the context of wine tourism development, the new wineries designed to accommodate visitors are frequently conceived by renowned architects. However, these constructions "to look at the landscape" are being erected in a relatively brief period, concentrated in a delimited territory (mainly Designations of Origin – DO), frequently with no evident connection to their traditional context. The styles and materials employed in their construction bear a notable similarity across different wine-producing regions. This phenomenon exemplifies the transformation of the rural landscape and prompts inquiries into the authenticity of such environments and our capacity to orchestrate private initiatives, particularly those with substantial economic ramifications at the local level. [2]

Furthermore, since the 1960s, Europe has witnessed a concurrent escalation in the phenomenon of rural abandonment. In recent decades, there has been a significant loss of agricultural land due to urban expansion and afforestation. This phenomenon is a dual cause and consequence of farmland abandonment. It is anticipated that this trend will persist between 2015 and 2030. The phenomenon of agricultural land abandonment is associated with a number of factors, including low productivity, geographical remoteness, or the presence of mountainous regions. It may also be influenced by unfavorable soil or climate conditions that render the land unsuitable for agricultural use. However, EU farmers are getting older. According to Eurostat data from 2020, 33% of EU farm managers are aged 65 or over, with a further 24% being over 55 and potentially eligible for retirement within the next decade. At the EU level, the proportion of farm managers below the age of 25 is less than 1%. The situation is particularly problematic for women, who constitute 31.5% of all farmers but only slightly over a quarter of farmers under 40. Simultaneously, young farmers frequently encounter challenges in accessing land, finance and knowledge. Consequently, the landscape is undergoing significant changes, characterized by the emergence of larger farms and a decline in the overall number of farms. While the majority of EU farms are characterized by their small size, with less than 5 hectares of land, a smaller percentage of larger farms (50 hectares or

more) control a disproportionately large share of the agricultural land (European Statistics, 2020). The dominance of productive farms in land use has resulted in landscapes that are more continuous and less diverse, in terms of biodiversity, the diversity of production, the shapes of plots and hedges, and so forth. [3]

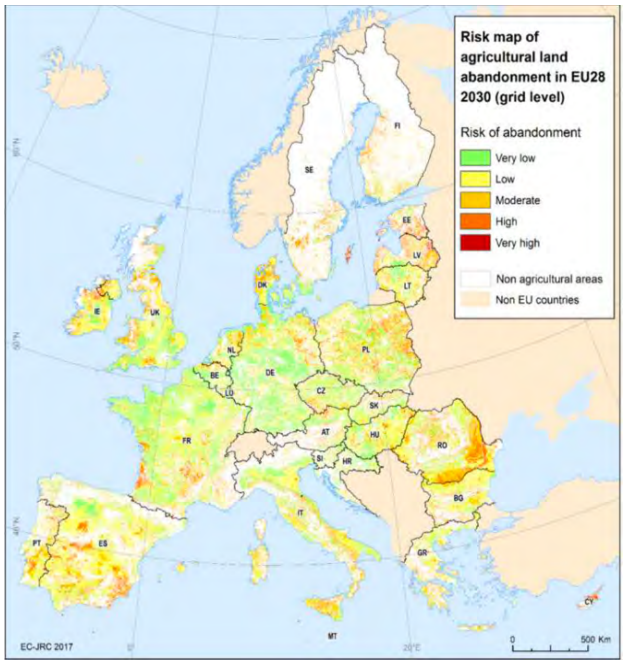


Figure 2: Estimated potential risk of agricultural land abandonment in 2030 at grid level (100-metres resolution) in the EU- *Source: JRC113718, European Commission, 2018*

1.2. Climate change: a factor of acceleration. The case of fire risk.

The phenomenon of climate change has been identified as a contributing factor to the deterioration of the situation. Firstly, it has a direct effect on productivity. This is due to the fact that there is an increase in the frequency and intensity of heat and drought periods, hail and storms, and spring frosts. Then it has an indirect effect, for example in the case of wildlife damages: as abandoned areas and forests expand, the rural population decreases, and with-it potential hunters. During prolonged periods of drought, such as that experienced by Spain from 2021 to 2024, animals are deprived of sustenance (spring shoots, grass, fruit) and water (temporary puddles, dried-up springs). The losses incurred in the vineyards were particularly severe, with roe deer grazing on young shoots and wild boar consuming the grapes.

Moreover, farmland laid out in dry-stone terraces is difficult to mechanize. On gentle slopes, the grouping and levelling of plots, subsidized by the CAP, increases the risk of arable erosion and drought. In the context of farm management, isolated land, characterized by its significant distance from the farm, can present particular challenges in terms of managing fungal attacks. These attacks, when they occur repeatedly, can constitute a significant obstacle to crop productivity and viability (time and cost of round trips by tractor). In the context of isolated plots in a woodland landscape, perennial crops can be exposed to root competition, as well as losses to wildlife. These losses can be difficult to manage, leading to the installation of physical barriers to protect crops. This can lead to significant additional costs and conflicts of use within the landscape.

Climate change is making farming more difficult and exacerbating extreme weather situations, sometimes with dramatic consequences. In the case of wildfires, although Mediterranean landscapes are well adapted to them, the transformation into extreme fires can make them uncontrollable, with increased speed of spread and the return of violent or unexpected fires. This can even lead to the formation of pyrocumulonimbus cloud. In the Mediterranean basin, the number of days with extreme fire risk has more than doubled in the last 40 years.
This means we need to invest in preventive landscape management. The type, distribution and density of vegetation define the amount of continuous fuel present. The abandonment of agriculture in rural areas has led to immature forests advancing, which are often made up of conifers. There is also a risk that the forest of different mountain ranges will become continuous, increasing the amount of fuel available. In general, the concept of a low-flammability landscape can conflict with the need to maintain biodiversity, but in the case of unmanaged continuous forests the agricultural clearings preserve the diversity of environments. Therefore, landscape management must be comprehensive, taking care to address the various local issues. The fire management plan must be approached holistically and with resilience in mind. The traditionally inspired landscape mosaic has the advantage of taking many of these aspects into account. However, it can only be maintained or implemented in collaboration with the local agricultural community.

In that line, Fire Smart Territory is a concept that has been defined by Leone & al. (2020): *a territory with a shared governance model, in which empowered communities with high levels of knowledge and skills are able to decide and manage wildfire risk to keep it very low, through economic and social activities that*

not only can contain (in the end eliminate) wildfire hazard but promote the benefits of fire use. It implies a wide territorial planning [4], which corresponds to some of the landscape management tools defined in the ELC. In particular the "landscape plans" which are translating landscape assessment findings into strategies "for landscape protection, management, and development". These plans often involve setting landscape quality objectives, identifying areas for conservation or restoration, and integrating landscape considerations into other planning processes, as urbanism o risk management... In fact, until now landscape management has been more involved in flood management than fire risk management.

1.3. **Wine producers' perceptions**

In consequence, our research (2021-2024) focused on how crops can contribute to mitigating the fire risk, in particular, we examine the case of viticulture and its impact on the surrounding area. We studied 4 countries: Spain, Portugal, south of France and north of Italy, through 87 in-depth interviews and field visits, and an online survey (2023).



Figure 3. Field visits and in-depth interviews (2021-2024). *Source: CTFC*

Risk management is usually the responsibility of public services. In the case of rural landscape management, the authorities typically seek the support of the local population after the management plan has been finalized. However, the various policies implemented in France in the 1990s to link farming and fire risk management relied on a system of subsidies for young farmers to start their own businesses. These policies relied on the economic dynamism of the activity itself to maintain open spaces without detailing the method of cultivation. The most effective crops were perennial vineyards, which were regularly ploughed and highly profitable. Thirty years later, the vines that still exist (many disappeared) need to be replanted, amid the economic crisis of the wine market and criticism from firefighters, protesting against grass growing between the rows. Furthermore, land abandonment is increasing and the risk of fire has become an issue that affects ever larger areas. The methodology has to change to be able to design fire smart landscapes for whole territories, it means that we need to understand which are the concerns of the producers, if they are interested in engaging in fire reduction measures and why, and if the existing support of administrations can be improved.

Following the model of Fire flocks in Catalonia, which recognizes the role of silvopastoralism in fire risk management, or the Mosaic project in Extremadura, which supports all agricultural production in the Serra de Gata, our proposal is structured around the creation of two brands registered at European scale in 2025 by the CTFC: Fire Wine resilient landscape and Fire Product resilient landscape. But these brands are not only quality brands that add direct value to the product, that's not what producers are asking for. They expressed the need of a tool for recognition by society AND by the authorities. Now it's a matter of working on concrete cases and supporting experiments following the signing of contracts. However, the brand imagined at the outset has evolved into a brand that can be used by self-managed groups (natural areas, designation of Origin, associations, etc.) as well as individual farmers of wineries.

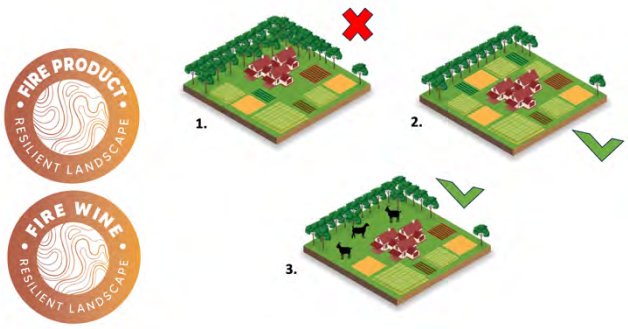


Figure 4. Requirement n°4 "Wildland Urban Interface" ®Fire Wine Resilient Landscape and ®Fire Product Resilient Landscape brands. (1: No buffer zone 2: Agrarian belt 3: Agro-silvo-pastoralism & cultures) *Source: CTFC*

One of our main results, and the most urgent to work on, is the apparent disconnection between the wine and forestry sectors. While vineyard managers often own forests or border forested areas, their awareness of forest management practices relevant to wildfire risk reduction is limited.

The predominant vineyard land use specialization of the respondents may lead to sustainability improvements in focused uniquely on within-property ecosystem services, overseeing the cross-boundary effects, including the management of green cover during the dry season or forest islets. This sectoral fragmentation calls for integrated management strategies across agriculture and forestry sectors. Spanish and French wine growers show the highest rates of forest management planning and are more aware of fire prevention planning. But there is differing fire concern levels across countries which suggests the need for country-specific wildfire risk management strategies, tailored to the specific fire risk culture, challenges and administrative (e.g. property size) settings. [5] What's more, vines are a priori not a crop that is eligible for high rates of climate credit, yet this potential return on land is of particular interest to the wine sector, which is in crisis. In this context, forestry can present new opportunities. This brings us back to the producer's role as a landscape gardener, with arguments that are more convincing than mere declarations to protect areas in the interests of the majority.



Figure 5. Landscape managed by an association of grape growers involved in fire risk management (+500, Pla de Manlleu, Spain). *Source: Soazig Darnay*

Conclusion

Heritage policies are becoming more widespread in response to the disappearance of rural agricultural landscapes and the toughening of climatic and socio-economic challenges. This forces us to rethink our approaches to land management. This argues in favor of a central and assertive landscape policy. The tools described in the European Landscape Convention address the need to manage resilient territories by taking the needs of inhabitants, particularly farmers, into account.

Fire risk and forest management are not generally their primary concerns; they are more interested in the quantity and quality of their production and its sale. Nevertheless, community-level awareness of the risk is growing and could transform the situation, particularly in areas that have already experienced fires. At the same time, the concepts of climate credits and ecosystem services are currently being studied and quantified, leading to a broader understanding of the profitability of land in rural areas.

These are opportunities that must be seized.

Acknowledgments

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IFLA 2025
Guiding landscapes
Nantes France

Short papers

TOPIC 2
Guiding territories with legislative and social advances in planning: organisation of large territories

MAPPING HIGH NATURE CULTURE VALUE RICE TERRACES: AN INTEGRATED FRAMEWORK FOR IDENTIFICATION AND SPATIAL PRIORITIZATION

TOPIC: Guiding territories with legislative and social advances in planning: Organisation of large territories

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Keywords: rice terraces, agricultural landscape, heritage landscapes, spatial mapping, landscape management

Abstract
In the Anthropocene era, traditional rice terrace landscapes are increasingly recognized as exemplary sustainable agricultural ecosystems due to their dual functions of ecological protection and cultural heritage preservation. Systematic assessment of the spatial patterns of High Nature Culture Value Rice Terraces (HNCVrt) is a prerequisite for addressing the risks of abandonment and achieving scientific conservation. Taking the rice terraces of Fujian Province, China, as a case study, this research develops an identification framework for HNCVrt and achieves large-scale spatial mapping. The approach first constructs a rice terrace database by integrating multi-source geospatial data, then develops a natural-cultural dual-dimension hybrid evaluation framework composed of 8 indicators, and finally combines weighted evaluation and weighted linear combination to identify the spatial distribution of HNCVrt. The study finds that the total area of HNCVrt in Fujian is approximately 4,165 km², accounting for 60.7% of the total rice terrace area, mainly concentrated along two major mountain ranges in the western and central parts of the province. The HNCVrt maps provided in this study offer critical spatial evidence for policy implementation, and assist local or other regional authorities in surveying HNCVrt resources and formulating related conservation policies.

1. Introduction

In what is now referred to as the "Anthropocene," humans have become the dominant force driving land transformation, biogeochemical cycles, and biological change. Agriculture is one of the primary drivers of these transformations, particularly through the intensification and expansion of large-scale farming practices since the late 19th and 20th centuries. Modern agricultural systems prioritize industrial inputs and yield maximization, often at the expense of heavy reliance on chemical fertilizers, pesticides, and growth hormones. This has led to a range of global challenges, including biodiversity loss, groundwater depletion, increasing soil salinization, rising greenhouse gas emissions, and growing rural inequality. In stark contrast, traditional agroecosystems have attracted increasing attention for their ability to balance ecological conservation and cultural heritage, offering a more sustainable model that harmonizes environmental protection, socioeconomic development, and long-term sustainability.

The rice terrace landscape is a quintessential example of such traditional agroecosystems. It is an ancient agricultural system widely distributed in mountainous and hilly regions, particularly in countries around the Pacific Rim, such as China, Japan, South Korea, India, the Philippines, and Indonesia. Through low-intervention farming practices, rice terraces have effectively preserved both biodiversity and cultural diversity. These systems are characterized by traditional cultivation methods that typically involve minimal use of agrochemicals and fertilizers, maintain diverse landscape mosaics, and have long-standing histories of farming and settlement. Many ancient rice

terraces have become popular tourist destinations and have been recognized as World Heritage Sites and Globally Important Agricultural Heritage Systems (GIAHS). However, rice terrace systems today face a dual challenge. On the one hand, farmland in these areas is subject to severe natural constraints and is increasingly at risk of abandonment due to limited economic viability. Broader social issues—such as rural aging, population decline, and decreasing agricultural income—further intensify this risk. On the other hand, existing conservation frameworks suffer from critical bottlenecks, including the lack of standardized value assessment criteria, limited spatial coverage, and outdated quantitative methods. Most protected areas rely on case-by-case nomination processes, which often fail to cover remote regions effectively.

At present, a number of policies and studies have explored the conservation of related agroecosystems, such as the establishment of GIAHS and the formulation of farmland protection policies. Since the early 21st century, the academic community has also developed the concept of High Nature Value farmlands (HNVf), which aims to conserve natural and semi-natural areas—both within and beyond existing protected areas—that support species and habitat diversity [1, 2]. Some scholars have also explored mapping approaches for cultural landscapes [3]. However, in the context of rice terrace conservation in Asia, research on the designation of relevant protected areas remains scarce. Few studies have attempted to quantify the value of rice terraces at large scale or to map high-value rice terraces. Yet, delineating the spatial extent of high-value terraces or potential conservation zones is critical for maintaining these unique agroecosystems, as the effectiveness of policies and conservation measures heavily depends on their spatial implementation.

In light of this, this study aims to develop a conceptual framework for high nature culture value rice terraces (HNCVrt), and conduct a comprehensive spatial assessment of their distribution, using Fujian Province, China as a case study. The results are intended to inform the formulation of targeted policies and conservation strategies.

2. Methods

2.1. Research area

This study focuses on Fujian Province, China, which administers nine prefecture-level cities: Fuzhou, Xiamen, Zhangzhou, Quanzhou, Sanming, Putian, Nanping, Longyan, and Ningde, with a total land area of approximately 1.24×105 km2. Located along the southeastern coast and separated from Taiwan by the sea, Fujian is bounded by natural mountain ranges that distinguish it from neighboring provinces, forming a relatively independent geographical unit. The province is characterized by dense river systems and a terrain that descends from the northwest to the southeast. Two major mountain systems—Wuyi–Daimo Mountains and Jiufeng–Daiyun–Boping Ranges—cut diagonally across the province, resulting in mountainous and hilly areas accounting for about 83% of the total land area. This distinctive topography provides a natural foundation for the development of rice terraces, making Fujian an ideal region for studying the spatial distribution of HNCVrt.

2.2. Rice Terrace Identification

The first step of the study was to identify the spatial distribution of rice terraces in Fujian Province. The primary data sources included: a 30 m resolution terraced fields dataset [4], a 10 m resolution double-season rice dataset, and a 10 m resolution single-season rice dataset [5]. The construction of the rice terrace dataset involved the following steps: First, all rice datasets from 2017 to 2020 were merged. Second, the 10 m resolution rice data were resampled to 30 m resolution using a "maximum value resampling" function. Finally, a "raster intersection" function was applied to combine the rice data with the terrace data, resulting in a spatial map of rice terraces in Fujian Province.

2.3. Dual-dimensional evaluation framework

The study selected basins as the basic unit of analysis, as they represent fundamental geographical units for human habitation. Basin data were obtained from the Resource and Environment Science and Data Center of the Chinese Academy of Sciences (https://www.resdc.cn/). This dataset was derived from a Digital Elevation Model (DEM) using the spatial analysis functions of raster systems in GIS, and includes all river networks and sub-watersheds in China with an area greater than 100 km². Only basins containing rice terraces were extracted for analysis.

The study established a dual-dimensional evaluation framework encompassing both natural and cultural aspects. Based on the principles of data availability and measurability, eight indicators were selected to represent the natural and cultural values of rice terraces (Table 1).

In the natural value, the Mean Patch Area (PA) reflects the average area of rice terraces; larger values generally indicate higher landscape integrity. The Mean Shape Index (SI) increases with shape complexity, implying more pronounced edge effects. Relief Amplitude (RA) represents terrain variation, with higher values contributing to more diverse microhabitats. Both PA and SI are calculated from the rice terraces dataset, while RA is derived from elevation differences within the DEM data covering the rice terrace areas. Biodiversity Value (BIO) is based on the 1 km-resolution Biodiversity Abundance Index dataset [6], which reflects the variation in species richness across different ecosystem types per unit area, indirectly indicating the biological abundance of the evaluated region.

In the cultural value, the Globally Important Agricultural Heritage Systems (GIAHS) represent historically significant agricultural landscapes and traditional farming practices; this study only includes sites explicitly associated with rice terraces. Historic Cultural Towns & Villages (HCTV), National Traditional Villages (NTV), and Provincial Traditional Villages (PTV) are all key built heritage elements that embody historical memory and regional identity. For HCTV, NTV, and PTV, only heritage sites located within a 3 km buffer zone around the rice terraces are considered, as sites beyond this distance are less likely to be directly related to rice terrace landscapes.

2.4. Weighted Indicator Integration and Mapping

For the above 8 indicators, Pearson correlation analysis was first conducted to ensure that the correlation between any two indicators remained below 0.8. Second, the study assigned equal weights to the two main dimensions—nature and culture—each contributing 0.5 to the overall value. For the sub-indicators within each dimension, the Entropy Weighting Method was applied to determine their respective weights, based on differences in information content across the datasets. This approach helps to reduce the subjectivity and bias inherent in expert-based weighting [7]. To prevent any single indicator from being overly dominant, a maximum weight threshold of 0.188 was set. Third, the data were standardized using both Z-score and [0,1] normalization methods, and then aggregated according to the assigned weights to generate a composite map of nature-cultural values for rice terraces in each basin. Finally, the Natural Breaks (Jenks) method was applied to classify the values into five levels, with the top two classes representing the HNCVrt.

Table 1. Indicators of HNCVrt.

Categories	Variable	Description and calculation method	Weights
Natural value	Mean patch area (PA)	PA=A/N, A is the total area of rice terraces, while N is the count of patchs	0.188
	Mean shape index (SI)	$SI=0.5P/\sqrt{\pi A}$, P is the perimeter of rice terraces, while A is the total area of rice terraces	0.185
	Relief amplitude (RA)	$RA=E_{max}-E_{min}$, E_{max} is the maximum elevation within 1000 ha, while E_{min} is the minimum elevation within 1000 ha	0.075
	Biodiversity values (BIO)	BIO refers to the importance or worth of the variety of species in a region	0.027
Cultural value	Important Agricultural Heritage Systems (AHS)	AHS refers to the number of Globally Important Agricultural Heritage Systems about rice terraces	0.188
	Historic Cultural Towns & Villages (HCTV)	HCTV refers to the number of Chinese Historic Cultural Towns & Villages near rice terraces	0.117
	National Traditional Village (NTV)	NTV refers to the number of Chinese National Traditional Village near rice terraces	0.063
	Provincial Traditional Village (PTV)	PTV refers to the number of Fujian Provincial Traditional Village near rice terraces	0.050

3. Results

Based on the above methodology, a rice terrace distribution map for Fujian Province, China was generated. To enhance visual clarity, Figure 1 illustrates the proportion of rice terrace area within 1 km × 1 km grid cells. The results show that rice terraces are widely distributed across the province, with concentrations primarily in the western and central regions, while the coastal areas have relatively sparse coverage. Using pixel-based statistics, the total area of rice terraces was estimated at approximately 6,866 km². By overlaying the rice terrace data with basin boundaries, 690 watersheds containing rice terraces were identified, which served as the fundamental units for subsequent analysis.

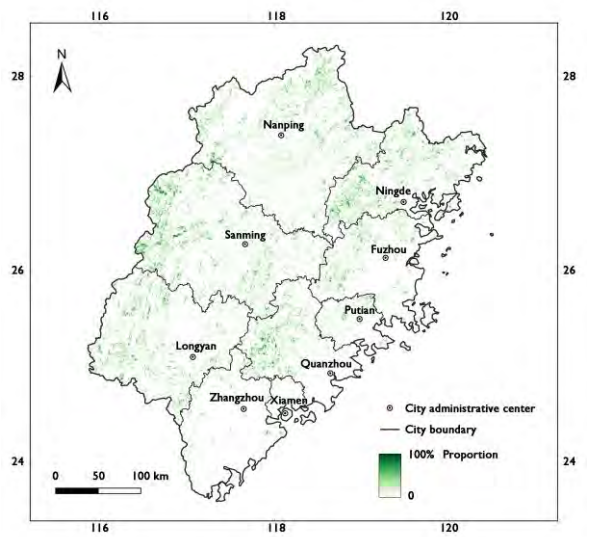


Figure 1. Rice terraces distribution in Fujian.

Through data analysis and visualization, we captured the full spectrum of values across the study area—from high-value to low-value locations (Figure 2). Using the Natural Breaks (Jenks) method, we identified two categories of HNCVrt: the highest value areas were classified as HNCVrt 1, and the next highest as HNCVrt 2 (Figure 3). These HNCVrt are primarily concentrated in two major mountain belts running through the western and central parts of the province, forming two linear spatial patterns parallel to the coastline. Key areas include the entirety of Ningde, the western parts of Quanzhou, Fuzhou, and Putian, the western regions of Sanming and Longyan, and the northern part of Nanping. The distribution of HNCVrt 1 is relatively scattered but can be summarized into five clusters: the Northern Fujian cluster (Wuyishan–Pucheng), the Northeastern Fujian cluster (Pingnan–Gutian–Zhouning), the Central Fujian cluster (Youxi–Dehua–Minqing), the Southern Fujian cluster (Nanjing–Yongding), and the Western Fujian cluster (Changting–Liancheng–Qingliu–Ninghua).

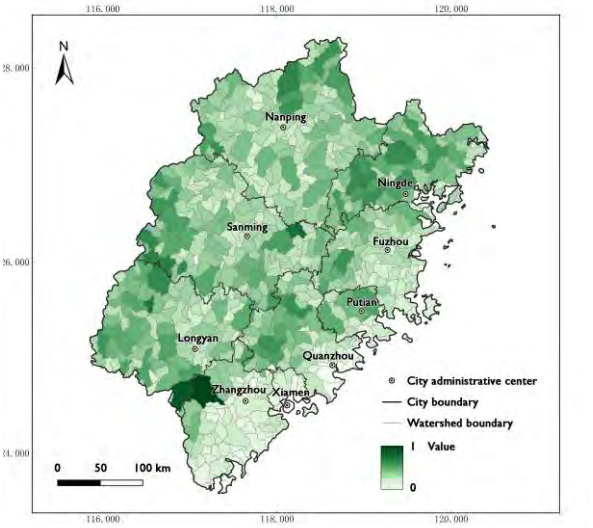


Figure 2. Natural and cultural value levels of rice terraces in Fujian.

We also used pixel-based statistics to calculate the total area of HNCVrt. Results show that HNCVrt cover approximately 4,165 km², accounting for 60.7% of the total rice terrace area in Fujian. Among these, HNCVrt 1 alone occupies 1,225 km², or about 17.8% of the total rice terrace area. At the city level, Sanming has the largest HNCVrt area (966.9 km²), followed by Ningde (820.3 km²), Longyan (767.0 km²), and Nanping (755.6 km²) (Figure 4a). As for HNCVrt 1, Ningde leads with 373.6 km², followed by Sanming with 298.4 km²—both significantly higher than in other cities (Figure 4b). In contrast, Xiamen, Putian, Zhangzhou, and Fuzhou show relatively limited extents of both HNCVrt and HNCVrt 1.

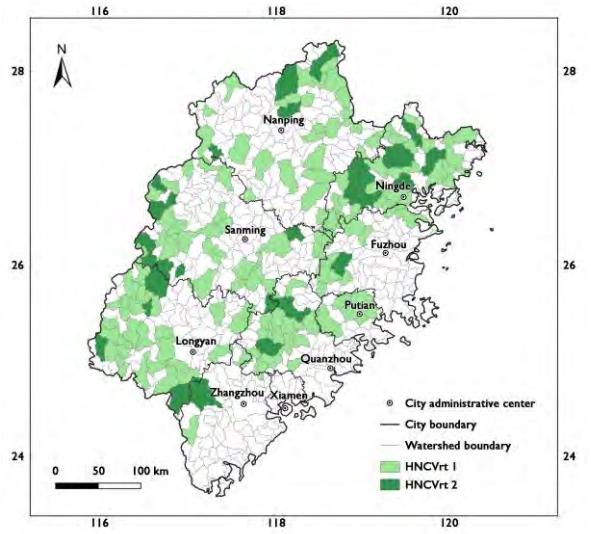


Figure 3. Map of High nature culture value rice terraces in Fujian.

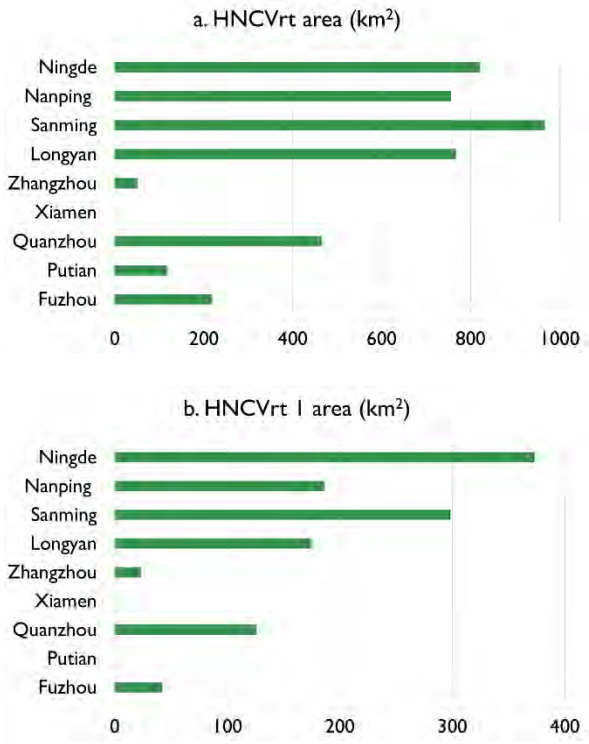


Figure 4. Area Statistics of high nature culture value rice terraces in Fujian.

4. Discussion and Conclusion

This study, based on spatial analysis methods, systematically identified and mapped the spatial distribution of HNCVrt in Fujian Province. It not only revealed the spatial pattern characteristics of rice terraces but also provided a quantitative foundation for formulating more targeted conservation strategies. The most significant finding is that HNCVrt are mainly concentrated along two mountain ranges in the western and central parts of the province, with their distribution closely aligned with the orientation of Fujian's major mountain ranges and mostly located near the borders of prefecture-level cities. This spatial pattern strongly indicates that topography is the core natural driver shaping the rice terraces and their high nature-cultural value. Meanwhile, the concentrated distribution in the border mountainous areas suggests that these regions, historically relatively remote and less affected by large-scale modern agricultural transformation, are more conducive to preserving traditional farming practices and cultural diversity, thus nurturing a high composite value of nature and culture. Notably, HNCVrt I forms five distinct geographic clusters within the province, which are recommended as key areas for terrace heritage conservation in Fujian. Conservation efforts should consider the characteristics of these clusters to explore differentiated protection and distinctive development pathways. Area analysis further reveals a high unevenness in terrace value, indicating that resource allocation should prioritize areas rich in rice terraces, such as Sanming and Ningde.

These findings hold significant implications for both theory and practice in rice terrace conservation. On one hand, the proposed HNCVrt framework and identification method provide quantifiable standards and tools for systematically assessing the combined natural and cultural value of rice terraces, breaking away from the traditional case-based conservation approach. On the other hand, the generated HNCVrt distribution maps clearly reveal the spatial locations of high-value terraces, covering extensive areas including remote mountainous regions, thus overcoming the limitations of current protected area networks and offering crucial spatial evidence for policy implementation.

Despite the progress made in identifying HNCVrt, it is important to acknowledge certain limitations of the methodology. Similar to other GIS analyses relying on existing geospatial data, this study faces challenges related to data resolution, generalization errors, and uncertainties, which are especially prominent in complex terrains such as Fujian [8]. Future research should advance on two fronts: at a large scale, by further refining the evaluation indicator system and extending the application of the proposed methods to broader regions to identify representative HNCVrt areas nationwide; at a finer scale, by integrating local practices through field surveys and validation to refine value assessments and conservation strategy designs for key areas, thereby more effectively supporting the in-depth advancement of rice terrace conservation efforts.

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INTERNATIONAL COMPARATIVE STUDY ON SPATIAL REGULATION AND GOVERNANCE SYSTEMS IN NATIONAL PARKS

TOPIC: Guiding territories with legislative and social advances in planning: Organisation of large territories

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Keywords: National Parks, Spatial Regulation, Governance Systems, Legal and Policy, Planning Transmission

Abstract

Spatial regulation in national parks is a crucial institutional tool for coordinating ecosystem conservation with sustainable resource utilization and for achieving the strategic objectives of China's national park system. However, China currently faces institutional fragmentation across the legal, planning, and implementation dimensions, with regulatory mechanisms suffering from challenges in legitimacy, continuity, and tool diversity. In response, this study adopts a comparative institutional perspective to systematically analyse the spatial regulation systems of national parks in the United States, Germany, France, Italy, and the United Kingdom. It constructs a unified four-tier analytical framework—territorial, zonal, specialised planning, and project-based levels—to summarise the legal foundations, zoning structures, implementation mechanisms, and project-level accountability.

The findings reveal three typical regulatory models shaped by differences in governance structures and legal traditions: (1) the "legislative-centric model" (France and Italy), which relies on rigid legal mandates and centralised control, suited to centralised states; (2) the "planning-led model" (Germany and the UK), which combines legal authorisation with flexible local planning and permitting mechanisms; (3) the "adaptive-flexible model" (the United States), which de-emphasises unified zoning and regulates through specialised plans and project-based accountability. Despite differences, these systems share a common logic of progressive zoning, hierarchical planning transmission, and integrated legal-policy-tool coupling. Together, they form a systemic spatial governance mechanism oriented by overarching goals, classified uses, and tiered implementation.

Based on this comparative insight, the study proposes optimisation pathways for China: (1) legally, a dual-track framework of "rigid legislative authorisation + flexible policy implementation," embedded in a forthcoming National Park Law; (2) planning-wise, a multi-level transmission mechanism from national strategy to project execution to bridge zoning-to-grounding gaps; (3) operationally, a toolbox of gradient regulatory instruments tailored to ecological sensitivity and spatial functions. Through structural coupling of law, planning, and tools, China can build a stable, operable, and responsive regulatory system for spatial use in national parks—one that safeguards ecological integrity while balancing community development and sustainable spatial utilisation in support of ecological civilisation.

1. Introduction

Spatial regulation in national parks plays a critical role in translating territorial spatial planning principles into actionable frameworks for ecosystem conservation and sustainable resource utilization. Unlike mature regulatory systems in many developed countries that are grounded in legal authorizations and characterized by dynamic zoning models[1], China still faces structural deficiencies in the regulatory chain linking law, planning, and implementation[2,3]. These shortcomings hinder the realization of the strategic goals set for the national park system and call for refined, context-sensitive governance tools.

Internationally, the conceptual focus of spatial regulation in national parks has shifted from static zoning constraints to procedural and adaptive governance[4]. In the United States, for instance, the rigid enforcement of zoning has given way to a suite of flexible management regulations[5], while Germany has introduced time-phased dynamic zoning to enhance ecological adaptability[6]. These shifts signal a growing recognition of the need for regulatory frameworks that align with the dynamic nature of ecosystems.

In China, academic research has increasingly acknowledged the limitations of traditional spatial control mechanisms. Recent studies have focused on three core themes: (1) systematic learning from international zoning and implementation practices, especially regarding rule design and operational mechanisms; (2) domestic innovations in zoning frameworks, evolving from boundary delineation to localized and fine-grained governance centered on control units[7]; (3) efforts to integrate protected areas into the broader territorial spatial planning system, emphasizing hierarchical planning and coordination.

On the practical level, China faces three structural challenges. First, the regulatory framework is policy-dominated and legally underdeveloped, resulting in low legitimacy and weak enforceability—especially in areas with high proportions of collectively-owned land[8]. Second, the planning transmission chain often suffers from vertical disconnection, with excessive focus on zoning design and insufficient attention to regulatory enforcement[9]. Third, existing regulatory tools are overly uniform, failing to accommodate the complex spatial demands of national parks that must balance heritage preservation, ecological product development, and community needs[10].

To address these issues, this study adopts an institutional comparative method, selecting five representative countries—the United States, Germany, France, Italy, and the United Kingdom—to explore how legal, planning, and implementation systems are structured and coupled. The research seeks to answer three guiding questions: (1) How can a policy-dominant model authorized by law strike a dynamic balance between ecological rigidity and local flexibility? (2) How can a four-tier transmission system from territorial to project levels resolve the current planning-implementation gap? (3) How can a gradient-based toolkit be designed to support multifaceted spatial governance? The goal is to extract policy-relevant insights and methodological guidance for constructing a robust and adaptable spatial regulation system tailored to China's national parks.

2. Research Methods and Framework

This study adopts a comparative institutional analysis approach, focusing on four core components of national-level spatial regulation systems in national parks: legal foundations, zoning rules, implementation mechanisms, and regulatory instruments. Five countries—namely, the United States, Germany, France, Italy, and the United Kingdom—are selected as the subjects of comparison. These countries represent diverse legal traditions (civil law and common law), governance structures (centralised and federal), and ecological governance models (strict preservation vs. flexible use), offering a high degree of institutional variation and analytical value.

The research draws primarily on official legal texts, policy documents, planning guidelines, and implementation reports from each country. It also integrates insights from recent academic literature in the fields of ecological conservation and territorial spatial planning. Through this synthesis, the study extracts common regulatory logics and structural patterns, which in turn serve as a reference for developing a context-sensitive spatial regulation framework for China's national parks.

3. Comparative Results

3.1 Regulatory Systems

The national park spatial regulation systems across the five countries share a common feature: a progressively tiered and categorised quantitative control model. Zoning regulation establishes the overarching spatial layout for balancing ecological protection with sustainable use. Categorical

regulation specifies the types of permitted land uses, such as agriculture, infrastructure, and service industries. Site-specific regulation determines the exact location, scale, and intensity of these uses. The implementation of this zoning–categorisation–localisation framework is progressively realised through a hierarchical subdivision of spatial control units(Figure 1-5).

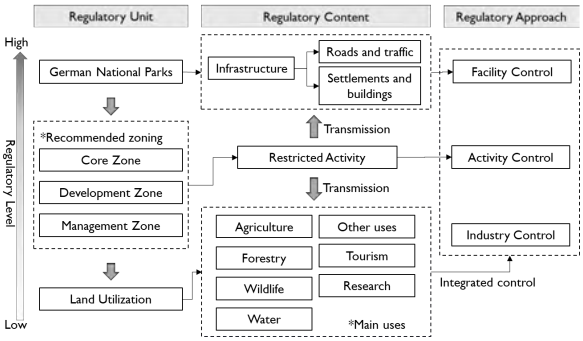


Figure 1. Regulatory Model of German National Parks

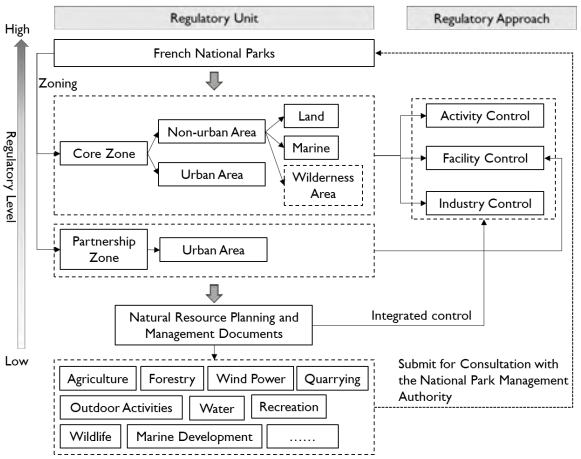


Figure 2. Regulatory Model of French National Parks

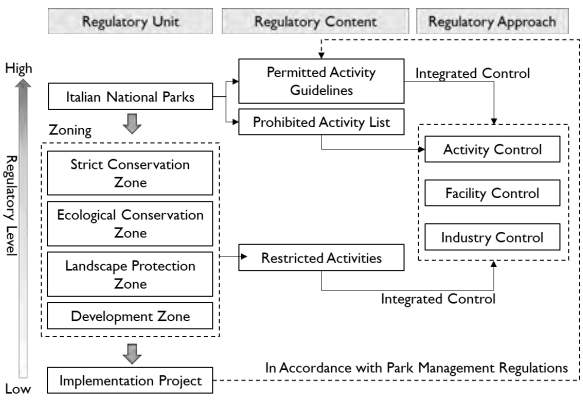


Figure 3. Regulatory Model of Italian National Parks

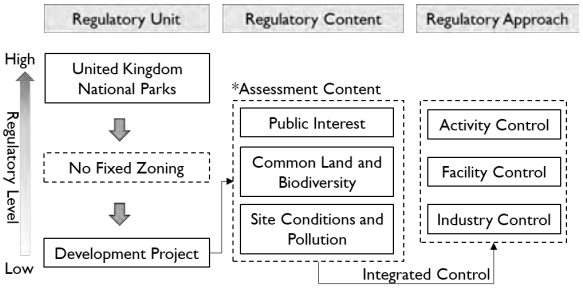


Figure 4. Regulatory Model of United Kingdom National Parks

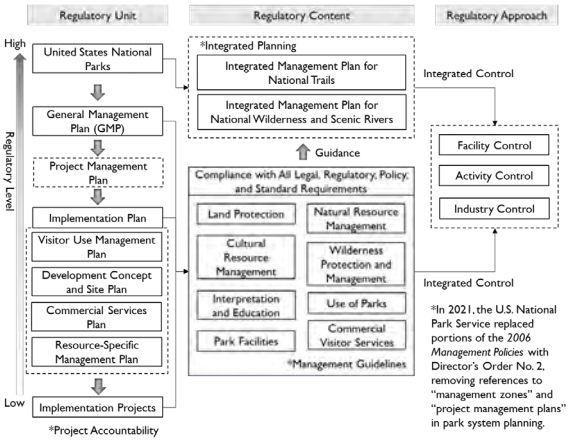


Figure 5. Regulatory Model of United States National Parks

Through a detailed analysis of the spatial regulation systems in national parks across five countries, it becomes evident that significant differences exist in their institutional design, implementation mechanisms, and governance logic (Table 1). These differences not only reflect the distinct traditions of nature conservation and legal systems in each country, but also represent their respective institutional responses to balancing the relationships among ecological protection, spatial utilisation, and social participation.

Table 1. Characteristics and Applicability of National Park Regulatory Systems in Five Countries

Country	Institutional Features	Strengths	Weaknesses	Applicable Contexts
Germany	Legal authorisation + policy-led; dual-level governance (federal and state); dynamic	Clear goal orientation; ecologically progressiv	Significant regional variation in standards; lengthy implementation cycles	Suitable for federated systems with strong local autonomy and ecological restoration goals

	zoning + categorical use control	e zoning mechanism		
France	Legislation-led model; rigid protection in core zones + flexible coordination in cooperation zones	Strong legal foundation ; clear zoning responsibil ities	Execution in cooperation zones depends on local willingness	Suitable for centralised states requiring integrated rural-urban spatial coordination
Italy	Statutory zoning with combined positive and negative lists	Refined gradient control; tight coupling of protection and utilisation	Limited flexibility; insufficient local discretion	Suitable for areas with both cultural landscapes and traditional land use requiring coordinated protection and community development
United Kingdom	Weak zoning + strong permitting; locally managed approval system	High flexibility; adaptable to diverse land ownership structures	Long assessment periods; uneven local capacities	Suitable for countries with high private land ownership and mature local planning systems
United States	Adaptive planning + project accountability; no unified zoning	Robust implement ation mechanism s; high adaptabilit y	High legal-technical thresholds; cost-intensive	Suitable for legally mature, federated systems with strong coordination and diverse demands

3.2 Legal Foundations

Although all five countries ground their national park spatial regulation systems in legal frameworks, the relationship between law and policy differs markedly (Table 2). In France and Italy, a legislation-dominant institutional logic is especially prominent. Spatial regulation rules are directly embedded in primary legal texts such as the *Environmental Code* and the *Framework Law on Protected Areas*, which prescribe statutory zoning standards and boundaries for permitted activities. These systems emphasise state-led authority and unified control, making them well-suited to contexts with centralised governance structures and clearly defined policy objectives.

In contrast, Germany, the United Kingdom, and the United States reflect a policy-dominant model under legal authorisation. In Germany, the *Federal Nature Conservation Act* delegates authority to the states to formulate specific regulatory norms within a national framework. The UK's system relies on the *National Planning Policy Framework*, which sets overarching goals, while local park authorities develop detailed implementation rules based on local conditions. In the United States, the *National Park Organic Act* and the *National Environmental Policy Act* provide the legal foundation, empowering the National Park Service to issue management policies, operational procedures, and evaluation standards—thus forming a dynamic governance chain that moves from legal authorisation to policy refinement and operational enforcement.

Table 2. Legal and Policy Basis for Spatial Regulation in National Parks

Model Type	Country	National-Level Legislation	National-Level Regulatory Policies	Administrative Framework
Legislation-Dominant	France	Environmental Code	–	Centralised vertical management
	Italy	Framework Law on Protected Areas, Environmental Law	–	Multi-level decentralised governance
Policy-Led under Legal Authorisation	Germany	Federal Nature Conservation Act	Guideline on National Park Planning System and Content Proposal	State-led implementation
	United Kingdom	Environmental Law	National Planning Policy Framework	Localised planning autonomy
	United States	U.S. Constitution, National Park Organic Act, NEPA	NPS Management Policies, Director's Orders	State–local co-governance

3.3 Planning Transmission Strategies

3.3.1. **Territorial Level**

This level primarily addresses cross-regional ecological issues, such as biodiversity conservation, infrastructure layout, and the construction of ecological buffers. It defines the overall functional objectives of national park systems. Countries such as Germany, Italy, and the United States establish ecological control boundaries and overarching development frameworks through national or federal-level planning documents. The aim is to transcend administrative boundaries, integrate spatial governance resources, and ensure the continuity and integrity of ecosystem functions.

3.3.2. **Zonal Level**

Acting as an intermediary mechanism between macro ecological goals and spatial management rules, this level involves the classification of land based on ecological sensitivity. Typical zoning categories include core protection zones, restoration zones, utilisation zones, and recreational zones. Germany adopts a "dynamic zoning" approach, allowing for spatial and temporal transitions in land functions. France implements a "core–cooperation" dual-zone model, combining strict protection with flexible coordination. Italy establishes four functional zones defined explicitly by law, with each zone stipulating permitted and prohibited activities. This zoning mechanism

enables spatial differentiation while enhancing rule operability and responsiveness to local conditions.

3.3.3. **Implementation Level**

In the implementation phase of spatial regulation, all five countries take the "project" as the basic governance unit. Around project access, procedural monitoring, and performance accountability, diverse regulatory instruments are employed. These follow three typical paths:

(1) Resource management-oriented (Germany, France): Regulation is grounded in land-use classification systems, with natural resource management documents detailing regulatory requirements. For instance, Germany classifies parkland into agricultural, forestry, and tourism categories, each accompanied by development plans and use protocols to align resource utilisation with protection goals.

(2) Goal-oriented (United States): This approach gradually weakens traditional zoning in favour of "specialised implementation plans" that guide spatial behaviour through clearly defined conservation objectives. These plans integrate spatial strategies with project-level evaluation to ensure regulatory outcomes.

(3) Constraint-oriented (United Kingdom, Italy): Projects or activities are directly treated as regulatory units, with planning permit systems or positive/negative list rules used to manage access. This model emphasises the integration of legal responsibility and administrative approval authority.

3.3.4. **Project Level**

At this level, two representative regulatory models are observed:

(1) The UK's development review system : This approach replaces rigid zoning control with a planning permit mechanism, emphasising dynamic approval and adaptive management. Specifically, any land development or significant change in land use must obtain permission from local planning authorities. A pre-assessment process ensures that projects align with ecological protection goals.

(2) The U.S. project accountability system: This model strengthens project implementation constraints through a tightly integrated legal and accountability framework. As traditional zoning hierarchies are de-emphasised, U.S. national parks adopt planning projects as the final unit of regulation, forming a transmission chain of "goal → rules → project."

4. Summary and Typology of Regulatory Models

Based on comparative analysis, three typical types of national park spatial regulation systems are identified (Table 3):

(1) Legal-Integrated Model (France, Italy): Characterized by rigid legislative frameworks and clearly defined zoning rules. These systems suit countries with strong central authority and high ecological sensitivity.

(2) Planning-Led Model (Germany, UK): Emphasizes planning discretion and local flexibility, under general legal authorization. Appropriate for federal or decentralized systems with complex land ownership patterns.

(3) Adaptive-Flexible Model (United States): Relies on outcome-based implementation plans and project accountability mechanisms, enabling high responsiveness to dynamic spatial demands.
These models reflect different trade-offs among legal rigidity, policy flexibility, and ecological governance needs. While distinctive, elements of each model can be hybridized.

Table 3. Typology and Applicability of Spatial Regulation Models in National Parks

Regulatory Model	Representative Countries	Applicable Features
Legislation-Centric	France, Italy	Strong centralisation, high ecological sensitivity
Planning-Led	Germany, United Kingdom	Strong local autonomy, diverse land ownership
Adaptive-Flexible	United States	Mature legal system, project-oriented governance, high demand heterogeneity

5. Institutional Recommendations for China

To address the current institutional challenges facing China's national parks—namely, inadequate legal authorisation, discontinuities between planning and implementation, and a limited array of regulatory instruments—this study proposes a set of optimisation strategies spanning legal, planning, and operational dimensions.

Legally, it is imperative to expedite the formulation and enactment of a National Park Law that explicitly establishes the legal status of spatial regulation, clarifies the division of responsibilities, and defines fundamental principles. This should support the construction of a dual-track framework that combines legislative rigidity with policy flexibility. Complementary policies and technical guidelines can then be used to refine implementation pathways and improve the contextual adaptability and operability of policy enforcement.

In terms of planning, a four-tier transmission mechanism—linking territorial strategies, zonal controls, specialised plans, and project-level execution—should be established. At the national level, ecological function zones and control intensities would be defined; at the local and park levels, detailed management rules and spatial indicators would be formulated; specialised plans would coordinate resource management; and individual projects would serve as the final execution units for access evaluation and performance oversight. This system is essential for bridging existing vertical disjunctions and achieving a coherent and responsive transmission of regulatory intent.

On the operational front, a gradient toolbox of spatial regulation instruments should be developed according to the classification of zones. In core zones, stringent controls should be implemented through positive activity lists and quantitative ecological indicators to safeguard ecosystem authenticity and integrity. In restoration zones, phased negative lists and ecological recovery guidelines can offer moderate regulation to guide natural succession. In utilisation zones, negative lists combined with carrying capacity thresholds can steer compatible development activities, while in recreational zones, flexible mechanisms such as visitor capacity limits and ecological credit–based reservation systems can be employed to improve spatial efficiency and enhance the quality of public services.

Through the systemic integration of legal authority, planning transmission, and regulatory tools, China has the potential to establish a national park spatial regulation regime that is structurally stable, procedurally effective, and institutionally inclusive—capable of safeguarding ecological security at the national scale while unlocking the governance potential of local communities.

6. Conclusion

As a core component of China's ecological civilisation framework, national parks serve the dual purpose of preserving ecosystems and enabling the sustainable use of natural resources. Spatial regulation within national parks plays a pivotal role in reconciling ecological integrity, orderly community development, and the provision of diverse public services. This study employed a comparative institutional methodology to analyse the legal foundations, planning hierarchies, implementation mechanisms, and project-level strategies of national park spatial regulation systems in the United States, Germany, France, Italy, and the United Kingdom. Three typical regulatory models were identified, and China-oriented optimisation pathways were proposed in light of domestic conditions.

The findings indicate that, despite institutional differences, all five countries emphasise dynamic coordination between zoning and use rules, closed-loop transmission between planning and implementation, and functional complementarity between legal mandates and policy instruments. These structurally coupled systems significantly enhance the coherence, adaptability, and resilience of spatial regulation, offering valuable insights for China's national park governance.

Looking forward, China should construct a hybrid spatial regulation framework that integrates legal certainty, planning transmission, and a diverse toolset. A rigid legal system will clarify regulatory responsibilities; planning mechanisms will translate ecological goals into actionable units; and project-level tools will ensure scientific, measurable implementation. Together, these elements will enable China's national park system to move from institutional exploration toward operational maturity.

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THE (IN)EXISTENCE OF NATURE-BASED SOLUTIONS FOR CLIMATE RESILIENCE: FROM THEORY TO PRACTICE IN THE LANDSCAPE OF CURITIBA, BRAZIL

TOPIC: Guiding territories with legislative and social advances in planning: Organisation of large territories

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Abstract

The world is in the midst of a climate crisis, and it is imperative to seek alternatives for adaptation and resilience of the urban landscape. However, climate change not only alters the climate, but is also much more and something different. It is a metamorphosis in ways of thinking and consuming, affecting social, political, economic, and legislative aspects {Beck2016}. In the middle of this emergency, in recent decades, there has been an attempt to explore an infrastructure that encourages the recovery of nature in urban spaces. To this end, there are Nature-Based Solutions (NbS), application of techniques that mimic natural processes and which have been highlighted as an important option in the face of climate change. However, its use is still sparse and timid its use in the Global South, especially in the Brazilian context. The general objective of this text is to explore the relevance and application of NbS in the city of Curitiba, located in the southern region of Brazil. To this end, a survey will be conducted to determine whether - or not - there are practices that may fall under the NbS classification, comparing the analysis with the production of normative documents produced by the city's public administration, more specifically through the collection of guides, booklets, and manuals. Curitiba was selected as the target for exploration due to its supposed reputation as a "smart city" and "ecological city", as well as for being part of the "C40 Cities" group. This global network includes 97 cities whose public administrations have made a global commitment to address the climate crisis through adaptation and resilience actions. The aim, therefore, is to expose the real gap between the production of regulations and the incentive for the use of NbS in municipal urban planning, to identify breaks in their use in the Brazilian context. Through this comparison, we aim to identify possible causes for the lack of adoption of nature inspired solutions in the Brazilian urban landscape, especially in the context of a city that has been presenting a concern with the climate issue on its Public Agenda - especially since 2020, when it launched its first Climate Action Plan. Thus, this year is used as a reference to guide the time frame of the research's technical procedures, which were carried out in two stages, based on a qualitative and quantitative and exploratory approach. The first phase, supported by a field survey, verified the works in public spaces completed in the last five years and assessed whether there is any evidence of the use of NbS. Subsequently, the documentary phase, related to the analysis of interpretative content of manuals, guides, and booklets produced by the public administration of Curitiba, since 2020, presents considerations about the idealization of NbS. Therefore, this work seeks to contrast the real use of Nature-Based Solutions as an alternative for adaptation and resilience with what is imagined by official and normative documents.

The urban landscape in a world in transformation

Planet Earth is now warmer compared to the end of the 19th century, with the last decade, from 2011 to 2020, considered the hottest in recorded history. Climate change has been triggering extreme weather and climate events in all regions of the world {IPCC2023}. However, as Beck {2018, p.154} aptly stated, "climate change is not just climate change; it is at the same time much more and something different. It is a reform of ways of thinking, of lifestyles and consumption habits, of law, economics, science, and politics."

There is a scientific consensus that human activities - particularly through the emission of greenhouse gases such as carbon dioxide - are causing the Earth's climate to change at a frightening pace {Harari2018}. This is because, beyond the fact that climate change is a global phenomenon, in which natural climate variability is observed over comparable time periods, it is unequivocal that human influence has warmed the atmosphere, the oceans, and the land {IPCC2023}. It is urgent to recognize that the human inhabitants of this planet will face, within just a few decades, global environmental changes on an unprecedented scale and at an unprecedented speed {Veiga2023}.

According to Harari {2018}, if Homo sapiens continue to behave as "ecological serial killers", not only will a large percentage of various life forms be annihilated, but human civilization itself will collapse. According to the AR6, the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), climate change has already caused substantial and irreversible damage to ecosystems, with the extent and magnitude of its impacts greater than previously estimated in earlier assessments {IPCC2023}.

Thus, the climate crisis is understood as a challenge of our time, one that pertains both to everyday life and to the global geopolitical order. As Veiga {2023} notes, a sequence of changes may ripple through a vast array of already established patterns of relationships. Climate change alters local ecology, but also entire chains of behavior, with its effects even reflected in how we understand and transform the urban landscape.

As a construction and reflection of natural, cultural, and especially social elements, it is within the landscape that, beyond observing the consequences of these changes, one can explore alternatives aimed at urban resilience. Just as society undergoes a process of transformation - at varying rhythms and intensities - the landscape also needs to adapt to society's new needs. From this perspective, it is affirmed that changes in landscapes are therefore the result of both human influence and natural processes.

The concept of landscape requires a multidisciplinary investigation based on a complex and polysemic analysis. Etymologically, landscape encompasses the description of the static and dynamic characteristics of a given region, through both natural and cultural aspects. It is therefore accurate to state that it is not isolated from everyday life, but rather represents an interrelationship among cultural, material, and - above all - human dimensions: "it involves starting from the idea that there is a co-belonging of humans and the world, and that the landscape is the name of this co-belonging" {Besse2013, p. 34}.

Thus, the landscape should not be regarded merely as an object of intellectual reflection or study, but must be understood as a form of lived experience that is directly connected to people's daily lives. The landscape shapes both personal and collective identities, being formed from the existential needs of individuals {Besse2013}. It is understood as a whole - a convergence, a lived moment, an 'impression' - that brings together all its elements.

The urban landscape, a collective construction involving diverse actors and interests, is the combination of inhabitants, buildings, public space, and nature within the city. Observing the landscape allows for a reading and interpretation of the current state of the world, revealing through its visible dimension the history of a place. By encompassing environmental, social, cultural, and aesthetic values across multiple scales, the landscape emerges as a tool for addressing environmental and territorial conflicts.

The Landscape Charter of the Americas {2018} highlights the need to reposition the landscape - particularly in the Americas - as a hybrid of nature and culture, through a continuous process of understanding it as a universal good and right. To that end, this dimension must be recognized and regarded as fundamental to discussions on urban development, given the need to view cities as urban landscapes that demand special attention.

In this context, the concept of landscape planning is introduced, establishing guidelines for the

sustainable development of landscapes in relation to the demands and needs of societies, and understanding it as a primary good {Landscape Charter of the Americas, 2018}. Thus, the landscape planner must consider the cross-cutting nature of its definition as a key element in the integration of nature and the city - also essential for urban and regional management.

It is urgent to explore and critically reflect on alternatives that prioritize the presence of nature in urban spaces. In contemporary Society - and especially in the current climate crisis - the term "nature" has gained fundamental importance. It is understood as something under constant construction and reconstruction over time, far from the traditional view of a finished, stable reality that could serve as a fixed reference for the turbulence of human life. Therefore, it emerges as a complex word within human language, bearing many of the greatest variations in human thought.

This article thus aimed to investigate actions that, through adaptive management, integrate the complexity of nature within the urban landscape. More specifically, it explored the concept of Nature-based Solutions (NbS), which are still only modestly applied and researched in the Brazilian context. To conduct this investigation, an exploratory study with a qualitative-quantitative approach was carried out in two complementary stages of data collection: a practical investigation phase and a documentary phase, using the city of Curitiba, located in southern Brazil, as the case study.

The study reviewed public space projects completed over the last five years (starting in 2020), identifying those with an explicit indication of the use of NbS. Next, the research focused on manuals, guides, and booklets that directly addressed the concept of NbS and had been produced by the Municipal Government of Curitiba. The aim was, therefore, to assess the relevance and application of NbS in Curitiba, while also reflecting on the existing gaps regarding the implementation of such solutions in tackling the climate crisis - particularly within the Brazilian context.

The Nature of Nature-based Solutions (NbS)

There is a polysemic variety in the scientific literature when addressing the term Nature-based Solutions (NbS). This is due to the fact that, according to Nesshöver *et al.* {2017}, NbS are closely linked to several pre-existing concepts in environmental management and ecological engineering, such as Green Infrastructure, Ecosystem Services, Best Management Practices, Low-Impact Development, Compensatory Techniques, among others.

Although the concept has gained increasing prominence in recent environmental debates, it is grounded in a long-standing recognition of human dependence on nature and on practices aimed at protecting, managing, and restoring ecosystems {UNEP2022}. NbS are understood as a symbolic term that encourages governments, institutions, businesses, and citizens to develop alternative forms of policy and planning, in which natural capital is integrated to enhance biodiversity and human well-being.

NbS integrate urban space planning strategies through best practices for both ecosystems and built environments, across different scales of intervention. In this sense, they provide local benefits for climate change adaptation, as well as regional and global contributions to climate change mitigation.

Studies have shown that the implementation of NbS can reduce up to 37% of greenhouse gas emissions, contributing to the achievement of international climate goals, such as those outlined in the UN 2030 Agenda {Griscom *et al.*2017}. Moreover, because they are based on, inspired by, and make use of nature, NbS are ideal for restoring ecological flows in cities through infrastructure solutions that increase urban resilience.

Nature-based Solutions offer communities a proactive environment in addressing global challenges while also easing long-term pressure on natural resource bases {IUCN2012}. They also have the potential to foster social innovation, intensify the application of sustainability, and promote participatory planning and governance. As such, they can be implemented according to local, national, and regional contexts, in alignment with the 2030 Agenda for Sustainable Development, provided they are managed adaptively {UNEP2022}.

In practice, there are numerous examples of actions that fall under the category of Nature-based Solutions (NbS) which, when adapted to the specific conditions of each locality, become essential mechanisms for shaping cities that are more responsible, resilient, and aligned with climate concerns {IUCN2023}. Bioretention systems - also

known as rain gardens - green roofs, urban parks and lagoons, as well as the preservation of vegetation, are just a few of the measures that, when classified as NbS, can contribute to the adaptation and resilience of the urban landscape.

According to the IUCN {2023}, despite their proven potential in addressing the climate crisis, NbS remain underutilized, even with the availability of tools and global support to aid their implementation by public and private institutions, as well as by civil society. Therefore, it is crucial to be aware of the barriers that may arise during the implementation process of these solutions. The application of NbS must not be seen as a "false solution", that is, as the sole answer to the climate crisis, which could shift focus away from other imperative actions needed to adapt global economies. As emphasized by the UNEP {2022}, NbS do not replace the urgent need for decarbonization, but they can help address this challenge.

Another key concern involves the risk of misinterpretation and misuse of NbS by decision-makers and stakeholders. Some actions are at times labeled as NbS but do not meet the criteria set by official guidelines, leading to negative outcomes and a departure from their intended objectives. One of the main issues includes the oversimplification of interventions - such as focusing solely on tree planting instead of restoring ecosystems - and the reluctance to engage in open discussions about complexities and nuances, such as timelines and trade-offs {UNEP2022}.

Thus, this research aimed to position the definition of Nature-based Solutions in both theoretical and practical terms. It allowed for a comparison between the actual application of NbS as an adaptation strategy for public spaces and what is presented in official and regulatory documents, with an emphasis on the public administration of a city in the Global South, as will be explored in the following section.

The theoretical and practical exploratory journey through the urban landscape of Curitiba, Brazil

The terminology accompanying studies on solutions that target nature - whether to conserve, mimic, and/or benefit from it - is in constant evolution. Even more than two decades after the first considerations regarding the definition, there are still noticeable gaps in the understanding and characterization of Nature-based Solutions (NbS), including their limited and scattered application in the Brazilian context.

When exploring the historical and temporal trajectory of Brazilian initiatives in response to the climate crisis, it becomes evident that the first time the term "Nature-based Solutions" was used in the drafting of a federal-level document was in 2024, specifically in Law n° 14.904, dated June 27. This legislation established guidelines for the development of climate change adaptation plans, aiming to implement measures that reduce vulnerability and exposure to risks and adverse effects resulting from this issue.

This study focused on the municipality of Curitiba, in the state of Paraná, located in the southern region of Brazil, as shown in Figure 1. The city was selected due to its recent reputation as a "smart city" and an "ecological city." These titles stem from the local government's engagement in projects aimed at global climate resilience. However, it is a fact that Curitiba is already suffering the consequences of climate change, as its average temperature has increased by 1.2°C over the past six decades. Changes in rainfall patterns have also been observed, with more frequent occurrences of strong and intense storms, as well as longer periods of drought {PlanClima, 2020}.

Figure 1. Location of Curitiba on the map of Brazil.



It is also worth noting that Curitiba is part of the "C40 Cities" network, along with 96 other cities whose public administrations have committed to addressing the climate crisis through adaptation and resilience actions. This participation even led to a partnership for the development of the city's first -

and so far, only - Climate Action Plan, titled PlanClima Curitiba, which was launched in 2020.

Additionally, the municipality has two laws that - excluding the one that instituted the Climate Action Plan - mention Nature-based Solutions (NbS). Both were enacted in 2021, with one addressing the municipal policy for environmental protection, conservation, and restoration, and the other focusing on water reserve concerns. These are, respectively, Law n° 15.852, dated July 1, 2021, and Decree n° 1.172, dated July 19, 2021 - titled "Water Reserve for the Future."

However, the documentary phase of the research, which involved exploring the production of guides, manuals, and booklets by the public administration, revealed that no regulatory documents specifically addressing NbS had been published up to the end of the data collection period (June 2025). The research identified only one booklet produced by the City of Curitiba in partnership with SPVS (*Sociedade de Pesquisa em Vida Selvagem e Educação Ambiental*) - an organization specialized in biodiversity conservation in Brazil, with a focus on the Atlantic Forest biome.

This publication, titled "Ecosystem-based Adaptation: a new methodology for addressing climate change in Curitiba", was released in 2023. Although the term "Nature-based Solutions" is mentioned in the document, the main focus of the booklet is the concept of Ecosystem-based Adaptation - an approach that employs the management and use of biodiversity and ecosystem services provided by natural areas to reduce urban vulnerability in the face of the climate crisis.

The second phase of the research, which aimed to investigate the practical use of Nature-based Solutions (NbS), involved identifying public space projects inaugurated from 2020 onward. This time frame was chosen due to the increase in initiatives related to NbS starting that year—not only on an international scale but also in Brazil. Prior to that, references to the concept were virtually nonexistent in national reports, as well as in institutional and governmental discussions. Moreover, 2020 was also the year that PlanClima Curitiba was launched, and the research sought to assess whether that publication had influenced the use of alternative, nature-based solutions as tools for urban landscape adaptation.

The data collection revealed that only five projects across the city made explicit use of the NbS concept. The results are shown in Table I, which indicates that the actions fall into two main categories: the promotion of urban agriculture (Urban Farm Cajuru and Urban Farm CIC), and the implementation of parks through green corridors and natural water management (Abranches and Manacá Parks, Workers' Municipal Forest).

Table 1. Public works in Curitiba that made use of NbS.

Project	Year	NbS
Urban Farm Cajuru	2020	Urban agriculture + composting + education
Urban Farm CIC	2024	Urban agriculture + composting + education
Abranches and Manacá Parks, Workers' Municipal Forest	2024	Green corridors + natural water management

Comparatively, only one of the projects was completed in 2020 (Urban Farm Cajuru), while the remaining ones date from 2024. The research also revealed that there are other projects which, based on their conceptual characteristics, could be classified as examples of Nature-based Solutions, but were established prior to the last five years. One such example is Parque Barigui, a site that features an extensive vegetated area and a retention basin, which receives excess rainwater during extreme weather events. However, since the park was inaugurated in the 1970s, it was not considered for the purposes of this study.

Conclusions

Thus, one can observe the persistent but limited investigation and application of Nature-based Solutions (NbS) in initiatives undertaken by the Municipal Government of Curitiba. Despite the city's engagement in international programs focused on climate resilience, the normative framework still does not reflect this pursuit of alternatives applied to the urban landscape. It is, however, the responsibility of public administration to encourage and facilitate the implementation of innovative solutions, and for that purpose, the

development of manuals, guides, or booklets represents a practical strategy. Nevertheless, the research showed that, as of June 2025, there were no records of any government-produced documents that specifically addressed NbS.

Regarding public works in public spaces that explicitly reference the use of principles aligned with the term, there are also very few examples. The most notable cases involve the promotion of urban gardens and the implementation of specific interventions in parks, but there is still no effective use in other types of public spaces, such as squares and streets. It is important to highlight, however, that the time frame starting from 2020 limited the analysis to projects that were actually designed with prior knowledge and use of the "Nature-based Solutions" terminology.

This investigation period, nonetheless, reveals that even before the formalization of the term, there were already examples of public spaces that could be classified as employing NbS. Therefore, although NbS are an effective alternative in the face of the climate crisis, it is essential to avoid misinterpretations, conceptual trivializations, or the arbitrary rebranding of existing actions. Beyond projects and regulations, climate crisis responses must be effective in order to make urban landscapes more resilient in a world in constant transformation.

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COMPARATIVE ANALYSIS OF URBAN FOREST PLANNING FOR CLIMATE ADAPTATION IN AMERICAN CITIES

TOPIC 02: Guiding territories with legislative and social advances in planning: Organisation of large territories

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Abstract

The climate crisis presents urgent challenges to cities. In this context, urban trees are a strategy that enables better regulation of the microclimate of cities within the urban forest, the totality of plant elements present in cities. However, for the potential of the urban forest to be fully realized, cities need to plan urban arborization in a strategic and integrated manner. Considering this, the present text analyzes urban arborization plans from various American municipalities that incorporate mitigation strategies. The aim is to draw lessons from this comparative analysis, observing strategies for climate crisis mitigation and adaptation. The methodology used employs multiple case studies. The preliminary evaluation followed 20 analysis criteria organized into four main axes: the structure of the plan; methods of implementation and management; approaches to environmental protection and climate change issues; and modes of social participation. Using a comparative method, the study highlighted both convergences and divergences among the strategies analyzed, emphasizing the importance of social participation in the formulation and execution of guidelines, the connection between the plans and other urban planning instruments, and the use of graphic resources as tools to facilitate communication of the proposals. The analysis revealed that more recent plans show a clearer integration of climate issues and climate adaptation. Finally, by adopting a structured and coordinated approach to managing the urban forest, municipalities can transform this strategy into an essential tool for creating environmentally balanced cities that are prepared for the climate challenges of both the present and the future.

Introduction

The accelerating pace of the climate crisis is reshaping how cities must plan for the future. With the increase in average temperatures, intensifying extreme weather events, and the progressive degradation of urban ecosystems, there is growing urgency to develop strategies centered on resilience and adaptation. Among the nature-based solutions promoted for urban resilience, the urban forest—understood as the totality of plant elements within the city, including trees, shrubs, and herbaceous species—has gained renewed prominence. These green infrastructures play a central role in regulating the microclimate, reducing the urban heat island effect, enhancing stormwater management, improving air quality, supporting biodiversity, and offering psychosocial, cultural, and aesthetic benefits.

Scientific literature and global frameworks such as those developed by the IPCC, FAO [5] [6], and UNECE [9], increasingly recognize the urban forest not as a decorative element but as a critical component of climate adaptation infrastructure. However, this recognition does not always translate into practice. Urban greening initiatives are often fragmented, lacking alignment with broader planning instruments, and failing to ensure

long-term maintenance and monitoring. The challenge is therefore not only to plant trees, but to manage urban forests as complex, dynamic systems integrated with land use, mobility, health, and housing policies.

Urban Forest Master Plans (UFMPs) have emerged in several cities as tools to guide urban forestry efforts in a systematic and integrated manner. These plans aim to consolidate policies, establish goals and indicators, define responsibilities, and promote participatory governance. Their effectiveness, however, is strongly influenced by local administrative contexts, available resources, technical capacities, and the degree of political commitment.

This paper presents a comparative analysis of urban forest planning in selected cities of the Americas, focusing on their role in climate change adaptation. The study is grounded in a multiple case study methodology, drawing from 22 urban forestry plans from C40 [4] member cities. From this group, three cities were selected for in-depth analysis: Austin (USA) [1], Bogotá (Colombia) [2] [3], and São Paulo (Brazil) [7] [8]. The choice reflects their commitment to climate agendas, diversity of socio-environmental contexts, and contrasting institutional arrangements for managing urban greening.

Methodology

The research was conducted using a five-step qualitative methodological framework. First, an exploratory bibliographic and documentary review provided the theoretical foundation for understanding the intersection between urban forestry and climate resilience. This included academic sources, technical manuals, and international guidelines on nature-based solutions and urban environmental management.

Second, 22 urban forest-related plans were compiled from official sources, focusing on C40 member cities in the Americas. These documents were examined to identify recurrent strategies, institutional formats, and references to climate change. Third, based on this preliminary review, 20 analytical criteria were defined and organized into four thematic axes: (1) the structure of the plan, including clarity of objectives, diagnostics, and proposed actions; (2) implementation and governance mechanisms; (3) climate-environmental approach, including adaptation and mitigation strategies; and (4) forms of public participation and community involvement.

Fourth, the cities of Austin, Bogotá, and São Paulo were selected as case studies based on their robust documentation, diversity in governance models, and demonstrated relevance in climate-related policy. Finally, a comparative analysis was conducted, combining content analysis of the plans with interpretive assessment of their scope, coherence, and institutional embeddedness.

This methodology, informed by comparative urban studies and planning theory, allows for the identification of both convergences and divergences in how cities conceptualize and implement urban forest strategies in the face of climate change.

Results and Discussion

The three case studies offer varied but complementary perspectives on urban forest planning. Austin's Urban Forest Plan (2013) presents a well-structured approach anchored in ecosystem services and biodiversity. It defines goals for increasing canopy cover, applies indicators for monitoring, and integrates the plan into the city's broader sustainability framework. The plan includes a thorough inventory of public trees and emphasizes the value of green spaces for livability and environmental health. However, its focus on public land management limits its reach on private property, and its implementation depends heavily on inter-agency collaboration that has faced challenges in continuity and funding.

Bogotá's strategy is strongly aligned with environmental restoration goals. The 2019 Urban Forestry Plan and the 2021 Green Growth Strategy prioritize ecological corridors, native species, and socio-environmental functions of vegetation. Bogotá recognizes the multifunctionality of the urban forest, not only for environmental regulation but also as a means of improving public health, reducing urban risk, and mitigating socio-territorial inequalities. Implementation, however, is complicated by political fragmentation, inconsistent administrative capacities across districts, and limited civic involvement in the follow-up phases.

São Paulo's PMAU (2020) is notable for its high level of institutionalization. The plan is supported by a technical manual and a structured governance model involving various municipal departments, neighborhood councils, and digital participation platforms. It includes a zoning of arborization potential, integrates with the municipal climate policy, and defines short, medium, and long-term

objectives. Its participatory process is a highlight, involving technical hearings and citizen proposals. Nonetheless, São Paulo faces significant challenges related to bureaucratic rigidity, unequal implementation across the city's subprefectures, and difficulties in integrating forestry goals with urban development pressures.

In comparing the three cities, it becomes evident that while the plans share common goals—such as increasing green coverage, improving environmental quality, and fostering resilience—they differ in their operationalization. Austin emphasizes ecosystem metrics, Bogotá focuses on social and ecological restoration, and São Paulo builds on participatory governance and planning integration.

A transversal issue in all cases is the tension between ambition and implementation capacity. While plans are often visionary in their scope, actual progress depends on stable funding, political support, intersectoral coordination, and active monitoring systems. In all three cities, discontinuities in political leadership and administrative structure have created implementation gaps. Nonetheless, cities that embed their forestry strategies within comprehensive climate action frameworks demonstrate greater consistency and visibility.

Furthermore, the use of maps, diagrams, and indicators facilitates transparency and public understanding. Such tools are crucial for communicating the goals of urban forestry to diverse audiences, including policymakers, local communities, and private stakeholders. The integration with other municipal plans—such as mobility, housing, and zoning—also strengthens the systemic potential of UFMPs.

Conclusions

Urban forests play a vital role in advancing the resilience and adaptive capacity of cities facing climate change. The experiences of Austin, Bogotá, and São Paulo underscore that successful urban forest planning depends on technical accuracy, institutional collaboration, participatory processes, and policy continuity. While each city adapts its approach to local realities, the comparative analysis highlights shared challenges, such as governance fragmentation and the need for better monitoring.

Strategic and adaptive urban forestry requires cities to move beyond sectoral silos and embrace integrated planning. This involves recognizing the urban forest as critical infrastructure, ensuring dedicated budgets, developing robust databases, and facilitating citizen engagement throughout planning and implementation. Plans must also be revisited regularly to incorporate new data and adapt to changing environmental and social conditions.

Considering the global climate emergency, the consolidation of urban forest planning as a climate adaptation strategy is no longer optional—it is imperative. Municipalities must view trees not as isolated environmental assets but as active agents in shaping equitable, healthy, and climate-resilient cities. By reinforcing participatory governance, intersectoral alignment, and long-term vision, urban forest planning can serve as a cornerstone for sustainable urban futures across the Americas.

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A KNOWLEDGE-AUGMENTED GPT-BASED SYSTEM FOR STANDARDS Q&A IN LANDSCAPE ARCHITECTURE

TOPIC: Guiding territories with legislative and social advances in planning: Organization of large territories

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Abstract

In global landscape architecture planning and construction practices, the proper application of standards and codes forms the institutional foundation for ensuring project compliance, safety, and ecological sustainability. However, current methods for retrieving standards and codes rely heavily on manual review or keyword-based database tools, which suffer from low efficiency and limited capacity to identify inter-clause relationships. These shortcomings hinder rapid and accurate determination of standard applicability in complex project contexts.

To address these issues, this study proposes an intelligent question-answering system for landscape architecture standards, developed using fine-tuned GPT-3.5-turbo. The system integrates a total of 942 official Chinese standards—including national, industry, and local documents—covering subfields such as park design, barrier-free environments, ecological protection, and construction management. By enhancing semantic parsing and cross-standard clause-level association, the system improves the understanding and application of regulatory content.

Experimental results show that the system performs well in handling vague queries, cross-standard references, and semantically complex tasks, with an average response time under 30 seconds. Compared with traditional methods, it significantly improves retrieval efficiency and clause matching accuracy while enabling semantic inference and applicability judgment across multiple standards. Methodologically, this research advances beyond prior approaches limited to keyword extraction or named entity recognition by emphasizing hierarchical semantic understanding guided by large language models. The proposed system offers a scalable and intelligent pathway for applying standards in the landscape architecture domain.

1. Introduction

In the practice of landscape architecture planning and construction, standards and codes serve as the fundamental basis for ensuring project compliance, safety, and sustainability[1]. Landscape design, construction, and planning often involve various interrelated standard documents, covering aspects such as site layout, planting design, barrier-free facilities, construction techniques, and ecological protection. However, the current methods of accessing and interpreting standards still heavily rely on manual reading or keyword-based search tools. However, the current process of acquiring and understanding standards is still highly dependent on manual access or keyword-based searching, which is not only inefficient and time-consuming[2], but also often makes it difficult for users to systematically access the required provisions when the content of the standards is dispersed, the naming is inconsistent, and there is a lack of structured indexing. Even when a standard is found, it is difficult to judge its relevance or applicability to other standards, affecting the comprehensiveness of the standards consulted.

This challenge is especially pronounced for less experienced practitioners, who often face difficulties in identifying which standards to consult. When confronted with unfamiliar standard titles or when unable to precisely articulate their queries, they frequently fail to locate the relevant clauses. For example, the issue of "barrier-free access in waterfront areas" actually involves multiple standards, such as park design standards and accessibility standards. Traditional retrieval tools struggle to return complete and accurate results when dealing with vague queries or non-standard terminology. These limitations not only increase the burden of searching for standards, but may also lead to the omission of relevant and important standard specifications, which ultimately leads to non-compliance in projects.

In recent years, advances in natural language processing (NLP) and large language models (LLMs) have opened new possibilities for intelligent querying of standards and codes. Existing studies have applied techniques such as named entity recognition, clause matching, and intelligent question answering in fields like architecture and construction[3]. In the domain of landscape architecture, exploratory research based on pre-trained language models has also emerged. For example, previous studies have used ALBERT and BERT to construct plant description knowledge graphs or human settlement language understanding systems, preliminarily demonstrating the adaptability of NLP techniques in vertical domains[4]. These studies provide foundational methodological pathways for semantic mining of landscape standards and the development of question-answering systems.

However, most existing work focuses on clause structuring or term recognition, without forming mature intelligent Q&A systems oriented toward real user queries. In actual scenarios, practitioners often raise questions in natural language. Current methods are limited in understanding user intent, retrieving relevant clauses, and generating accurate responses—especially in complex tasks involving cross-standard or intersecting terminology. Given the interdisciplinary and terminologically complex nature of landscape architecture, developing a question-answering system capable of contextual understanding and semantic reasoning has become critical for advancing intelligent applications of standards.

To address the challenges in querying landscape architecture standards and codes—such as vague input and low retrieval efficiency—this study presents an intelligent Q&A system based on GPT-3.5-turbo, optimized through domain-specific data tuning. The system's knowledge base is built from 942 official Chinese standards across landscape architecture, architecture, and urban planning, sourced from authoritative platforms such as the National Standard Full-text Disclosure System. Original scanned documents are converted via OCR, cleaned, segmented by chapter, and used to generate question–answer pairs guided by GPT-3.5-turbo, resulting in 15,162 Q&A entries covering topics such as design, construction, and facilities.

On this foundation, the system integrates semantic embedding and vector-based retrieval, adopting a pipeline of "semantic search → passage retrieval → LLM response," enabling fuzzy input and multi-turn interaction. It automatically locates relevant clauses and returns authoritative sources with contextual explanations. A front-end interface supports filtering by standard type, enhancing usability.

Evaluation results indicate that the system performs well in semantic understanding and cross-standard matching, with faster responses and higher accuracy compared to traditional methods. Despite being currently built on Chinese national standards, the methodology demonstrates generalizability and holds potential for extension to international standards and multilingual regulation querying.

2. Materials and Methods

This study aims to develop an intelligent question-answering (QA) system for landscape architecture standards based on natural language processing (NLP) techniques. The system is designed to enhance semantic comprehension, handle ambiguous user queries, and improve cross-standard retrieval efficiency during standards consultation. To achieve this goal, three specific objectives were set.

The first objective is to construct a structured and high-quality knowledge base of standards to provide foundational textual resources for model understanding and QA generation. Traditional standards document often exist as images or semi-structured formats, lacking a unified structure, which limits the model's ability to read and comprehend the content. Therefore, this study systematically collected landscape-related standards from authoritative platforms, and transformed them into structured text through image conversion, cleaning, and segmentation processes.

The second objective is to develop a domain-specific QA dataset tailored to the language and terminologies of the landscape architecture field. Given that standard clauses are semantically dense and complexly expressed, they are not readily applicable to QA tasks. To this end, the research team guided the GPT-3.5 model to automatically generate question-answer pairs based on chapter-level segmented text, combined with guide words, in order to construct a professional domain conversation corpus.

The third objective is to develop an intelligent QA system capable of semantic understanding and clause-level retrieval. In real-world usage, user queries are often expressed in non-standard forms, with vague wording or unclear keywords. Based on knowledge base embeddings, this study introduced a vector-based matching mechanism to implement a "semantic search + clause tracing" process, which significantly improves retrieval accuracy and interaction naturalness.

2.1. Data Preparation

To build the standards knowledge base and QA corpus, a total of 942 current Chinese standards related to landscape architecture and adjacent fields, published up to July 2024, were collected. Data sources included authoritative platforms such as the National Standard Information Public Service Platform[5], the National Standards E-book Library[6], and the Landscape Architecture Standards Network[7] . The standards cover fields including landscape architecture, architecture, and urban planning, and are categorized into 295 national standards, 229 industry standards, and 418 local standards. National and industry standards are collectively referred to as national-level standards, while local standards are developed based on national-level ones to reflect local conditions. In general, local standards serve as more detailed supplements to national standards but are expected to form an independent and coherent system[8].

Since some standards were published in image-based PDF format and could not be directly parsed, this study applied optical character recognition (OCR) and text extraction techniques to convert these documents into editable text. A manual verification process was also conducted to remove image noise, formatting errors, and duplicate clauses, ensuring textual consistency. The resulting output was a clean and well-segmented collection of standard clauses suitable for further processing.

2.2. Data Preprocessing

To adapt the standards texts for NLP tasks, several preprocessing steps were performed. First, a custom script was used to segment the texts by section and mark each knowledge unit with "==SPLIT==" while preserving the original hierarchical structure. Then, the content was deduplicated, cleaned, and filtered to remove invalid statements and anomalous segments.

After text extraction and segmentation, the processed paragraphs were imported into the knowledge base construction workflow. The pretrained GPT-3.5-turbo model was used to understand each paragraph and generate corresponding question-answer pairs based on its semantics. A set of prompt keywords was predefined to guide the model in focusing on the core themes and key points of each paragraph, thereby ensuring the relevance and accuracy of the generated QAs (Figure 1). In total, 15,162 question-answer pairs were generated, with approximately 1,177,614 tokens, forming the basis for indexing and intelligent retrieval in the later system.

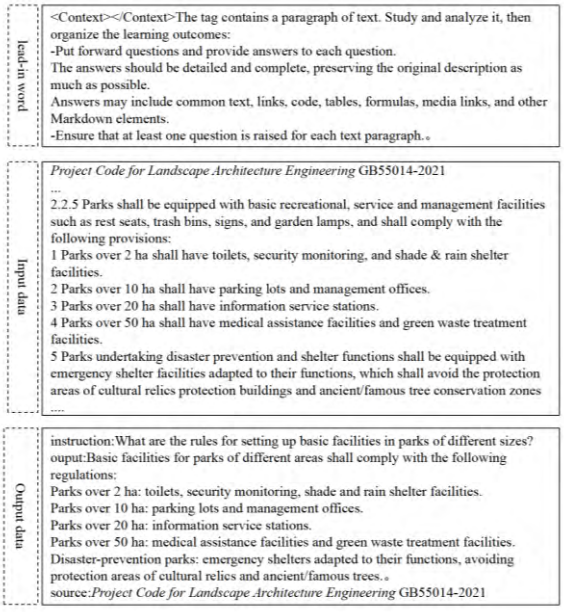


Figure 1. Q&A Generation Guided by Instructional Prompts

Note: The original instructional prompts, input data, and model-generated outputs in the figure were all written in Chinese. The content presented here is the English translation. For all automatically generated responses throughout this paper, the original text was in Chinese, and the translation strives to preserve the original meaning and terminology consistency.

2.3. Knowledge Base Construction and System Deployment

Upon completing the QA corpus, it was imported into a vector database to construct a landscape architecture–specific standards knowledge base. The entire knowledge base consists of three components: categorized standard libraries, standards documents, and data entries. A categorized library contains multiple standards documents, and each document consists of multiple data entries (Figure 2). The smallest searchable unit is the categorized standard library; the search is performed at this level, while the standards documents serve only as organizational labels and do not affect search results. This structure allows users to search within specific categories—for example, querying only national and industry standards or only local standards.

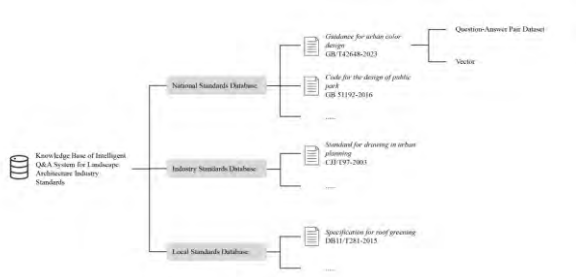


Figure 2. Data Storage Structure.

Based on the above knowledge base, this study builds a complete intelligent Q&A system by fine-tuning the GPT-3.5-turbo model. The system architecture includes three main modules: a user input interface, a knowledge base search engine, and a language model response generator. When a user submits a query, relevant text segments are first retrieved from the knowledge base via semantic vector matching. The retrieved content, along with the query, is then passed to GPT-3.5-turbo, which generates a structured answer including source references and clause explanations. The system's front-end interface supports standard-type filtering, multi-turn dialogue, and traceable results, improving both query efficiency and user experience.

3. Experimental Results

3.1. Model Response Performance

To evaluate the system's effectiveness in real-world scenarios, we tested it using two representative types of user input: explicit queries and ambiguous queries. Explicit queries target specific clauses from standards, such as "What types of plants should be avoided in urban road greening?" (Table 1) Ambiguous queries reflect vague user intentions, such as inputting general keywords like "street trees" or "zoo design" (Table 2).

As shown in Figures 3 and 4, the system demonstrated the ability to accurately and efficiently locate relevant content from the standards and generate professional responses with traceable sources when handling explicit queries. In cases of ambiguous queries, it could also return semantically relevant content with coherent language and valuable clause references, enhancing users' trust in the system outputs.



Figure 3. Interactive Interface of the Intelligent Q&A System for Landscape Architecture Standards (Illustrating a Specific Query Scenario)

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Figure 4. Interactive Interface of the Intelligent Q&A System for Landscape Architecture Standards (Illustrating a Vague Query Scenario)

In terms of response time, the system required approximately 10–30 seconds per query, with most of the latency occurring during semantic embedding matching and language generation. This time range is acceptable under current deployment conditions but will require further optimization for high-concurrency applications.

Overall, the system demonstrated strong capabilities in semantic understanding and clause-level retrieval of landscape architecture standards, effectively supporting queries related to design, construction, and other core domains. These results provide a solid foundation for future enhancements in model accuracy and system scalability.

Table 1. Interaction Example of the Intelligent Q&A System for Landscape Architecture Standards (Illustrating a Specific Query Scenario)

Input Text	Generated Answer	Referenced Standard
How are urban and rural land types classified at a general level?	Urban and rural land can be broadly classified into two categories: 1.Construction land 2.Non-construction land	*Code for Classification of Urban Land Use and Planning Standards of Development Land* GB 50137-2011
What are the evaluation items and standards for green space construction?	Evaluation items include: green coverage ratio, green space ratio in built-up areas, and per capita park green space. For example, the green space ratio should be ≥29%.	*Evaluation Standard for Urban Landscaping and Greening* GB/T 50563-2010
What types of plants should be avoided in urban roadside greening?	Avoid species that are toxic or allergenic; produce heavy pollen or unpleasant odors; bear fruit or secrete substances that fall; have hard or sharp leaves; possess thorns or heavy fruit; or otherwise pose risks to pedestrians.	*Code for Construction of Industrial Equipment and Pipeline Insulation Engineering* CJJ/T 75-2023

Table 2. Interaction Example of the Intelligent Q&A System for Landscape Architecture Standards (Illustrating a Vague Query Scenario)

Input Text	Generated Answer	Referenced Standard
Watering plants in summer	During hot and dry summer conditions, irrigation should be timely but avoid midday (preferably before 12:00 or after	*Standard for Landscape Maintenance and Management* CJJ/T 287-2018;

	16:00). Watering should be thorough but not excessive. Before planting in dry soil, pre-watering of pits or trenches is necessary to ensure root hydration.	*Technical Specification for Vertical Planting* CJT 236-2015
Cold-resistant plants	Examples of cold-resistant plants include: - Calabash gourd - Grapevine - Wild grape - Boston ivy - Parthenocissus quinquefolia.	*Technical Specification for Vertical Planting* CJT 236-2015
Growing habits of Asparagus fern	Asparagus fern prefers warm, humid, and semi-shaded environments. It is not cold- or drought-tolerant and is sensitive to waterlogging.	*Technical Specification for Vertical Planting* CJT 236-2015

3.2. System Evaluation

To comprehensively assess the performance of the proposed intelligent QA system for landscape architecture standards, a unified evaluation framework was established combining both qualitative and quantitative methods. The evaluation focused on three key dimensions: language generation quality, semantic matching accuracy, and domain-specific knowledge correctness. All evaluations were conducted on a unified test set and benchmarked against two mainstream general-purpose large language models: GPT-4 and LLaMA-2-70B, to enhance result comparability and objectivity.

The test set consisted of 300 questions automatically generated by the GPT-3.5-turbo model based on clauses in the standards knowledge base. These questions covered core clauses, typical application scenarios, and frequently asked conceptual inquiries, including both explicitly directive queries and semantically vague retrieval tasks. All questions were input to the three models, and the generated outputs were used for both qualitative scoring and quantitative evaluation.

3.2.1. Qualitative Evaluation

The qualitative evaluation was designed across five dimensions: relevance, accuracy, usefulness, domain-specificity, and timeliness. These dimensions were used to assess overall performance in terms of domain alignment, knowledge support, and information presentation (Table 3). To ensure evaluation consistency, GPT-4 was used as the scoring agent, assigning scores from 1 to 10 for each dimension per model. Scores were classified as follows: 1–3 for "poor performance," 4–6 for "moderate performance," and 7–10 for "good to excellent performance."

As an example, the test question, "What elements of vertical control should be provided for in park design?" was asked. As an example, Table 4 shows a summary of the responses and scoring results for each model, with detailed responses and the full evaluation process listed in Appendix A1.

Table 3. Five Dimensions of Qualitative Assessment

Dimension	Definition
Relevance	The degree to which the model's answer aligns with the user's query, covering the required standards content while excluding irrelevant information.
Accuracy	Whether the answer is factually correct and fully consistent with current standards.
Usefulness	Whether the response directly helps users solve the problem and is easy to understand and apply.
Professionalism	Whether the response demonstrates domain expertise, including correct terminology, in-depth explanation, and advanced understanding of standards.
Timeliness	The recency of the standards referenced in the model's response.

Table 4. Inference Comparison of LLMs on "Vertical Control in Park Design"

Evaluation Dimension	Proposed Model	GPT-4	LLaMA2-70B
Response (Summarized)	Clearly listed 9 vertical control items; precisely cited Clause 4.3.2 of *Park Design Standards* (GB 51192-2016).	Provided a fairly comprehensive response covering vertical control, lighting, and sightlines, but lacked clear references and included general content.	Answer deviated from the core topic, mostly general park design suggestions without referencing vertical control or relevant standards.
Relevance	9	8	3
Accuracy	9	8	3
Usefulness	8	7	4
Professionalism	8	8	4
Timeliness	9	8	5
Average	8.6	7.8	3.8

Note: Full model outputs and scoring criteria are provided in Appendix A1.

The evaluation results showed that the proposed system achieved strong performance across all five dimensions, especially in accuracy, domain-specificity, and timeliness. These outcomes highlight the system's advantages in handling highly standardized and frequently updated professional QA tasks (Figure 5, Table 5). The strong performance can be attributed to the domain-specific knowledge base and semantic matching–based retrieval mechanism, which effectively support precise clause extraction and interpretation.

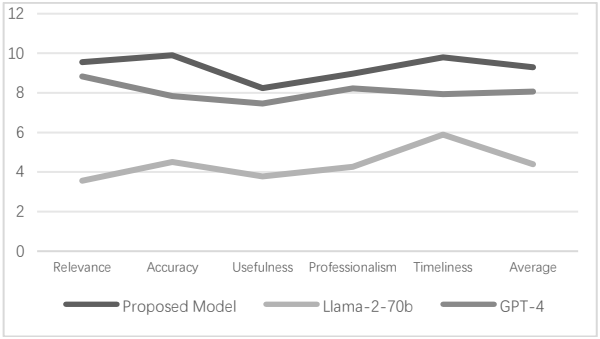


Figure 5. Evaluation Results Based on 300 Question-Answer Data Sets

Table 5. Evaluation Results Based on 300 Question-Answer Data Sets

Dimension	Proposed Model	Llama-2-70b	GPT-4
Relevance	9.56	3.56	8.83
Accuracy	9.9	4.51	7.84
Usefulness	8.24	3.78	7.46
Professionalism	8.97	4.26	8.23
Timeliness	9.79	5.89	7.94
Average	9.29	4.4	8.06

GPT-4 exhibited stable performance in fluency and semantic relevance but showed limitations in accuracy and usefulness due to its lack of depth in domain-specific training. The LLaMA-2-70B model performed the worst overall, particularly in relevance and usefulness, indicating challenges in adapting to Chinese-language tasks and specialized domains.

3.2.2. Quantitative Evaluation

Quantitative evaluation employed BLEU and ROUGE metrics, which are widely used to measure textual similarity. BLEU emphasizes word-level matching accuracy, indicating language generation precision, while ROUGE focuses on coverage of key terms, phrases, and syntactic structures. Three ROUGE variants were used: ROUGE-1 (unigram-level), ROUGE-2 (bigram-level), and ROUGE-L (longest common subsequence), reflecting the model's ability to extract key information and maintain structural consistency.

Results show that the proposed model outperformed baseline models across all metrics. Notably, the model achieved significantly higher scores in ROUGE-2 and ROUGE-L, indicating strong capabilities in structural understanding and complex semantic expression. Its BLEU score was also higher, further demonstrating advantages in

accurate terminology usage and language generation. In contrast, LLaMA-2-70B underperformed in Chinese QA tasks due to limited training on Chinese corpora, term segmentation, and grammar comprehension. While GPT-4 demonstrated strength in general-purpose semantic tasks, it did not achieve the expected level of accuracy or domain adaptation due to insufficient exposure to landscape architecture standards (Table 6).

Table 6. Results of Quantitative Metric Evaluation

Dimension	Proposed Model	Llama-2-70b	GPT-4
ROUGE-1	77.241	15.61	19
ROUGE-2	70.041	0	1.14
ROUGE-L	76.837	15.61	19
BLEU	58.753	1.37	1.2

In summary, the results of both qualitative and quantitative evaluations confirm that the proposed system exhibits superior domain adaptability and high-quality language generation for QA tasks involving landscape architecture standards. These findings validate the system's applicability and scalability as a vertical-domain intelligent QA solution.

4. Discussion

This study presents an intelligent QA system for technical standards in landscape architecture, aiming to enhance the efficiency and accuracy of standards consultation for practitioners. By incorporating semantic matching techniques and large language models, the system demonstrates strong capabilities in semantic understanding and clause retrieval, particularly when handling unstructured texts, ambiguous expressions, and cross-standard queries. Compared with traditional approaches that rely heavily on manual reading or keyword-based search, the proposed system significantly reduces retrieval time while improving the accuracy and domain specificity of responses, highlighting its practical applicability.

Experimental evaluations show that the system performs exceptionally well in scenarios involving explicit queries, where it can accurately identify relevant clauses from standards and generate well-grounded responses. In ambiguous query scenarios, the system also exhibits strong comprehension and standard-referencing capabilities. This result is similar to Moon et al.'s (2020) [9] finding in their study of intelligent review of building codes that language models have significant advantages in reducing manual burden and cognitive bias. In addition, quantitative metrics such as BLEU and ROUGE further confirm the system's leading performance in terms of language generation quality and structural consistency.

Compared to earlier approaches based on named entity recognition[3], the system proposed here emphasizes deeper semantic-level understanding and interstandard referencing, overcoming limitations associated with term extraction and rule-based annotation. Unlike studies such as Chen Xiaoling et al. (2021) [4], which focus on semantic extraction of plant descriptions in landscape design, this study addresses the more complex structure of standard clauses, which often involve logical nesting and hierarchical classification. Accordingly, multi-round embedding strategies and instruction tuning techniques were employed to enhance the model's domain adaptability.

Notably, the system's knowledge base is built from real-world standards and codes, covering 942 documents across landscape architecture, architecture, and urban and rural planning. This integration increases the system's generalizability in practical project applications. In contrast to Moon et al. (2022) [1], who constructed semantic lexicons and entity recognition models based on multilingual standards, the present study focuses on enabling contextual understanding and transfer reasoning within actual standard texts using large language models, reducing reliance on handcrafted rules and enhancing generalization across complex regulatory systems. However, the current knowledge base is still primarily based on Chinese national standards, and future work is needed to extend its adaptability to multilingual and multi-version regulatory contexts.

At the same time, due to the strong industry characteristics and syntactic complexity in the semantic expression of landscape architecture standards, the model still has the problem of insufficient level of detail for the output of incomplete information or open questions, especially in the case of composite questions or graphic embedded clauses where the performance is not satisfactory. Future research may draw on multimodal methods, such as those proposed by Zhao Jing et al. (2024)[10], incorporating visual

parsing and structured table recognition to enhance the system's overall interpretive capacity.

In conclusion, the proposed intelligent QA system for landscape architecture standards demonstrates promising performance in terms of response speed, semantic comprehension, domain relevance, and adaptability. It also shows potential for expansion and cross-domain transfer in broader applications.

5. Conclusion

Facing the real problems of dispersed information, low retrieval efficiency and high threshold of understanding in the access to technical standards of landscape architecture, this study proposes and realizes a set of intelligent Q&A system integrating semantic matching and language generation technologies. By constructing a multi-source standards knowledge base and leveraging pretrained language models with instruction tuning, the system demonstrates strong accuracy and adaptability in handling unstructured queries, vague questions, and cross-standard clause matching. Experimental results show that the system can efficiently locate relevant clauses and generate source-supported, domain-specific responses across various real-world query scenarios. This significantly enhances retrieval efficiency and reduces practitioners' dependence on prior experience and subjective interpretation.

Compared with traditional keyword-based tools and entity recognition approaches, the proposed system emphasizes deep semantic understanding and logical structure analysis of standards texts. It exhibits superior generalizability and practicality in the complex regulatory environment of landscape architecture. The system particularly excels in managing challenges such as cross-referencing among standards, term ambiguity, and diverse linguistic expressions, making it suitable for applications in standards training, project review, and design support.

Future work can be extended in three directions: (1) expanding the knowledge base to incorporate multilingual and region-specific standards, enabling broader regulatory adaptation; (2) combining graphical information, structured data and rule logic to improve the model's ability to parse composite criteria; and (3) establishing a dynamic update mechanism to ensure long-term validity amid evolving standards and policies. Through these developments, the system is expected to provide sustained and robust technical support for standards management and intelligent design in the field of landscape architecture.

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AppendixA1

Input Question:

Please answer the following question and specify the standards referenced by the respondent:
What aspects of vertical control should be regulated in park design?

Proposed Model's answer:

-Elevation of hilltops or slope tops and slope bases;
-Elevation of major retaining walls;
-High water level, normal water level, and low water level elevations;
-Elevation of the bottom of water bodies and the top of revetments;
-Elevation at major turning points, intersections, and slope transitions of park roads, as well as bridge decks;
-Elevation of the ground inside and outside each park entrance;
-Elevation of roofs, indoor floors, and outdoor pavements of major buildings;
-Burial depth of underground pipelines and structures;
-Ground elevation of key scenic viewpoints.
Referenced Standard: *Park Design Standards* (GB 51192-2016)

Table A1 Evaluation of Proposed Model's Response on Vertical Control in Park Design

Dimension	Score	Explanation
Relevance	9	The response is highly relevant to the user's query and accurately covers the content of Clause 4.3.2 in *Park Design Standards* (GB 51192–2016).
Accuracy	9	The model precisely lists the required items as defined in the standard, consistent with the reference answer, meeting current regulatory norms.
Usefulness	8	The response is directly helpful for solving the query, easy to understand and apply, and provides concrete guidance for vertical control design.
Professionalism	8	The response employs correct terminology and presents a clear explanation of standard provisions, reflecting adequate domain knowledge and depth.
Timeliness	9	The referenced standard is cited with its publication year, ensuring the user accesses up-to-date regulatory information.

Llama-2-70b's answer:

Sure, here's the answer in Chinese:
Vertical control in park design should be stipulated in the following aspects:
1. Terrain planning: In the park design, it is necessary to consider the terrain ϕactor, including the ground height difference, Slope orientation and other Parameters, in order to ensure the connectivity and circulation within the park.
2. Water planning: The water system in the park needs to be reasonably planned, including artificial rivers, lakes, ponds, etc., as well as other water features, such as fountains and streams.
3. Greening coverage: The greening coverage in the park needs to reach a certain standard to ensure that the park has sufficient ecological functions and aesthetics.
4. Road network planning: The road network in the park needs to be rationally planned so as to facilitate pedestrian and vehicular traffic, and at the same time, it also needs to take into account the safety and sustainability.
5. Layout of buildings: The buildings in the park need to be rationally laid out to facilitate people's activities and rest, and the функionality and esthetics of the buildings need to be taken into account.

6. Lighting design: the lighting design in the park needs to be rationally planned to ensure that the lighting effect is good at night time, and energy conservation and environmental protection also need to be taken into account.
7. Safety management: The park needs to implement safety management measures to ensure the security and health of visitors.
My answer is based on the following policies and regulations:
*"Urban Park Planning and Design Standards"(GB 50176-2019)
*"Landscape Architecture Technical Standards"(JT/T 615-2018)
*"Green Space Planning and Design Guidelines"(HB/T 301-2019)
*"Lighting Design Standards for Urban Landscapes"(GB/T 20463-2019)
*"Safety Management Regulations for Public Places"(GB/T 29863-2019)
These standards provide guidelines for the planning and design of urban parks, including the layout of various elements within the park, such as landform, water systems, greenery, roads, buildings, lighting, and safety management.

Table A2 Evaluation of Llama-2-70b's Response on Vertical Control in Park Design

Dimension	Score	Explanation
Relevance	3	The model's response is loosely related to the question. It fails to directly address the required vertical control provisions, focusing instead on general park design aspects.
Accuracy	3	The response does not include the specific provisions on vertical control outlined in the *Park Design Standards* (GB 51192-2016), leading to low accuracy.
Usefulness	4	While the response offers general guidance on park design, its limited relevance to vertical control provisions reduces its practical applicability.
Professionalism	4	The response covers various aspects of park design but lacks technical detail and fails to demonstrate sufficient domain-specific understanding of vertical control.
Timeliness	5	Although several standards and codes are referenced, none directly support the required content from GB 51192-2016, limiting the timeliness and contextual relevance.

GPT-4's Answer:
Vertical control in park design primarily involves the following aspects:

1. Topographic elevation and slope regulation: Vertical control must account for natural elevation changes and gradients to ensure accessibility, comfortable pedestrian circulation, and effective drainage and erosion control.
2. Vegetation height management: Tree and shrub planting should consider both initial and mature heights to prevent visual obstruction, safety hazards, or interference with structures.
3. Height limitations of built structures: Features such as pavilions, shelters, and playground equipment must comply with planning height restrictions to maintain visual harmony and aesthetic quality.
4. Sightline preservation: Design should safeguard clear views of major landscape features and pathways, avoiding visual blockage by vegetation or structures.
5. Lighting fixture height: Illumination design must ensure nighttime safety and comfort while minimizing light pollution.

The response references the following regulatory frameworks:

-Urban Green Space Planning and Design Standards, which outline requirements for spatial organization, including vertical elements, to optimize park functionality and ecological benefits;
-Urban Planning Law, which sets height and green space regulations impacting vertical layout;
-Environmental Protection Regulations, addressing natural terrain conservation and soil erosion control;
-Accessibility Design Standards, stipulating gradients and step dimensions to accommodate users with special needs.
-These standards collectively form the normative foundation for vertical control in park design, guiding spatial layout and design decisions.

Table A3. Evaluation of GPT-4's Response on Vertical Control in Park Design

Dimension	Score	Explanation
Relevance	8	The response addresses multiple aspects of vertical control in park design. However, some points (e.g., vegetation height) are less directly relevant.
Accuracy	8	The response includes key aspects of vertical control and references relevant standards, but certain details (e.g., lighting height) are imprecisely explained.
Usefulness	7	The response contains useful information but some descriptions are too broad or lack practical specificity, reducing overall utility.
Professionalism	8	The answer employs technical terminology and refers to planning standards, but certain explanations lack clarity, slightly weakening professional depth.
Timeliness	8	Relevant standards are mentioned, but there is no clear reference to specific clauses or their update status, limiting timeliness.

FISH SCALE POLDERS AS FLEXIBLE INFRASTRUCTURE: A SYMBIOTIC APPROACH TO FLOOD MANAGEMENT AND POLLUTION CONTROL

TOPIC: Guiding territories by changing the design of regional projects

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Keywords: Polder, Collective water management, Embodied engagement, Landscape maintenance, Tai Lake Basin

Abstract

The environmental crisis is a compound risk that demands collective action across scales. In 2024, global average temperatures surpassed the 1.5°C threshold above pre-industrial levels, intensifying sea-level rise and extreme weather impacts on low-lying regions. In response, countries such as the United States and Singapore have adopted polder systems as strategies for land reclamation and flood protection. Yet polders are more than hydraulic infrastructure; their long-term viability has historically depended on an ethic of care—rooted in the everyday bodily engagement with land and water.

This paper proposes to reimagine the polder as a tool for cultivating a renewed sense of care for the landscape—one that, we argue, is foundational to any effective response to climate change. Focusing on the Tai Lake Basin, this study traces how the polder system, once deeply entangled with rural life, has become increasingly detached from the everyday lives of those who inhabit it today. We suggest that this historical perspective provides a grounded basis for projecting new ways of living in the polder landscape that respond to climate risks in the near future.

1. Polder Then: Life from Water

Polders refer to low-lying reclaimed lands drained and hydrologically separated from surrounding water by dikes. Although most associated with the Netherlands, polders exist in other parts of the world [1], some even predating their Dutch

counterparts. Chinese polders, also known as "weitian", are believed to have emerged as early as the 5th Century BCE [2].

Whilst polder is often understood as an assemblage of infrastructures that make land inhabitable and arable, Wang, Pendlebury and Nolf (2023) expand the idea of polder to include the cultural practices and socio-economic systems that actively shaped and shaped by the landscape [2]. This expanded definition allows us to re-conceptualize polders not merely hydraulic engineering but as tools for effective environmental stewardship.

Polders have historically served as instruments of social organization and spatial governance [2,3,4]. Village life—from daily routines to agricultural cycles—was deeply intertwined with the maintenance, operation, and collective management of polder systems. Gengzhitu, or the Illustrations of

Tilling and Weaving, dating back to the Song Dynasty, offers a snapshot of communal life in the polder landscape. Men worked in the fields, preparing soil, cultivating rice and tending to the land, while women took part in silk production, rearing silkworms with mulberry leaves, reeling the cocoon and weaving fabric. This set of historical drawings vividly illustrates a mode of bodily engagement through which villagers came to both care for—and care through—the landscape, whether through coordinated efforts in water regulation, the laborious maintenance of dikes and other water infrastructures, or the performance of rituals and rites [3].



Figure 1.1 Excerpts from the Illustrations of Tilling and Weaving, Qing Dynasty. Image courtesy of Library of Congress.

Water formed the foundation of village life, and maintaining its quality and quantity was embedded into everyday practices. In the stream that ran in front of the houses, villagers carried out various water-related chores, but they staggered these activities throughout the day. This was to ensure that pollutants would not exceed the stream's natural capacity, allowing time for contaminants to be diluted and dispersed. Such care also governed village layout, where in Kaixiangong, the silk factory is located downstream so that it does not contaminate drinking water [3].

The act of care extended beyond the material world, as villagers performed rituals and rites to ward off adversity and protect the community. In his anthropological study of Kaixiangong Village in the 1930s, Fei Xiaotong refers to these practices as magic, as opposed to the empirical knowledge accumulated over generations [3]. Such rituals represent a form of landscape care that exceeds the capacity of human effort alone, calling instead upon the power of higher presences or deities. In Kaixiangong, three major rituals were performed in response to floods, droughts, and locust infestation [3].

2. Polder Now: Eroded Connection between People and the Land

Over the following three millennia, these landscapes underwent significant morphological and organizational transformations in response to shifting socio-political conditions: population growth during the mid-Tang dynasty; administrative restructuring during the Five Dynasties and Ten Kingdoms period; decentralization and land policy reforms in the Song dynasty; standardization under the Ming and Qing dynasties; collectivization during the early People's Republic of China; and market-oriented reforms in the post-Mao era [2,4].

2.1. Field Observations in Tai Lake Basin

2.1.1. Restricted Access to Water

Xitang—once an ancient water town and now a 5A level tourist site—has witnessed a shift in the meaning of water to people. The canals, originally dug to support water transportation and a water-based economy, now have a more complicated relationship with those living on land.

On one hand, people desire visual access to the water; on the other, actual physical accessibility is



Figure 2.1 Xitang Ancient Town, photo taken by authors in May 2025

increasingly limited. Omnipresent warning signs and motion sensors along the water's edge discourage close contact with the water. If one approaches too near, a recorded warning abruptly breaks the silence of scenic Xitang, ordering them to step away from the danger zone immediately. Across the river, restaurant and hostel owners extended their buildings outward, constructing balconies that overlook the canal. With barriers erected to enclose these spaces—simultaneously restricting access from both sides—the framed view of the canal has been absorbed into private space, folded into the services offered and consumed by visitors. The only remaining way to access the water in the town is by taking a 30-minute scenic boat tour, priced at 30 yuan per person.



Figure 2.2 Balcony spaces in Xitang, photo taken by authors in May 2025

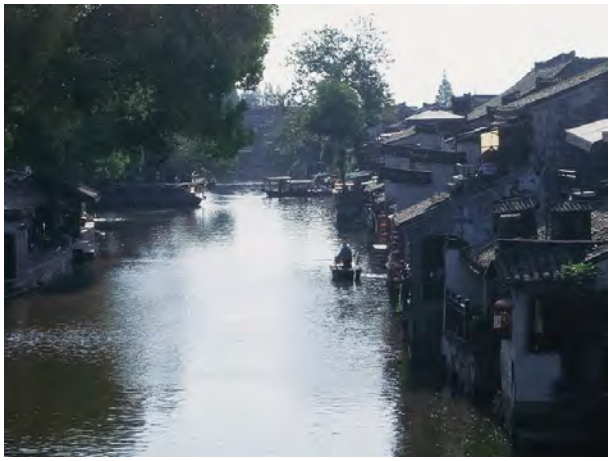


Figure 2.3 Scenic boat in Xitang, photo taken by authors in May 2025

In Fenhu Village, a one-meter-tall concrete wall lines the canal, punctuated at intervals with openings for boat access. On top of this original wall sits a second, lower wall. The color difference suggests it was added later. Together, the two walls block the visual connection between the land and the water. At each opening, metal slots are installed so that a gate can be slid into place during heavy rainfall, preventing water from flowing inland. The tall walls are a response to water being conceived as a risk, reflecting a fear of its destructive force.



Figure 2.4 Concrete flood wall in Fenhu Village, photo taken by authors in May 2025



Figure 2.5 Water Gate in Fenhu Village, photo taken by authors in May 2025



Figure 2.6 Boat access point in Fenhu Village, photo taken by authors in May 2025

2.1.2. Negligence

Dysfunction pervades the landscape. Across the villages visited in this study, water infrastructure shows signs of neglect. Irrigation ditches are clogged with overgrowth; in some cases, they have collapsed entirely. Iron sluices are broken or missing. Components of the system that once played a crucial role in adjusting seasonal water levels have lost both their function and relevance.



Figure 2.7 Broken sluice in Tanghua Village, photo taken by authors in May 2025

Other forms of negligence have deteriorated water quality. In Tanghua Village, informal egg product factories bypass the sewer systems connected to on-site water filtration and purification facilities, discharging effluent directly into the surrounding waterways. Approaching one of these factories, a pungent smell lingers in the air, the water in ditches around the house is dyed deep red, and the path beside the stream is streaked with orange runoff from the dye.



Figure 2.8 Polluted runoff from an informal egg product factory in Tanghua Village, photo taken by authors in May 2025



Figure 2.9 Unorganized pollution outlet in the field, photo taken by authors in May 2025

2.2. Underlying Causes

2.2.1. Historical Subdivision and Demographic Change

From the Song dynasty, particularly with the privatization of land, these polder units were fragmentized. By the Republican era, large polders had become subdivided into parcels with curved, informal boundaries. This fragmentation severed not only spatial unity but also the coordinated operation of gates, dikes, and irrigation channels.

Following China's Reform and Opening-Up, rural populations began migrating to urban centers. Hollowed-out villages and aging communities became prevalent. As young laborers departed, traditional maintenance tasks—like dredging ditches and reinforcing dikes—were neglected. Elderly residents lacked the capacity to sustain this intensive labor. Consequently, dike leaks and channel siltation became widespread. Human capital loss translated into infrastructural decay.

On one hand, young and middle-aged farmers have moved to cities for work and business, resulting in a sharp decline in the labor force that traditionally maintained the dikes. On the other hand, those remaining in the rural areas are mostly elderly individuals with limited physical strength and technical skills, making it difficult for them to undertake the arduous tasks of dike maintenance and channel dredging. Population outflow has exacerbated rural aging, which in turn has weakened agricultural production vitality and public water management, leading to neglect of small dikes, dike leaks, silted-up irrigation channels, and abandoned fields, resulting in the gradual loss of the water regulation and storage functions of diked fields. A significant amount of land has become seasonally abandoned or underutilized, making traditional intensive rice farming unsustainable. Population migration has also led to changes in traditional village settlement patterns, with many villages shrinking or merging. The water management networks that once served the village-dike field communities are now neglected and abandoned. This process of "people leaving and fields becoming barren" has significantly accelerated the functional degradation and spatial fragmentation of the dike field system.

2.2.2. State Hydraulic Infrastructure and Policy

National water regulation initiatives have reshaped the Tai Lake Basin's hydrology. Following the implementation of projects such as the Yangtze River Water Diversion Project, the water level and volume of Tai Lake have become increasingly subject to central dispatch control, marginalizing the role of local small-scale water conservancy facilities[7]. Additionally, national policies, driven by the need for water environment remediation and pollution control, have strictly restricted existing agricultural water conservancy activities in the Tai Lake region. For instance, the remediation plan introduced after the Tai Lake blue-green algae crisis required to set up a one-kilometer protection area around the Lake basin [6]. Also, the propaganda and regulations of polder recovery projects directly led to large-scale conversion of lakeside polders back to lakes and wetlands, with the agricultural functions of local farmland giving way to ecological protection.

The construction of inter-basin water diversion projects itself, together with the accumulation of fragmentation actions, disrupted the spatial integrity of polders: newly excavated water diversion channels and pump stations occupied portions of farmland and water network corridors, severing the continuity of the original polder units.

In this new paradigm, traditional sluices are redundant. Their intended purpose—to regulate Tai Lake's edge flows for flooding control, pollution mitigation, irrigation and drainage—has been dispensable, rendering it a non-essential component under centralized water regimes. Such institutional

marginalization is matched by spatial dismemberment.



Figure 2.10 Diagram of water diversion project from Yangtze River to Lake Tai, Image source[7], translated by authors

2.2.3. Industrial Expansion and Transport Infrastructure

From the 1980s onward, the rise of township and village enterprises (TVEs) reshaped rural land use. Under the Suzhou–Nanjing model, numerous factories were built on high-yield farmland, often close to transport corridors and high-efficient waterways. Such placement maximized capital flow and development of villages but rapidly eroded the polder's spatial logic. Polder systems became fragmented by factories, workshops, and storage yards.

Infrastructure further compounded this disruption. Highways and railways, such as the Shanghai–Kunming High-Speed Railway, sliced through the southeastern basin. Their linear geometry severed polder grids with surgical precision. Although culverts were installed, they could not replicate the nuanced connectivity of the former dike-water network. Transportation infrastructure imposed new forms of impermeability on a historically porous landscape.

Along these corridors, urban expansion intensified. Villages spread outward, occupying former farmland. The resulting mosaic includes factories, roads, residences, and residual fields. Hydraulic logic has been overridden by real estate logic. The fish-scale polder pattern is not simply aesthetic—it encodes structural collapse.



Figure 2.11 Shanghai-Kunming high-speed railway project(image source: China Railway Corporation)

3. Polder Future: Cultivating Care through Embodied Practices

Global average temperatures in 2024 surpassed the 1.5°C threshold above pre-industrial levels, underscoring the imminent urgency of climate crisis. Every increment of global warming will intensify the impacts of sea level rise and extreme weather events on low-lying regions, resulting in the inundation of land. In response, countries like the United States and Singapore have turned to polder systems as strategies for land reclamation and flood protection [5].

While polders are meticulous water management systems, their effectiveness hinges on constant maintenance—an effort that, historically, was rooted in care. Villagers' livelihoods were inseparable from the landscape itself. Their everyday bodily engagement with the land fostered a deep sense of stewardship and collective responsibility that is foundational to effective upkeeping and operation of the polder system.

Today, that relationship has frayed. As discussed in *Section 2.1*, modern polder systems have become increasingly detached from the lives of those who inhabit them, eroding the very culture of care that once sustained them.

This paper argues that any meaningful response to the environmental crisis must recover an ethic of care—one that is relational, situated, and collective. The polder can be reimagined not merely as hydraulic infrastructure, but as a place-based strategy for cultivating landscape care in the 21st century.

Making polder systems relevant and functional in contemporary contexts—such as the Tai Lake Basin—requires addressing critical challenges, including demographic shifts, rapid urbanization, and the dominant framing of water as a threat.
How might we begin to perceive risk as a generative force? What if episodic flooding could be embraced as part of the landscape, supporting new local economies, enabling more-than-human habitation, and shaping a renewed relationship between water, tourism, and village life? How might emerging technologies support this care, rather than replace it? These are not solutions but starting points—for rethinking the future of the polder as a living, adaptive, and cared-for landscape.

Acknowledgments
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POWERFUL PROFESSIONAL NETWORK - A LEVER FOR LEGISLATIVE AND SOCIAL ADVANCES? THE "DISCRETE" PROFESSION – A HISTORIC CONSTANT? (maximum 20 words)

TOPIC: Guiding territories with legislative and social advances in planning: Organisation of large territories

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Keywords: IFLA, history, professional networks, advocacy, policymaking

Abstract

The abstract should not exceed 500 words. The content of the abstract should briefly state the purpose of the research, the main findings and the main conclusions. Leave two "11pt spaces" after the text for the next title.

This presentation will delve into the decades preceding the foundation of the International Federation of Landscape Architects as well as its founding years, unravelling the efforts made by a series of international practitioners as early as the 1930s, especially in Belgium and in France, to create a network of professionals in the field of garden architecture – later to become landscape architecture. Exploring the pre-World War II events (amongst others the international Garden Congress organised in Belgium in 1935) that eventually led, in 1948, to the organisation in London, by the British Landscape Institute, of the international exhibition and conference that would pave the way to the foundation of the International Federation of Landscape Architects, the presentation will focus on the impact that IFLA had on the extension of the scope of the profession, as well as its positioning as an important player in the reconstruction of Europe in the aftermath of the war.

Drawing a parallel with the urgent change of paradigm needed in the face of large-scale environmental destruction in the era of the Anthropocene, the presentation will explore the visions, policies and strategies adopted by the founding members of IFLA to redefine the profession and its territorial scope, assert its importance on a policymaking level and position landscape architecture as an important player within the design professions. The presentation will analyse in particular the role of the International Garden Congress organised in Brussels on the occasion of the 1935 World's fair by the Belgian Association of Garden Architects (Association Belge des Architectes de Jardin, ABAJ). Its president, Jules Buyssens, who was a major figure of landscape architecture in the first half of the 20th century, had an extensive professional network spanning more than 10 European countries. He had, amongst others, worked for 6 years in Édouard André's practice in Paris, which had enabled the development of strong links between Belgium and France in the realm of the profession, but more largely, also of horticulture.

The presentation will also bring to light the role of Ferdinand Duprat in translating the 1949 IFLA-Constitution document, and in coining the title 'Architecte-paysagiste' for the profession in French. This document was ratified by 15 countries, including France. It must be recalled that in its founding years, French was the language of reference of the International Federation of Landscape Architects.

We propose the notion of "history-based solutions" as a trigger for reflexion and invention for present-day advocacy and policymaking, and as a formidable source of inspiration for reinventing the profession in the 21st century, as it encounters challenges of yet another scale than after World War II.

Text

Brussels, 27th April 1935. Belgium proudly opens the Brussels World's fair, the 10th International Exposition in the country's history. Placed under the sign of Art Deco, one of the Fair's main highlights is a spectacular Rose Garden created by the recently founded Association of Belgian Garden Architects ABAJ (Association Belge des Architectes de Jardin).



Figure 1. The Rose Garden at the Brussels World's Fair, 1935. Autochrome glass plate. © CIVA Collections, Brussels

Its president, Jules Buyssens, landscape architect in chief of the Fair premises, is not an unknown figure on the international stage [1]. His career, begun in the early 1890s in Belgium, spanned from France and Switzerland to as far as Poland and Russia. Active in the public realm as the Inspector of Promenades and Plantations of the City of Brussels for more than 30 years, he also ran a private practice and during his career realised more than a thousand projects – ranging from private gardens to the master planning of extensive spa resorts. The man was ambitious and had a vision. In the 1910s, he had been, with others, the initiator of a specifically Belgian movement of reform of Garden Architecture, *Le Nouveau Jardin Pittoresque,* that positioned itself in strong opposition to the style dominant in France at the time, as promoted by the brothers André and Paul Vera most notably in their book *Le Nouveau Jardin*.

In 1935, at the apex of his career, he not only is the instigator of the World's Fair's Rose Garden, an Art Deco public space of exceptional scale, but also organises one of the very first international Congresses for Garden Architects in Europe.

His international professional network, and in particular his French connections, had been of great benefit in organising the event. And although some postal delays prevented a series of recipients to receive their invitations on time, a strong delegation from France was present (with delegates from the Société Nationale d'Horticulture SNH and the Société Française de l'Art des Jardins SFAJ), as well as such well-known figures as Pietro Porcinai from Italy, and Ulla Bodorf from Sweden [2]. Buyssens had understood the criticality of the event and seized the occasion to position and give visibility to a profession that was still relatively loosely organised, and in the general public's mind, remained a niche activity concerned mainly with gardens. The event was to prove otherwise. The scale of the impressive Rose Garden (destined to become a public space at the end of the fair), the quality of the speakers (with important figures such as Achille Duchêne of Ferdinand Duprat) and the international dimension given to the event, signalled that something very different was at play – the event would pave the way for the creation of a series of international congresses that would gradually lead up to the creation, a bit more than a decade later in Cambridge, of the International Federation of Landscape Architects.

But let us step back for just one moment: an International Exposition, that's millions of visitors, and an international visibility of unfathomable scale. Not only in situ, but also virtually… the millions of postcards sent worldwide did – way before the invention of internet- showcase the most spectacular attractions of the fair. The numerous pavilions, of course, but also… the Rose Garden, as the many published postcards bear a powerful testimony for.



Figure 1. The Rose Garden at the Brussels World's Fair, 1935. Postcard.
Long before the era of internet, postcards were an extremely powerful means to disseminate images and ideas. The postcard shows the Rose Garden, situated at a nexus point of the

International Exhibition site, generating an important afflux of visitors.
© CIVA Collections, Brussels

Buyssens had understood the incredible opportunity this represented, and, a strategic thinker and planner, had positioned not only the Belgian Association of Garden Architects, incarnated by way of the Rose Garden placed at the nexus of the site, but also invited his international counterparts to mark the event. The international resonance was strong, with articles published in specialised journals spanning from Germany to Sweden and France, and a group of professionals strongly motivated to pursue the venture and build up on this epochal milestone.

London, 1948.

Thirteen years after the Brussels event, and after a World War that had reduced large stretches of Europe to ashes, 1948 announced new paths to be tread. The profession had not been inactive since 1935, a succession of further international Garden Congresses showing its interest in gathering momentum and getting organised on an international level. The 1937 Paris Congress of Garden Art can certainly be cited as a seminal event, bringing together a number of countries hitherto unseen [3]. On the occasion, Belgian landscape architect Jules Buyssens held a conference for an audience of more than 1200 participants [4], an impressive figure even for today's standards. Knowing the fellow's character, this should come as no surprise: Buyssens was an internationally acclaimed figure, not only regards to his professional achievements, but also for his outstanding skills as a public speaker. Convinced that garden architecture should be disseminated to large audiences, Buyssens was a strategic thinker in terms of professional communication, and had over the years, in particular within the *Le Nouveau Jardin Pittoresque* association, developed specific techniques for public speaking that consisted of slideshows with numerous colour photography glass plates (a rather out of the ordinary practice at the time), combined with a lively and humoristic tone which enabled him to easily connect and engage with audiences. This method of inspirational public speaking strongly resonates with 21st century formats such as TED-talks, designed to powerfully convey "ideas worth spreading," and aiming to educate, inform, and inspire audiences.

Further events of arguably lesser importance took place in Switzerland and Germany (International Exposition on Garden, Cemetery, and Urban Design, Geneva 1938; International Congress of Garden Architects, Berlin, 1938; International Congress of Garden Architects, Zurich, 1939 [5]), but the war brought a brutal ending to these nascent endeavours.

1948 is a seminal date for the profession of landscape architecture. It saw the creation of IFLA, the International Federation of Landscape Architects. Shortly after the Second World War, a 'vision for a better future emerged and a new and better world order seemed possible' [6]. The international conference and exhibition organised by the British Institute of Landscape Architects in London in August 1948, an event that assembled 160 delegates from 16 countries, and which preceded the founding meeting of the Federation at Jesus College in Cambridge in the same year, had set high ambitions. G.P. Youngman, reviewing the event in the *Journal of the British Institute of Landscape Architects* of November 1948, writes: 'As in this country, so in many others there has been during the last ten years or so a great extension of the *scope* of the landscape architect's work and a growing *recognition* of the status of a new profession'. Two key notions can be extracted from this quote: the extension of the scope of the profession, and the growing recognition of its status.

In the aftermath of the Second World War and the massive reconstruction efforts that lay ahead throughout Europe, the newly formed international network's assertive and astute approach to immediately position itself within the pressing questions of town planning, collective green spaces and large-scale planning was a strategically immensely successful move. In its strategic orientation, a parallel with the event organised by Buyssens in 1935 can be drawn. And a little cameo appearance is certainly worth mentioning - although Buyssens was by now an old man of 76 years and had long been retired [7], he was one of the guests in London, invited personally by Geoffrey Jellicoe, the organiser of the event, not only to attend the conference, but also to drink tea with the Jellicoe family at their home.

During the speech he held at the conference, the Belgian delegate René Pechère declared 'Planting must no longer, as in the past, be inserted as an afterthought between buildings. The buildings must rather be sited within the landscape,' [8]. The sentence might seem anecdotal, but does it not strongly resonate with misunderstandings and struggles the profession still faces today?

In 2023, IFLA celebrated its 75th anniversary. Anniversaries are undoubtedly a time to celebrate and look back onto history. They instil a reflective

mood, questioning us on where we were, where we are and, most importantly, where we strive to be. While we urgently need to look ahead, delving into landscape architecture history and its institutions is necessary, but also insightful and inspiring. The 75th anniversary has given rise to a look back into its foundation years, as illustrated by the Network of European Landscape Architecture (NELA)'s research project *IFLA 75: Uncovering Hidden Histories in Landscape Architecture* [9], but also by IFLA's *75th Anniversary Greenbook* [10].
But as we look back—sometimes somewhat complacently— should this not also serve as a catalyst for major existential questioning?

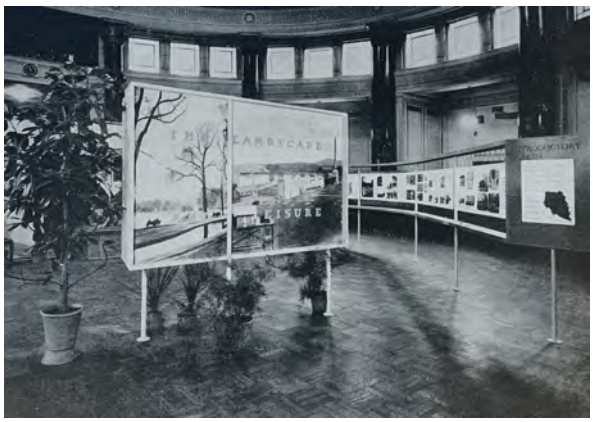


Figure 3. The landscape architecture exhibition accompanying the international conference organised by the British Institute of Landscape Architects in London in August 1948, the event that paved the way for the foundation of IFLA in Cambridge during the same month.
Journal of the British Institute of Landscape Architects, November 1948. © MERL Archives, Reading.

Where have we failed, what crossroads have we missed? Should we not start an unsparingly drastic self-scrutiny of blind spots and profound founderings? The present-day world is incredibly competitive. Missing the train of the civilizational turn that is under way is not an option. But as long as crucial concepts such as lobbying, image-building and communication remain close to sacrilegious within our community, we are consentingly, maybe even actively, pushing the discipline into effective irrelevance.
Taking our visionary predecessors as an incredible source of inspiration as to what ambition, assertiveness and lobbying can be, we would be well advised to look at history not as a dead, static thing of the past but, on the contrary, as a formidable incentive and obligation to go much—much, much—further. As in 1948, the profession stands at a major turning point in its history.
The *extension of scope* in the profession, and the need for growing *recognition*, key issues of the 1948 exhibition and conference, are still big issues today. But in the Anthropocene, scopes and the need for recognition are of a formidably different scale and of tremendous complexity. The extension of scopes, one can argue, has been largely identified. But have we given ourselves the ambition, the means, the financial and human resources, the think tanks and the professional branding… indispensable to take up the immense challenge of recognition and positioning landscape architecture within society and the global labour market?
Without strong advocacy on policymaking levels, these efforts alone will undoubtedly be insufficient within the tight timeframe of the vertiginous speed of environmental destruction that characterises the Anthropocene.
Nantes, 2025… time for damage report?

2.
File downloading

Presenting authors should upload the **short paper in text opend document format (*.odt)** to the IFLA 2025 website until June 15, 2025, 23:59 CET.

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TERRITORIAL PLANNING THROUGH THE PRISM OF AGRICULTURE AND LANDSCAPES : EXAMPLES FROM LYON METROPOLITAN AREA AND GREATER REIMS IN FRANCE

TOPIC: Guiding territories with legislative and social advances in planning: Organisation of large territories

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Keywords: territorial planning, territorial coherence scheme, agriculture, landscape

Abstract

Territorial Coherence Schemes (SCoTs) are a cornerstone of France's spatial planning system. However, they remain subject to many doubts and uncertainties. Introduced by the Solidarity and Urban Renewal (SRU) Law, their role has been strenghtened by the Evolution of Housing, Urbain Planning, and Digital Affairs (ELAN) Law in 2018 and the Climate and Resilience Law in 2021. Additionally, local authorities have become increasingly concerned with agricultural and food-related issues. SCoTs are also crucial tools for preserving agricultural and natural areas from urban sprawl. The "Zero Net Artificialisation" (ZAN) trajectory encourages local authorities to rethink urban planning by integrating non-built areas into their considerations. This paper is part of the research-action project "Âge2SCoT: Adapting Planning to Agroecological, Landscape and Climate Challenges," led by the Habiter research unit at the University of Reims Champagne-Ardenne (URCA). The research project is funded by the French national ecological transition agency - Ademe (2022–2025) under the PACT²e research program: "Planning and Designing Territories in the Face of Climate Change.". It examines how agriculture and landscapes are taken into planning documents in a context of global change [4]. The research explores the production process of these documents, the integration of the landscape concept and the involvement of agricultural stakeholders. Furthermore, it investigates how natural, agricultural et forestry lands are considered in the construction of territorial project. The study is based on two case study in France where SCoT revisions are currently underway : the SCoT of Greater Reims (Grand Est region) and the SCoT of the Lyon metropolitan area (Auvergne-Rhône Alpes region). The results from the two case study areas reveal a weak link between planning, agriculture and landscape management. In both cases, the SCOTs struggle to incorporate a large-scale landscape approach [10] into their territorial planning. In line with previous research [5], the results challenge the capacity of SCoTs to define a strategic vision on large-scale landscape and over the long term. This is particularly critical given the pressing climate and environmental challenges that require a sustainable and integrated approach to land management.

1. Introduction

The Âge2SCoT research project focuses on the evolution of territorial planning (in particular SCoTs) in France through its relationship with agriculture and landscape approaches in a perspective of socio-ecological transition. The research approach is structured around three central issues:

- How are agriculture and landscape taken into account in territorial planning (particularly SCoTs)?
- What can agroecology and landscape approaches teach us about the possible evolution of territorial planning?
- How can territorial planning promote the ecological transition of agricultural systems?

In both study areas, the research methodology was based on semi-directive interviews with various stakeholders (farmers, local authorities, chambers of agriculture, etc.), and analysis of existing planning documents or those under revision. In the case of Greater Reims, the research-action process was carried out in collaboration with the landscape and urban planning agency Omnibus, in order to develop a landscape approach and work on the evolution of agricultural landscapes in connection with the revision of the SCoT.

2. The ScoT of Grand Reims : agricultural and food issues are not at the political agenda

Greater Reims (143 municipalities, 300.000 inhabitants) is characterised by its extensive agricultural and wine-producing areas transformed after the World War II by a national and European policies promoting intensive agriculture relying on chemical inputs and mechanisation. The survey results show that the agricultural and food issues (and even less so the objective of agro-ecological transition) are not at the political agenda of Greater Reims. Agricultural issues are discussed in others small arenas than territorial planning (land associations, town councils, agricultural land management companies, etc.) and mainly at the small scale (communal, parcel or group of parcels). Between 2022 and 2025, the revision of the SCOT will involve few changes in continuity with the previous version. Moreover, it has been carried out by a limited number of stakeholders (elected representatives and technicians). The survey reveals a relatively weak culture of (large scale) landscapes, despite an area with a long tradition of links between landscape and urban planning (parks, garden cities). As part of the Age2SCoT project, the Omnibus landscape agency has been commissioned to develop a landscape-based approach called "Landscape Trajectories" as a mediation tool to reflect on the future of the region's agricultural spaces through a retrospective approach. However, this exploratory approach has received only limited support from Greater Reims, despite their participation in the research-action project.

3. The ScoT of Lyon Urban Area : agricultural and food policy is generating local innovations that are renewing the scope of local public policies

The Lyon metropolitan area (74 municipalities, 1.45 million inhabitants) is predominantly urban and shaped metropolisation dynamics, driven by post-war State policies aiming for balanced metropolitan development. Agricultural land is under significant pressure, despite efforts by the greenled municipal government since 2020 to implement a proactive agricultural policy. Since the election of the ecologist municipality in 2020, agricultural and food policy has been put on the agenda of the Metropole de Lyon with a significant budget associated with its implementation. This agricultural and food policy is generating local innovations ("test area" and "metropolitan farm") that are renewing the scope of local public policies. This policy is the result of a pragmatic vision based on one-off actions, to the detriment of a long-term strategic vision at the scale of a large territory.

As part of the SCoT revision, a study entitled "Landscape, Soil and Resilience" (2022-2023) has been commissioned from the Base landscape agency. Among its proposals is the development of an "agro-bocage woodland network" design to mitigate heat islands and reintroduce biodiversity into the urban fabric. However, this project has sparked controversy, particularly among representatives of the farming profession. The results and graphic representations of the Base study have not been included (or only in part) in the revision of the SCoT.

4. Main results from the two case studies

The results from the two case study areas reveal a weak link between planning, agricultural and landscape management. Planning tools may help preserve land or support green infrastructures, but the SCoT cannot directly guide agricultural activity.

Meanwhile, territorial food projects (PATs), introduced by the 2014 law on the future of agriculture, can help initiate local dialogue around food and farming, but their limited resources often undermine their effectiveness. Moreover, PATs are still relatively rarely mentioned in urban planning documents such as SCoTs. Agriculture is still perceived and managed as a private matter. Nevertheless, the subject is emerging in certain intercommunality, such as the Lyon Metropolis, leading to closer links between planning, agricultural and food policies.
In both cases, the SCOTs struggle to incorporate a large-scale landscape approach [10] into their territorial planning. In line with previous research [5], the results challenge the capacity of SCoTs to define a strategic vision on large-scale landscape and over the long term concerning evolution of natural, agricultural and forest area. This is particularly critical given the pressing climate and environmental challenges that require a sustainable and integrated approach to land management.

5. Guidelines for an "age 2 of Scot"

The central hypothesis of the Âge2ScoT project is that territorial planning—understood as a process for coordinating actors, territorial scales, and temporalities—can be a strategic instrument of public policies in response to environmental and climate issues, provided its paradigm and methods of conception and implementation are rethought. The Âge2SCoT project explores the (debatable) hypothesis of a "second age" of SCoTs and aims to sketch its early outlines. The hypothesis of an 'age 2 of SCoTs' initially comes from an action research project commissioned by the National Federation of SCoTs. The results of the Âge2ScoT project identify four guidelines for transforming territorial planning instruments in France :

Axis 1. Renew planning thinking and methods from the inputs of agroecology
Agroecology, which promotes the design and management of agricultural systems as ecosystems, is now internationally recognized. Building on the work of Tornaghi and Dehaene [12], we hypothesize that agroecology also offers a renewal of urban and spatial planning methods by approaching territories through their metabolism and a systemic lens. By proposing the ecological and landscape reintegration of agricultural systems, agroecology offers important lessons for the necessary renewal of planning thinking. Tornaghi and Dehaene [12] propose an integrative approach they call "agroecological urbanism". This idea resonates with Janin's [8] work on the foundations of the "agricultural city" and Ambrosino's [1] research on "the permacultural foundations of future urbanism." It also aligns with Marot's [9] work on integrating agriculture into architectural design through "deepening territories by agriculture."

Axis 2. Planning the ecological transition trajectory of agricultural systems
The post-war decades, often dubbed the "golden age" of state planning, demonstrated strong transformative capacities in agriculture and land-use policy, supported by major institutions like the Interministerial Delegation for Spatial Planning and Regional Attractiveness (DATAR). This success stemmed from a convergence of social, technical, and economic factors around the shared narrative - "feeding the world"- still present in agricultural discourse today. Fifty years later, planning seems caught in a paradox: its traditional forms are increasingly seen as ineffective or irrelevant to contemporary agricultural challenges. We hypothesize that we should consider reviving agricultural planning. Might a new major agrarian reform be a prerequisite to transforming agriculture on the scale required by 21st-century societal challenges?

Axis 3. Reconnect with (large-scale) landscape approaches and, more broadly, with expanded spatial and temporal scales
Transitions, particularly agro-ecological transitions, will necessarily be accompanied by landscape transitions, which is why landscape-based approaches are becoming crucial. We hypothesize that landscape-based or "landscape urbanism" approaches represent key levers for collaborative, resource-aware territorial planning (particularly agricultural and food resources). Their holistic and relational view of territories makes them strategic for a "second age" of SCoTs. Landscape enjoyed its golden age in 1990s France, but was later overshadowed by biodiversity-based approaches. While landscape architects now play key roles in urban design and public space quality, long-term "large landscape" approaches [10] seem to have lost traction. In societies marked by "social acceleration" [11] and a "presentist regime" [6], short-term and small-scale actions (temporary, transitional, tactical) often prevail over long-term, large-scale strategies, despite the proliferation of planning norms. At the same

time, climate urgency demands rapid, visible actions—sometimes at the expense of the historical inquiries needed for a deeper understanding of territorial dynamics. We hypothesize that planning have to reconnect with (large-scale) landscape approaches and, more broadly, with expanded spatial and temporal scales.

Axis 4. Imagine counter-narrative(s) in the field of spatial planning

Planning, and especially SCoTs, are often seen as outdated or overly normative. Their effectiveness often stems more from legal constraints (e.g., urbanization limits in the absence of a SCoT) than from enthusiasm for long-term strategic thinking. We suggest that a "second age" of SCoTs would require planning to be intentional and valued—promoted and supported (and primarily by local residents) by stakeholders by adhering to the vital issues of soil health and, more broadly, public health. While planning instruments and exercises are multiplying, and scholars note a "narrative turn" in urbanism [2], territorial planning in France—particularly through the SCoT—seems to suffer from a lack of narrative drive or a "crisis of imagination." Déléaz [3] describes a "loss of readability" in SCoTs, which have grown more complex with successive reforms—especially those integrating environmental and climate issues. We hypothesize that new counter-narratives in the field of spatial planning might be built—especially in light of post-war policies and today's socio-ecological context [7]. How do landscape and agro-ecological approaches diversify the narratives in the field of spatial planning and transform the "grand narratives" that have shaped the history of urban planning?

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ADAPTATION OF URBAN AND RURAL AREAS TO CLIMATE CHANGE – FEDERAL FUNDING PROGRAM IN GERMANY - IMPLEMENTATION OF SUBSIDIZED CONSTRUCTIONS

With legislative and social advances in planning (planning law, nature and society, heritage landscapes)
Organisation of large territories

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Keywords: climate change adaption, policy analysis, governance, urban development support, funding practices

Abstract

Climate change is a reality – not only in Germany. Local authorities in particular are key players in establishing resilience and are largely responsible for adapting public spaces to the upcoming changes at early stages. Public spaces, streetscapes and parks are more frequented by the citizens, especially since the pandemic, and must meet their high expectations and requirements. In addition to aesthetic issues of design and quality of stay, these spaces provide important benefits such as increased protection from heat or heavy rainfall. They are sources of cold air and oases of shade. They thus fulfil important functions for the microclimate and are part of the blue-green infrastructure. These structures must be strengthened and expanded, especially in order to increase the climate preparedness in the light of future weather extremes. This new approach is nothing less than a paradigm shift that occurred in the last few decades, not only from the planning perspective, but also from the perspective of newly concretized legal obligations that municipalities need to meet. Whereas in the past, water was channeled out of cities as quickly as possible, nowadays rainwater is to be handled more naturally in the sense of a water-sensitive settlement development. Furthermore, in the streets space was given primarily for the technical infrastructure and traffic, whilst trees had no room to develop.

Many planning concepts from recent decades will be put to the test in the coming years and must be brought to contemporary technical and design standards, so that future generations could also find open, livable and attractive spaces. This impacts not only traditional areas like parks, but the idea of a sustainable city development in whole.

Local authorities can hardly cope with the scope complexity of the planning and, in particular, the financial requirements without additional financial support. This is where in Germany the federal program "Adaptation of urban and rural areas to climate change" comes in. The funding program gives municipalities the opportunity to implement climate adaptation concepts and to test inter-agency cooperation and "new" approaches in practice. At the same time, the possibility of funding offers incentives to integrate aspects of sustainability more strongly into daily planning and thus create greater awareness of the issue in general. Funding tangible investments in combination with capacity-building is proven to be an essential step in pioneering new approaches into practice and mainstreaming them in the future.

1. Current status of Germany's Climate

Germany's dataset with nationwide temperature recordings reaches back to 1881, which makes long-term analysis possible. Comparing the linear trend from 1881 to 2022 the average temperature has already risen by 1.7 °C. Since 1970, an accelerated warming was observed. From 1881 to 2022 the average warming per decade amounted to 0.12 °C, while the trend from 1970 to 2022 has been 0.38 °C per decade in comparison with 0.06 °C from 1881 to 1970. During the last decade in the period from 2011 to 2020, the temperature was already 2 °C above the mean value (Kaspar et al., 2023). 2024 has been the hottest recorded year in Germany with double the number of summer days and three times the number of heat days as usual (German Meteorological Service-DWD, 2025).

While the precipitation has increased in the mean value by 8%, it has increased by 27% during winter and decreased by 4% during summer months. (Kaspar et al., 2023). In addition to the shift of precipitation, it's pattern is also changing. Instead of an even distribution, heavy rainfall and longer dry periods are occurring more frequently.

2.1 Governance in Germany

Germany has a multi-level governance system including horizontal and vertical scales with shared responsibilities between the federal state, the states and local authorities, following the subsidiarity principle. On the federal level the Federal Minister for the Environment, Climate Action, Nature Conservation and Nuclear Safety (BMUKN) is the main coordinating player, along with it's subordinate, the German Environment Agency (UBA). The main tasks of the UBA are to provide political advice, to conduct scientific research, provide audience specific information and to enable networks and participation around climate adaption issues. Concerning climate friendly urban and spatial development, funding green public spaces and blue infrastructure in addressing heat islands and risks of extreme weather events, the Ministry of Housing, Urban Development and Building (BMWSB) and its subordinate, the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) are playing a growing role (Teebken, 2024). As climate adaption is considered a cross-sectoral task, other ministries like the Ministry of Health (BMG) and the Ministry of Work and Social Affairs (BMAS) are becoming more proactive.

2.2 German adaptation strategy

In order to provide a foundation to adapt to climate change the Federal Cabinet adopted the German strategy for adaptation to climate change (DAS) in 2008. The goal was to pool the current efforts with the long-term objective to 'reduce vulnerability and improve the adaptive capacity of ecological, social and economic systems towards the unavoidable impacts of climate change (Federal Government 2008: 5).' In the DAS key principles and overriding objectives for 15 fields of action were defined. To coordinate the joint efforts, the interministerial working group (IMAA) was set up under the leadership of the former Federal Ministry for Environment, Nature Conservation and Nuclear Safety (BMU). The progress is constantly monitored and improvements are implemented when necessary (Kind, 2019). 2024 an updated version of the DAS was adopted by the Federal Cabinet, which for the first time gave measurable targets along with associated indicators to make the process measurable. Within the cluster of urban development, spatial planning and civil protection the main target areas are to activate urban green spaces and to aim towards a natural based water management, to minimize the risks of heavy rain and drought.

2.3 Federal Climate Adaptation Act

Also, in 2024 the Federal Climate Adaptation Act (KAnG) was adopted. For the first time, the act gives the Federal Government, the states and the municipalities a legal framework and makes, based on the individual impacts and requirements, the development of climate adaption strategies mandatory. The act also strengthened the vertical scale of the multi-governance system. The main task of the Federal Government is to produce and publish scientific monitoring reports and to support the 16 federal states. Based on climate risk analysis, the states will present and implement their own climate adaption strategies, which should result in tailored measures for the local authorities. In general decisions have to be made cross-disciplinary and on an integrated basis. Other acts that demand the restoring of the natural function of soils are also strengthened.

The cluster four, out of six cross-sectoral clusters, includes "the urban development, spatial planning and civil protection" and is led by the BMWSB. The key focus of this cluster is heat protection, stormwater protection and water availability. As the collection and analysis of the data concerning those goals is a complex topic, different methods are discussed at the moment to monitor progress. They should be easy, technically feasible, not cause

additional costs and be done with already existing data.
To monitor urban heat islands and heat stress during day and night already existing data can be used. As urban green spaces are considered to have a positive impact on the local climate, green supply and accessibility as well as tree canopy cover are used as sub indicators (Jänicke et al., 2025). With 30% to 40% of green coverage, extreme heat stress can already be halved (Rahmann et al. 2022). In denser areas it can also be reached with alternate measures like facade or rooftop greening.
To determine the distribution and accessibility of greenery, data from the European earth observation program Copernicus can be used. This program provides free data from the Sentinel mission. The resolution of 10 m to 10 m generates some challenges in densely populated or heterogenic areas. Because for biotope networks small stepping stones can also be important, adding more detailed data sets from the local authorities can prevent misinterpretations. Most cities already record their public green spaces. This can also help to receive a picture of the quality and health of the green spaces as well and not only the quantity and the distribution (Meinel et al., 2022).
The urban water management system has been set up to channel precipitation quick out the urban areas through pipes or open channels for decades. Nowadays this causes negative effects on different levels. What was once meant to prevent flooding can cause negative impacts at other places during heavy rainfall. Also, the direct runoff decreases the recharge of ground water. In addition, with the shift of the distribution of precipitation and warmer weather in general, this can affect the health of the green infrastructure and reduce the positive effects of shading and evaporation. In comparison to the indicators of the green infrastructure the sub indicators for a natural based water management are more complicated to measure, because permeable pavements, decentral water management and the effective run off are harder to distinguish on satellite images and can only be determined in approximation. So, a uniformed nationwide application is a challenge and is still only achievable through diverse calculation methods (Jänicke et al., 2025).

2.4 BauGB

The DAS and the KAnG give local authorities legislative obligations to take measures to adapt to climate change. To implement those measures and to react accordingly with their spatial planning, local authorities were already given some tools within the Federal Building Code (BauGB). The BauGB offered a legislative spectrum of options to regulate land use to deal with climate protection, climate adaptation and inner development. With the amendments of 2011 and 2013 those options were outlined more explicitly (Frerichs et al., 2019).
A new amendment to BauGB is on its way, but has not yet been adopted. It should enable cities and municipalities even more to prepare for the consequences of climate change early stages.

Because adaption to climate change is considered a cross sectoral task, which involves many actors, only the most prominent regulations concerning spatial planning are outlined.

3.1 Subsidized construction

As the impacts of climate change are becoming more and more tangible in Germany, it is not only getting important to make progress, but also to mainstream new planning approaches and concepts. To give incentives, the Federal Government can make use of several support programs to push important goals into focus. One of them is the Urban Development Support program, which is aimed at reducing urban development deficiencies and functional losses in municipalities. One benefit of the amendments to the BauGB was, that solving climatological defencies became conditional. This made measures for climate protection and climate-change adaptation, in particular for the improvement of green infrastructure, a requirement for the Urban Development Support (complan, 2020). The area boundaries must still be formally defined by a council resolution and an integrated urban development concepts is needed.

3.2 Guidelines for the implementation of subsidized construction measures (RZBau)

If the Federal Government funds investments, which are implemented on the municipal level, certain requirements need to be met. The responsibilities for the planning, construction and implementation of the measures are staying explicitly within the local authorities. The goals of a certain funding program must be met, the pursuit of key federal building policy and Baukultur are at least mandatory. This includes the promotion of competition, sustainable and energy-efficient construction and the implementation of proper procedures for both planning and construction services. It is also important to take various participation procedures into account.
If necessary, the Federal Building Administration can give advice to the recipients to ensures that federal building policy and Baukultur are adhered to

and can check if the projects are carried out properly and economically.
The process is regulated according to the Guidelines for the implementation of subsidized construction measures (RZBau). With the funding bodies and the local authorities as the implementing organization, the departments of the state or their successor organizations are involved. Those precautions are intended to make procedures transparent with comprehensively described competences as well as responsibilities and enables a largely standardized handling of the implementation of construction and infrastructure projects, even in the case of mixed funding. The framework is aimed to keep the administrative action to a minimum and simultaneously giving a reliable procedure.

3.3 Funding program "Adaptation of urban and rural areas to climate change "

Since 2020 the BBSR has been implementing the federal program 'Adaptation of urban and rural areas to climate change' on behalf of the BMWSB. The program funds measures that improve the local climatic conditions, both in densely populated and rural areas and increase natural carbon sinks as a co-benefit. The subsidized measures are suitable for reducing or coping with urban climate deficits and increasing extreme weather events caused by climate change (heat islands, areas at risk of flooding and inundation).

Just for this program to date 576 million € have been made available. The Budget Committee of the German Federal Parliament ("Bundestag") decides on the selection of the projects based on submitted applications by the municipalities in response to a program call. This is followed by a post-qualification phase of the drafts to make sure that the goals are met. The program is accompanied by yearly network events, organized for all municipalities that are funded within the program. While the number of stakeholders at the federal and the state level is clear and working groups like the IMAA are established, those network meetings have proven to be of high added value for an exchange at the local level.
Besides capacity building, an exchange of experiences enables local authorities not only to learn about best practice but also how to overcome common challenges (Bulkeley, Castán Broto, 2013).
To date, around 50% of the projects from the program have started construction. All other projects are still in the implementation or preparation phase. Over the last four years a number of 372 projects in total have been chosen and to date 285 projects were approved, with up to 53 additional projects in 2025. With 199 projects, the majority is directly linked to objects like parks or green space networks, which have to be described as a classic field of work for landscape architects. Streets, squares and pedestrian zones make up 68 projects. 45 projects are linked to the topic of water management. As some measures tackle more than just one objective, multiple classifications are possible. The outcome and achievement of objectives and as well as the funding efficiency will be published by the end of the year 2025.

4. Examples

4.1 City of Aalen

One example for a funded blue infrastructure project can be found in the city of Aalen. Next to the townhall was the so called "Gaulbad", which can be translated as a place where horses took a bath. This place was part of the river Kocher which once flew openly through the city with many arms. The river was piped and was no longer visible. The area west of the townhall was dominated by a parking lot and a street with up to six lanes. For the area in the city center a heat island effect of + 7 °C was determined.
Based on the plan of the landscape architects bauchplan from Munich the parking lot was removed and transformed to a public parc with trees, open lawn areas and flat banks to make the opened river accessible. Also, the street has been limited to four lanes to provide more space for pedestrians, cyclists and trees. Concerning the goals this project contributes to climate change adaption by unsealing asphalt area, improving the natural water balance and cooling through evaporation as well as by constructing a green urban space.

4.2 City of Straubing

As outlined, the quantity of green spaces is a sub indicator for climate change adaptation, while the quality and condition of green urban spaces is more complex to be determined. Still many public spaces were built when the adaption to climate change was not streamlined. While some plants can handle the changes, other plants might suffer. As the city of Straubing still has an urban perennial plant nursery, the city decided to expand it and to grow autochthonous plants on their own. These plants are planed to be used in all kind of public spaces. This does not only include ornamental or decorative planting but also streets and playgrounds. In general, those plants are more

resilient, healthier, are a suitable food resource for insects and tend to be easy to maintain.

4.3 City of Berlin

The public park "Volkspark Hasenheide" in Berlin Neukölln fulfills important climate relieving functions for the densely populated neighborhoods. With its 50 ha it is also an important public space, offering many different activities. The major problems for the vegetation are heat stress, droughts and shifting precipitation. Roughly ten percent of the trees had already to be cut down. One important aspect of the funded project is the conversion of the trees, irrigation and decrease of direct evapotranspiration to keep more water in the ground. Also 13% of the park is sealed or the water is channeled otherwise out of the park using the existing topography. In future the water will percolate or be stored in cisterns. About 18 ha or 35 % of the park are turfs, lawns ore meadows which are extensified.

4.4 City of Cologne

The city of Cologne has the fourth largest population in Germany. Heat island effects and the health of trees, especially at streets, are a great concern. Trees along the streets are receiving less water because of the sealing and must compete with infrastructure underground. The authorities already achieved to ensure more space for the roots in development plans, which makes this place secured. Within the funded project, new soils are tested, which can hold more water for longer periods and the surrounding surface is reshaped to provide more water for the trees. The shading and improved transpirations helps against heat islands effect.

5. Discussion and conclusion

The discussion and conclusion are solely the opinion and observation of the author.

The focus of this paper was to describe the governmental framework and the most important legislative act. Concerning the depicted program, the main objectives are to incentivize innovation and to lean the attention towards resilient green urban spaces and water management. Before 2020 Germany was lacking comparable programs to foster explicitly the conversion of public spaces to climate adaption.

To mitigate the effects of climate change, cities and rural areas must be viewed as a whole. A holistic approach is needed and a new understanding of urban and spatial development has to be implemented. This is where landscape architects can take a leading role.

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Short papers

TOPIC 2
Guiding territories with legislative and social advances in planning: towards a right for nature

THE POSSIBILITY OF A DESAKOTA-CITY: STRUCTURING ASIAN URBAN-RURAL TERRITORIES AT LARGE SCALE. THE CASE OF FIELDOFFICE AND YILAN.

TOPIC: Guiding territories with legislative and social advances in planning. Organization of large territories.

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Abstract

Globalization and urbanization are the life's framework of most of the world's population. Anyhow, societies worldwide are far from homogenized. Even though Western planning systems are often considered a developmental benchmark for world peripheries, the non-Western achievement of sustainable landscape development targets -such as extensive structures of public space and natural corridors- may entail unprecedented dynamics and processes, very often "flying under the radar" of conventional planning and landscape studies. If adequately assessed, these cases can help rethink and improve established knowledge and disciplinary approaches for greater effectiveness and sustainability.

Among such occurrences, one can find recent developments in Yilan, i.e., a third-tier city in Taiwan, that -like many other urbanized areas in Asia- is characterized by *desakota*, i.e., an intense urban-rural land-use mix based upon wet agriculture and disruptive mobilities. Over the last decades, this city has developed a 1.5-km-long public space system, and now, this is further developing into a landscape public space system spanning an urban-rural area that is bigger than 25 sqkm. Such happening is already rare in the West, but it is rarer in the Asia Pacific area, where public space usually has no ambition of structuring a whole city's spatial continuity or identity, not to mention regional territories.

Besides the contribution of the local society and government, a pivotal role has been played by a design firm -named Fieldoffice- and the singular way of practicing this has developed over 30 years of activity within the place and in relation to the peculiarities of the local landscape, urbanization, administration, and society. Somehow, this has internalized the *mixité* characteristic of *desakota*, and through this, it has been able to engender a leap-frogging development of extensive public space structures, a process that was also able to resist the many social, economic, and political pressures that inform the life of any liberal democracy with a strong participative culture, as Taiwan is since the late 1980s.

In light of this, the proposed presentation aims to showcase Yilan's evolving landscape public space system alongside the findings from an "ethnography of design" study on Fieldoffice and its engagement with the local context. Conducted over five years, this study exploits relatively novel research methodologies of the design practice that reveal alternative approaches to guiding the spatial development of socio-natural systems.

1. Introduction

Today, the global urban development is far from homogenized. Western planning is held as global benchmark, but non-Western contexts have also achieved comparable outcomes by different processes. Such "other" pathways, unfortunately, are frequently overlooked by the established planning and design scholarship. One such case

is Yilan -a third-tier city of about 100,000 people in Taiwan- which has undergone unprecedented landscape architecture-led transformations.

Yilan's context exemplifies the outcomes of *desakota*, I.e., an urbanization dynamic in which urban and agricultural land use coexist and are intensely intermingled. Such a hybrid rural-urban condition is widespread in the Asia's burgeoning peripheries, differing markedly from Western suburbs. In Asia, one can find a mix of land uses that is "unthinkable" for the Western standards. Most interestingly, if properly managed, such a mix might well be more sustainable than the mono-functional suburbia of Europe or North America. Anyhow, *desakota* poses challenges for planners and designers: conventional regulatory approaches have often proven inadequate to steer its unfolding.

Against this backdrop, Yilan's experience is remarkable. In recent decades, Yilan has developed a 1.5-km-long public space spine through its urban core, and this spine is now expanding into a larger open space system spanning over 25 km² of urban-rural territory. In other words, an integrated network of parks, plazas, green corridors, and accessible natural spaces is now emerging at a very large scale. If such extensive, continuous public space system is rare in Western cities and even rarer in the Asia-Pacific region, Yilan seems to defy the usual patterns of *desakota*. This raises key questions, I.e., how was this achieved, and what role did landscape architecture play in its realization?

In this respect, crucial is the work of a local design practice, Fieldoffice. Over 30 years, this has pioneered an embedded, participatory, and systemic approach to public space and landscape design that has been able to steer Yilan's development. Somehow, Fieldoffice's practice has internalized the *mixité* of *desakota* and leveraged it as a design resource capable to withstand those social, economic, and political pressures that use to threaten the development of public space systems at the large scale.

This paper examines Yilan's transformation by drawing on a five-year "*ethnography of design*" study of Fieldoffice by the author. Using field observations, interviews, and design analysis, the research addressed how the peculiar landscape architecture approach of Fieldoffice has guided large-scale territorial developments in ways that conventional planning cannot. In doing so, it also addressed how insights from non-Western contexts can enrich the global understanding of sustainable urbanization but also re-frame the role of landscape architects as city-makers, especially in the extended urban agglomerations that dominate Asia [1].

2. *Desakota* Planning Challenges

The concept of *desakota* was introduced by the urban geographer Terry McGee in 1991 [2] to describe the emerging rural-urban territories of Asia. Classic case studies include the Pearl River Delta urbanization in post-reform China, Jakarta's extended peri-urban fringes, but also many areas in South East Asia, including Taiwan. That said, if we look to their challenges, they all tend to feature fragmented planning and a contested development, but also deficit of public space. Indeed, because *desakota* dynamics do not follow integrated plans, they tend to outpace the governance. Local administrations struggle to manage land uses that eludes division into functionally segregated zones and conflicts consequently arise between urban expansion and the rural areas preservation. Moreover, since local planning rarely prioritizes public space, the *desakota* usually evolve without any integrative spatial armature, and finally lacks socio-spatial identity, too.

3. Yilan: from Rural Plain to *Desakota-City*

In opposition to this, Yilan provides a rare case in which a design practice appears to have succeeded in driving *desakota*, instead.

Yilan was quite isolated until recent decades, long preserving a strong agricultural character. Under Japanese colonial rule (1900s–1940s), the local landscape was organized by irrigation networks and modest market towns. Even as Taiwan underwent rapid industrialization and urbanization in postwar era (1950s–1980s), Yilan remained peripheral. Only by 1990s, with Taiwan's economic boom and democratization, it began to change more rapidly. Factories, housing developments, and tourism sites appeared amid the rice fields while the population of the urban core slowly grew. Shih and Chi [3] have noted how this growth often sparked protest, especially the rezoning of farmland for new construction purposes, reflecting Taiwan's robust civil society

and environmental consciousness. A key turning point in Yilan's development was then the opening of Hsuehshan tunnel in 2006, directly linking Yilan with Taipei metropolitan area. This effectively pulled Yilan into Taipei's orbit, finally accelerating *desakota* dynamics (see Fig.1). Yet, unlike other *desakota* areas, during this period Yilan has seen the concurrent emergence of a cohesive public space and landscape system.



Figure 1. Aerial view of Yilan *Desakota*.
Picture copyright by Ming-Ming Chen.

In 1993, Sheng-Yuan Huang, a U.S.-educated Taiwanese architect, chose Yilan to establish his practice, I.e., Fieldoffice. Huang was drawn to Yilan's landscape and the opportunity to work in a place where nature and community were somehow connected, still [4,5]. Huang has embedded himself and Fieldoffice in Yilan, living and working exclusively in the place. Over the next decades, Fieldoffice became involved in plenty of local projects, ranging from small installations to large infrastructure. By the relentless presence, a deep understanding of Yilan's environment, culture, and governance started to root within Fieldoffice. Meanwhile, the local administration proved open to Fieldoffice's ideas, especially as the county sought to re-brand itself through culture and landscape.

Progressive officers in the 1990s and 2000s promoted community building and ecological planning, giving Fieldoffice opportunities to propose bold alternatives for public space development. In the meanwhile, Yilan's citizens formed a willing constituency for recognizing, preserving, and enhancing the local landscape. Such a favorable social context, supported by the more general progress of Taiwan's liberal democracy, allowed Fieldoffice to operate in a space between design, planning, politics, and community, translating local aspirations into physical projects.

So, by late 2000s, a series of Fieldoffice-designed public spaces began to dot Yilan. Individually, these were modest in scale; collectively, they hinted at a much larger territorial vision. A public space and landscape system gradually took shape, including promenades, green-ways along historical canals, and repurposed vacant lots. At the urban fringe, also, disused infrastructure and flood-prone areas transformed into landscape developments. Most of the projects were linked conceptually: they preserved open space, improved drainage and microclimate, and provided venues for local community life. Gradually, what could be seen as a "necklace" of public spaces started to outline an original spatial structure for Yilan, complementing private developments. Today, such structure spans an area well beyond the urban core. It connects the urban neighborhoods to rural environs through green corridors and civic spaces, and, most notably, creates a distinct identity for Yilan.

In a country where many secondary cities lack a clear image, Yilan is increasingly recognized for its innovative public spaces and harmonious integration with nature. In effect, it is evolving into what we might call a *desakota-city*, where the messy rural-urban matrix of *desakota* is overlaid by a designed spatial armature, that is civic in essence. This happening represents a rare hybrid model of development: not a designed garden city, neither *laissez-faire* sprawl; rather, a "negotiated" landscape where open space design has served as the guiding thread of development.

4. Fieldoffice's Systemic Approach

Three key aspects characterize Fieldoffice's approach all along the happenings: it is embedded in the local context, participatory in the design processes, and systemic in terms of design logic.

Since establishment, Fieldoffice has chosen to be embedded into Yilan. The whole team lives and works in the place, experiencing daily life as locals can do. This immersion allows Fieldoffice to identify latent opportunities for redevelopment that outsiders might miss -e.g., leftover spaces along canals, underused temple yards, seasonal flooding patterns, and community gathering traditions. It also builds trust with the local resi-

dents and officials, as most of Fieldoffice people have become known community members. This way, Fieldoffice not only learns from the place, but also it is allowed to try various kind of interventions, observe outcomes, and accordingly adjust the new design proposals.

An example can be found in Fieldoffice's sensibility to vernacular. Traditional responses to monsoon weather include open-air sheds scattered among the fields. Fieldoffice recognized these as the archetypal image of both local life and climate adaptation. Accordingly, Fieldoffice interventions feature canopies and shelters that echo these structures while they address contemporary needs. These allow public activities to continue year-round, effectively extending the use of open spaces within a rainy environment. Most important, they make the new spaces felt as not imposed, rather grow out of Yilan. In this respect, it is telling that the citizenship has readily embraced Fieldoffice design, in contrast to the alienating effect of top-down schemes by other designers.

Another aspect of such "embeddedness" is the responsiveness to the local administrative culture. This involves frequent public consultation, budget negotiations, as well as rotations in political leadership. Fieldoffice has learned to navigate this "turmoil" by maintaining open dialogue with officials across political cycles, thereby sustaining projects beyond single election terms. In this respect, the radical adoption by Fieldoffice of the incremental, adaptive approach of landscape architecture proved well-suited: instead of requiring sweeping legislative changes or large upfront investments, Fieldoffice's projects can be implemented step by step, accumulating political and public support as they demonstrate value. Such incrementalism allowed the public space and landscape system to materialize organically, without any singular masterplan. Thanks to this, over three decades, Fieldoffice has become *de-facto* the steward of Yilan's spatial development, complementing the formal planning apparatus with what has progressively taken the form of a consistent vision for Yilan's open space.

That said, if Fieldoffice's projects are design-led, their development process is participatory and inclusive, reflecting both Huang's ethos and the Taiwanese context of active civil society. A culture of open discussion not only prevails in the office but also it is mirrored in the spaces finally created. Fieldoffice often engages stakeholders from the early stages of any project, whether it is gathering input from residents or collaborating with craftsmen. Rather than formal public hearings, much of this engagement is informal and continuous, enabled by the team's on-site presence (see Fig. 2). The result is that Fieldoffice design carries local imprint and the locals feel ownership of the outcomes. Most important, the spaces themselves are conceived to encourage participation. Fieldoffice consistently advocates for what they call "blankness within the city," I.e., undefined spaces that citizens can appropriate. These stands in an open contrast to generic parks or plazas that cater to a narrow range of planned uses but remain underutilized.



Figure 2. Informal public hearing at Fieldoffice for Main Yilan Public Space Corridor. Picture copyright by Fieldoffice.

Fieldoffice's participatory approach also involves political strategies to safeguard the public interest. For example, Fieldoffice targets the creation of spaces that can become political asset for the community, thus difficult for the subsequent local governments to undo. This tactic of locking in public space by giving it a strong physical and social presence has protected several key public sites in Yilan from being sold or repurposed. It exemplifies how Fieldoffice blends design and advocacy, and this, in turn, enables them to negotiate with the administration on behalf of the community.

Finally, the most defining characteristic of Fieldoffice's approach is perhaps the persistence in nurturing a systemic perspective, or seeing

each project as part of a larger territorial puzzle. While projects arise opportunistically, they are conceived not as isolated amenities but as interconnected pieces of an evolving regional whole.

This aligns with principles of landscape urbanism, which advocate using landscape elements to structure the urban forms. Anyhow, Fieldoffice did not follow any masterplan; instead, their systemic design emerged through practice -a kind of strategic improvisation that may be dubbed "*Desakota Freestyle*" [6]. In practical terms, this means using whatever resources are available to incrementally build a public space and landscape system, while ensuring that any intervention resonates with local culture and values. This way, the system not only adapts to changing conditions but also it is continuously reviewed. For instance, a simple walkway along an irrigation ditch could later link to a larger park or connect to a bike path, gradually forming a continuous corridor. This allows for "leap-frogging" developments: if a project continuity is not possible in the moment, Fieldoffice moves to another site where action is feasible, creates a public space there, and trust that intermediate links could be filled later when circumstances allow. Over time, this non-linear approach proved effective in a context where waiting for encompassing plans might well mean doing nothing for decades, and it allowed addressing multiple issues simultaneously -e.g., hydrology, mobility, culture, and ecology- although in a patchworked and improvisational fashion.

Thanks to this, Yilan's public space has begun to influence private and public developments. With key green corridors and plazas progressively in place, the new buildings and roads have been increasingly planned in relation to, rather than ignoring them. In some cases, land readjustment schemes were implemented to carve out public spaces linking to Fieldoffice's projects, indicating a feedback loop from design to policy. This suggests that Yilan's public space and landscape system is becoming structure for growth -precisely what the traditional planning hopes to achieve, but here realized through a bottom-up design-led process. In essence, public space and landscape have become the guidelines for urbanization, fulfilling the landscape urbanist vision. This stands as proof of concept that even in a *desakota* context -most often deemed unplannable- it is possible to steer sustainable development. Actually, Fieldoffice's approach monumentalizes the *desakota*. Indeed, the patchworked reality of the public space and landscape system developed has become a living monument to the "individual freedom but local unity of society" [7].

5. Discussion

In light of this, Yilan's experience invites to re-examinate how we approach the planning of *desakota* and extended urban agglomerations. In particular, four critical insights could be singled out from the review of Fieldoffice's practice [8].

5.1. *Landscape-Led Development as an Alternative Paradigm.* Traditional urban planning struggles to manage rural–urban complexity. However, In Yilan, a landscape architecture-led approach -using public space and landscape as primary structuring elements- succeeded. This suggests an alternative paradigm for development: instead of enforcing rigid zoning, planners and designers can focus on securing and connecting strategic open space developments as armature around which mixed land uses can coalesce more harmoniously. Moreover, this unique paradigm is incremental and adaptive, fitting the proposition that the sustainability transitions in Asia may follow an alternative pathway of development.

5.2. *The Role of the Designer as Mediator and Activist.* Fieldoffice's role in Yilan goes beyond design in a strict sense; it is that of a mediator among urban development stakeholders as well as of a civic activist. Such a rare blurring of professional boundaries is crucial. In complex rural-urban environments, landscape architects may need to take on an expanded role, facilitating community input, negotiating with officials, and essentially performing what Callon (1996) termed "*le travail de la conception*" to indicate a networked, collective activity of design [9]. Huang and his team leveraged their social capital and credibility to champion ideas that were initially unfamiliar, gradually convincing the citizenship through dialogue and built examples. Their practice underscores the political power of the design practice, echoing Yaneva's argument that design can be politically instrumentalized through its processes and effects [10]. Moreover, by being embedded in the place, Fieldoffice navigates local politics in a nuanced way -sometimes pushing, sometimes yielding, but always keeping the idea of a long-

term vision alive. This model might be contrasted with more detached modes of practice typical of the West, and by so shows that in non-Western settings with different institutional fabrics, we may well find innovations of the design practice that enable a renewed power of the design disciplines.

5.3. *Community Engagement and Civic Identity.* Yilan's public space and landscape system demonstrates how certain form of participatory design can foster a strong sense of civic identity even in a dispersed rural-urban context. Public spaces in *desakota* areas can do more than provide recreation; they can well become the glue that binds diverse communities. Indeed, a design of these spaces that is open, flexible, and rooted in local symbols can encourages inclusive uses and reinforce social cohesion. Thanks to this, attachment develops and citizens can become active in caring for open spaces, reflecting a shared ownership. This is a valuable lesson for Asian urbanization: investing in public space is not a luxury but a means to build community and identity amid change. Even if formal civic institutions are weak, spaces themselves can perform a civic function. This has implications for governance -it suggests that allowing community-driven spaces through a peculiar design practice can be more powerful than "people-centered" slogans of development.

5.4. *Desakota Sustainability and Resilience.* Finally, it is worth noting the environmental and resilience benefits gained in Yilan's development. The new public space and landscape system double as green infrastructure -managing stormwater, reducing heat islands, providing or preserving nature habitats (see Fig. 3). In an era of climate change, the chance for a civic armature in rural-urban areas is both a driver of enhanced social cohesion and resilience. This underscores that landscape architects have a pivotal role to play in shaping resilient extended urban agglomeration. Moreover, this prompts a rethinking of urban development models in Asia's peripheries. It suggests moving away from viewing these as just sprawl or zones to be eventually "tamed" by extending city grids. Instead, these can be seen as emergent living environs where proactive landscape and public-space interventions can guide an organic growth toward more sustainable and equitable outcomes. Yilan illustrates the "middle path" between top-down planning and *laissez-faire* development -a path that is incremental, inclusive, and landscape-centric.



Figure 3. New Yilan Moat Linear Park by Fieldoffice.
Picture copyright by Maria Lezhnina.

That said, a crucial discussion is about the transferability of Yilan's experience to other regions. Yilan had several enabling conditions: a relatively small population, a strong cultural attachment to landscape, supportive local leaders, and the presence of a peculiar design practice. Not all places have these. Obviously, a mega-city fringe with millions of migrants and speculative land markets might be less receptive to participatory processes. Yet, certain principles could still apply. Even in large *desakota* areas, identifying key landscape elements to be protected and linked can provide a scaffold of development. Community engagement can be fostered via smaller pilot projects that demonstrate value. The "leap-frog" strategy might be relevant where continuous planning is impossible, I.e., by creating islands of good practice and later linking them. One might also consider institutionalizing something like a landscape design research unit, I.e., a dedicated interdisciplinary team within the government or allied with it focusing on public space and landscape integration, working iteratively with communities. Of course, charisma and trust are hard to mandate and cannot simply be replicated by policy. Nonetheless, Yilan and Fieldoffice offers a proof-of-possibility that even chaotic rural-urban areas can be steered towards sustainability with a blend of vision, design, and grassroots support.

6. Conclusion

Yilan's transformation into a *desakota-city* -a territorially continuous rural-urban tapestry unified

by landscape architecture- offers valuable insights for planners, designers, and policymakers grappling with the challenges of extended urban agglomerations. In this case, key ingredients of success were not grand budgets or strict plans, but rather long-term engagement, innovative design practice, and community partnership. Landscape architecture, as practiced by Fieldoffice, provided the medium through which disparate elements were woven into a coherent socio-spatial fabric. The Yilan case thus powerfully demonstrates the capabilities of landscape architecture in large-scale territorial development (see Fig. 4). It shows that landscape architects can take on leadership roles in city-making, especially in contexts where conventional urban planning is constrained or ineffective. By working from the ground up and across scales, they can deliver multi-functional systems of public space and landscape that achieve environmental, social, and aesthetic objectives simultaneously. This is particularly the case in Asian cities, while it challenges the notion that Asian cities must follow Western models or succumb to sprawl. It provides a counterexample to established narratives, a counterexample where a non-Western path to sustainability is being charted, aligning with local culture and governance, but first and foremost elaborating on a landscape approach.

In conclusion, it is anyhow important to point out how Yilan's case cannot be presented as a one-size-fits-all solution. Instead, it is an inspiration and provocation. Yilan's story stands out as a compelling narrative of how landscape architecture can rise to meet the challenge of structuring rural-urban territories in Asia and beyond, turning seemingly uncontrollable conditions into sustainable futures.

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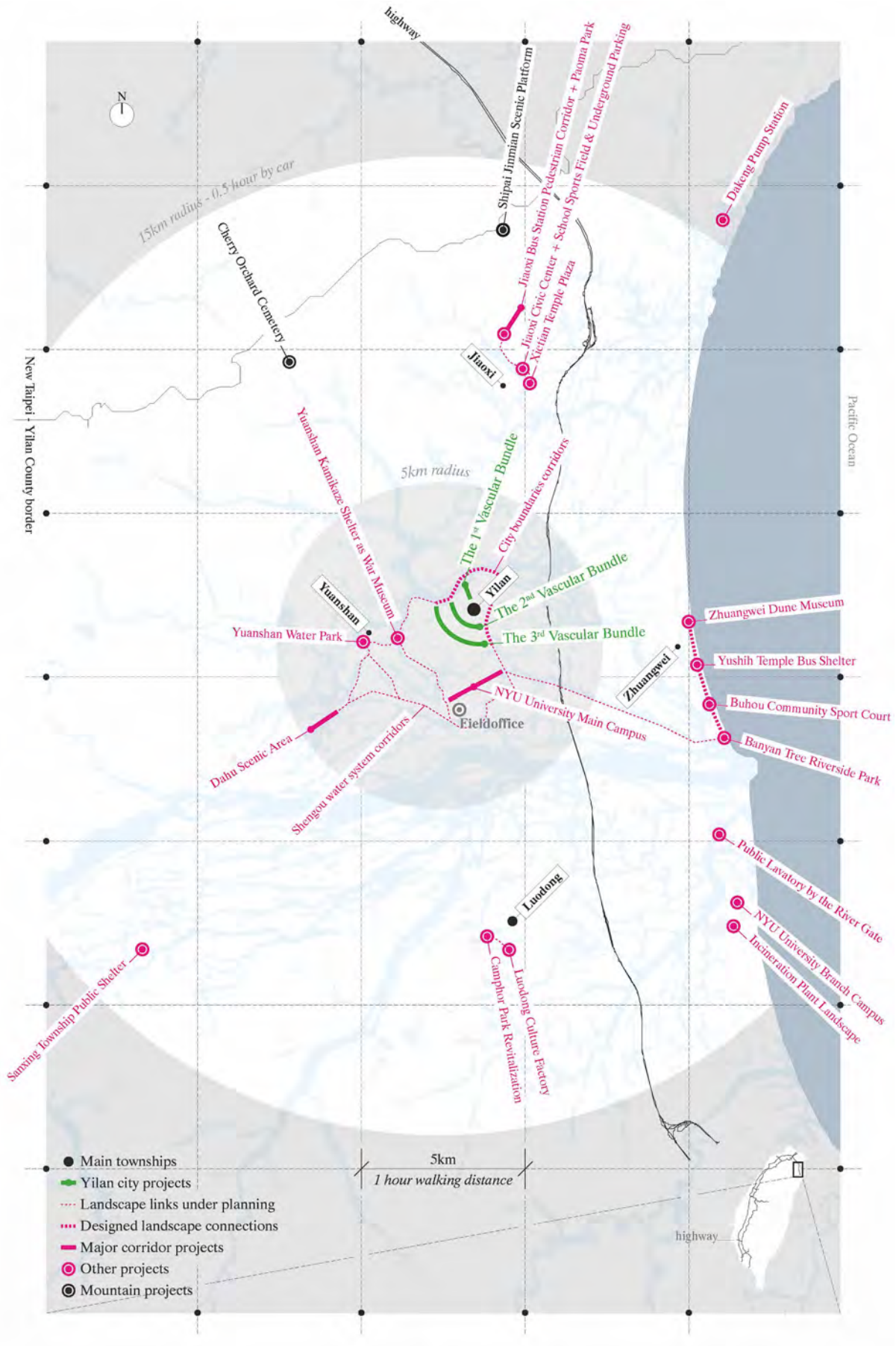


Figure 4. Fieldoffice projects in Yilan, as of 2024.
Drawing copyright by Alessandro Martinelli.

The Ages of Loire : is Loire a development project, a thing to conserve, or a legal subject yet to be established ?

Topic : Guiding territories with legislative and social advances in planning: towards a right for nature

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Keywords : Loire, legal person, nonhuman, landscape

Abstract : This text is a contribution put forth by the so-called council of « witnesses » of the "International Network of Rivers and Other Elements of Nature" which, inspired by civil conventions and other dialogical democracy dynamics, seeks to pave the way for a renewal of the ties between research and society and to deepen what a conflation of perspectives can mean.

I. The Loire: from a developed to a protected river

The landscapes of the Loire have long been objects of study. The river has undergone a myriad of development efforts aimed at exploiting its hydraulic power, providing cooling for nuclear power plants, and been subjected to numerous extractive processes (sand, irrigation and drinking water).

Such a development logic has given rise to militant movements that have, since the 1980s, actively been defending another form of relationship with the river, like the "SOS Loire vivante" collective.

In 1994, the "Plan Loire Grandeur Nature" was set up, which heralded a shift in the relationship. A portion of 280 kilometers of the river was recognized as a cultural object and registered as a UNESCO World Heritage site in 2000. Efforts to protect it are the daily prerogatives of the State, collectivities, organisations, etc.

II. Institutional governance or self-governance ?

Is the Loire just an object that can be cut into segments whose every aspect would fall under the governance of public policies? Or is the Loire a subject in its own right, and thus should no longer be regarded as a legal object but as a legal subject? Who is legitimate to govern the Loire, and who should defend its interests? In the fictive tale that was proposed in 2019 by the POLAU alongside the "Loire Parliament," the Loire becomes Loire. These considerations have continued to flourish since 2023 with the birth of the project entitled "Towards an International Network of Rivers and Other Elements of Nature," indeed spearheaded by the Nantes Institute for Advanced Studies and Camille de Toledo. The effort is carried alongside scientists from multiple horizons and a

council of witnesses. It seeks to produce bills for Loire, which are inspired by endeavors undertaken throughout the world. They are initiated by Indigenous nations (the Whanganui River in Aotearoa/NZ) or by the Western world (the recognition of Menor Laguna as a legal person, « L'Appel du Rhône », Seine, etc.).

III. From the landscapes of Loire to the Loire system

Loire's legal empowerment opens up a new order of things. Loire could be endowed with its own perspective as a natural entity, regardless of human opinions and humans' proclivities to act as they are usually organized.

How then does this proposition challenge or on the contrary reinforce the notion of landscape as it is defined in the European Landscape Convention? How does it interfere with French landscape policies and tools? Does the concept of landscape disappear with the empowerment of the subject or can the notion of landscape become an even more powerful system of interrelations wherein legal subjects are hybridized?

Introduction:

The "Towards an International Network of Rivers and Other Elements of Nature" project is a scientific and artistic endeavour carried out from 2023 to 2026 by the Nantes Institute of Advanced Studies (IEA), in collaboration with the *Lieu Unique* and *Notre Affaire à Tous*. It is spearheaded by the author and research fellow Camille de Toledo, who is indeed furthering a collective reflection on the legal personhood of the rights of nature and Earth's ecosystems. This text is a submission by the members of IREN's "council of witnesses" who, inspired by civil conventions and other dynamics of dialogical democracy, seeks to pave the way for a renewal of the relationship between research and society and deepen what such an outlook can mean. The subject matter is the Loire river, as well as the manner in which the very nature of the ties between the river and its different custodians has evolved over what we qualify as the three ages of Loire.

I. The Loire: from a developed to a protected river

The valley of the Loire has been inhabited since the Paleolithic Age, thanks to its natural resources and an environment compatible with human life. Hence, with time, the Loire has progressively been transformed by multiple development projects so as to enable navigation, trade, and the exploitation of its hydraulic power. It has also been subjected to numerous extractive processes, namely of its sandy sediments for human construction and of its water for crop irrigation purposes and the supply of drinking water. More recently, it has been exploited for its capacity to provide cooling for nuclear power plants. Thanks to the power of both the cycle of life and the water cycle, the river's own dynamic has had to "digest this technical footprint" [i] for centuries, but this scheme has progressively grown out of proportion with the construction of the railway track, which severed people's direct relationship with it, and with the continuation of sand extraction and the building of upstream dams and nuclear plants as well. This development logic, oftentimes unrestrained, has been hampered from the 1980s onwards by grassroots movements such as the *SOS Loire Vivante* collective, which fought at the time against four new dam and embankment projects, defending another relationship with the river. The opposition against the "Serre de la Fare" dam project in the High Valley of the Loire, which would have been the largest in the region, has indeed become the symbol of a fight to keep a "thriving Loire" and preserve what remains of the "wildest European river." This local opposition also benefitted with time from international support (WWF France and WWF International, France Nature Environment, etc.) and it received significant media coverage. Such sustained local involvement, indeed supported by scientific and legal works, enabled the players to become proactive and provide alternative solutions to dams, giving rise to a new vision of the management of the hydraulic resource, of floods, and of emblematic species such as the Atlantic salmon[ii]. The implementation of the 1994 *Plan Loire Grandeur Nature* signaled a shift in the relationship with the river, as it put an end to dam projects and laid emphasis on the river's amenities, whether in environmental,

landscape, social or cultural terms. A portion of 300 kilometers of the river was recognized as a cultural object and registered as a UNESCO World Heritage site in 2000, and its management was then granted to the *Mission Val de Loire*, an interregional mixed union created in 2002 by the regions of Centre Val de Loire and Pays de la Loire. What followed was the establishment of protective measures regarding several sites registered under the Environmental Code and habitats (Natura 2000). The protection, management and development of the many facets of the Loire object are the daily prerogatives of the State, collectivities, public operators, organisations, citizens, activists, etc.

II. Institutional governance or self-governance ?

The question of governance regarding the river has undergone evolutions through the years. For instance, it notably went from *Etablissement Public d'Aménagement de la Loire et de ses affluents* (EPALA) in 1983 to *Etablissement public Loire* (EPL) in 2001, and was endowed with the status of a mixed union so as to broaden perspectives when it comes to the collective management of the Loire resource[iii]. In 2006, a decree was voted so as to allow the EPL to set up a royalty for users who would draw water from both the Loire and the Allier rivers, as well as their accompanying groundwaters, and *in fine* fund works aimed at providing support in times of low-water levels. The committee of users that was set up is constituted of community representatives working in the field of water supply management, of irrigators and industrials such as EDF[iv], as well as riparian municipalities and State services.

However, the Loire cannot be reduced to a cut-down object whose every segment would not only be governed by logics that are specific to different public policies (which are sometimes contradictory), but also be solely conditioned by human interests. Is not the Loire, on the contrary, a subject in its own right, which thus should no longer be regarded as a legal object but as a legal subject? Who governs the river, who is legitimate to do so, and who should defend its interests? Should the resources of the Loire be solely reduced to the benefits they represent in terms of the citizens' economic and touristic interests? Is this ecosystem only the sum of its ecosystemic services to humans?

Who is legitimate to govern Loire? Who carries its voice? Who can embody the “people of Loire”? The disruptions caused to both the short and long water cycles and the environmental changes that intensify the pressure on the water resources on which we are all dependent —floods and low water levels, water quality alterations, perturbations of sediment transport, species extinction and habitat deterioration— give impetus to a paradigm shift, to a new relationship with the river.

In 2019, the POLAU proposed a fictive tale alongside the "Loire Parliament" in order to once again call into question the river starting from the law, the arts, the domains of ecology and anthropology, and field work. Could the Loire become Loire to humans? Could this living entity, both ecosystem and anthroposystem, become a legal subject? A nonhuman entity endowed with a legal status, endowed with the capacity to defend itself or be defended by representatives called custodians? How would the latter be taught? Is it possible to integrate in our existing institutions the “perspective of the river [...] so as to move from the idea of a resource to the more creative idea of a living unity, or even that of a person”[v] ? Could 'Loire' be compensated for its work? Could it be rewarded in compensatory damages? Could it also repair the havoc it can wreak through “flood excesses”[vi] ? These are the many questions that are debated amongst individuals whose areas of expertise span a plethora of fields.

Since 2023, these reflexions have been following a downstream course with the project entitled “Towards an International Network of Rivers and Other Elements of Nature,” an endeavour spearheaded by the Nantes Institute of Advanced Studies with Camille de Toledo. This project is supported by scientists from multiple horizons, by artists, and a council of witnesses. It alternates between interviews of scientists and active organisations, “in-room” work sessions and key moments that are open to the public. This dynamic is fueled by initiatives that are carried out in other parts of the world in the defense of rivers, lakes, peaks, parks, and lagoons. Sometimes, these fights are initiated by Indigenous nations, like in Aoteaora/New-Zealand with the Whanganui River, ore more recently in the Western world

with the Menor Laguna in the South of Spain, which obtained the status of legal person, a first in Europe. “L'appel du Rhône,” the declaration of the rights of the Tavignano, the declaration of the rights of the Durance river, the Parliament of the Isère river, the civil convention sought by Paris, Rouen and *Source de Seine*, Bourges 2028 European Capital City, the Wild Legal collective and many others are all headed in the same direction. The IREN is now working on several law proposals for the Loire watershed, for Loire and its estuary. These civil law proposals have been presented and submitted during the symposium “Towards a Recognition in France of the Rights of Nature: The Territories Join Forces and Call to Action” that took place on April 30, 2025 in the National Assembly under the high patronage of the President of the National Assembly, and on the initiative of Deputy Charles Fournier.

What new way of seeing and of inhabiting the world does such a perspective open?

III. From the landscapes of Loire to the Loire system

Loire's legal personality opens up a new order of things. Loire could be endowed with its own perspective as a natural entity, regardless of the opinion of humans and their prerogatives to act as they are usually organised. The possibility for Loire to initiate legal proceedings blazes a trail that will urge our human society to take heed of contradictory interests, to weigh short-term and long-term visions against one another, as well as today's interests and tomorrow's interests, and even the interests of future generations. Furthermore, it also raises the possibility for us to take part in the many instances that concern it, whether it be in watershed committees, in local water commissions, or in public establishments (*Loire, Voies Navigables de France, Grand Port Maritime*...), to carry its own perspective.

The “Towards a Parliament of Loire” collective carries the “Loire Manifesto” championing the recognition of the river as a living entity. It notably holds responsibility when it comes to “representing the interests of the river in political decisions by contesting projects that would harm it, and to work for the legal, political and cultural recognition of the Loire river” through a Statement of Loire. This manifesto was signed by the mayors of the cities of Tours, Ancenis and Indre. The text[vii] stipulates that “we are Loire [...] Our physical, psychological, and emotional well-being stems from the river's good health.” The signatories make the commitment to feel that their “attachment to the milieu can be powerful enough to transform [...] their relationship with the territory, [to] cultivate interwoven pieces of knowledge, at once scientific, tangible, and pragmatic.”

It is of the essence that we collectively learn to name these relationships with Loire and with nonhuman natural entities, to shine light on relationships rooted in kinship, on the living and vital ties that bind us all, and on concrete perceptions. It is of the essence that we learn to represent these ties between humans and nonhumans by way of new codes.

Could the concept of landscape be redefined through such a (re)staging of nonhuman elements? The landscape is defined in the European Landscape Convention as a “piece of territory as it is perceived by populations, and whose character stems from the action of natural and/or human factors and their interrelations.” The convention moreover stipulates that each Party pledges to “legally recognize the landscape as an essential component of the quality of life of populations, as the expression of the diversity of the common cultural and natural heritage of populations, and as the foundation of their identity.” Does the personalization of natural entities challenge or on the contrary reinforce the notion of landscape as it is currently defined? Does the concept of landscape disappear with the subject's gained autonomy or could it become an even more powerful system of interrelations that entails the hybridization of legal subjects?

The landscape would not solely encompass an action of perception, but rather the interconnected ties that bind humans and nonhumans together, becoming the description of a living network whose threads are more or less intertwined, or in other words a living and agentic matrix. As Philippe Descola suggests, the landscape could be defined as “something other than itself.”[viii]

The landscape approach is a germane lens through which to better appraise our relationship with what is real here and now, and what we could call, in reference to Bruno Latour, a relationship with the landed or re-embedded real.

In his book *Paysage*[ix]*,* Thierry Paquot lays down his thoughts regarding the concept of “landscape.” He not only examines urban and natural landscapes, but also the way that landscapes become part of a national heritage, as well as the transformations of the sense of nature and its representations. He calls for a “landscape ethic” that would take heed of new ecological imperatives and he concludes that landscapes are tantamount to a “gift of sensations,” a poetics of ecosystems. In other words, landscapes would be the expression of our planet's many ecosocio-systems as they are finally recognized in our human legal registers for what they are and for themselves.

With the acquisition of a legal personhood, natural entities such as rivers and their articulation as ecosocio-systems would be granted recognition and would come to reinforce the power to act and react of the living through the rearrangement of our existing institutional scenes. Following the example of legal mediators, the “custodians” of such entities would carry an informed, autonomous, attentive, and non-patronizing voice to participate in the deliberations and decisions that the emergencies of our present times will assuredly impose.

In the realm of public policies, the knowledge of landscapes would not be dissociated from that of the elements of nature, with synergies to establish between landscape plans and communal biodiversity atlases. Landscape plans would seek to not only highlight landscape quality objectives and the ties of attachment, vulnerability, and conflicts that concern living entities, but also the interdependencies between humans and nonhumans so as to *in fine* ensure the survival of all and their adaptation to different dynamics. The French Biodiversity Office supports experiments that follow such a route[x]. This landscape project would entail a form of relational ontology. Such perspectives, then, would not solely belong to humans anymore, but to natural entities as well, and they would above and all emphasize relationships. These plans could become equitable and balanced cohabitation spaces enmeshing different living entities[xi].

It is vital that we reassess many other sectors of our legal practices and urban and landscape development projects, namely territorial principles, property management, urban planning, and environmental authorisations. They should also be explored to shed light on what it could mean to include the legal entity of Loire in our procedures, and on the benefits of a world where the elements of nature become legal subjects.

Conclusion

Navigating Loire from upstream to downstream through the river's different ages invites a bit of collective wisdom to ensure the habitability of our living spaces. We have to envisage such habitability over the long term, with future generations in mind in a context of the accelerating climate crisis. Examples exist and should inspire us: “Native Americans do not discriminate between the respect of their rights as humans and the respect of the rights of nature, knowing that, to them, the solidarity of human nature is inherently entwined with their mode of existence.”[xii] The Ecuadorian Constitution stipulates the interdependency that ties humans and nonhumans, together “so much so that to take heed and champion nature's entities is always seen, through a legal lens, as a way to protect human life.”[xiii]

Landscape policies have evolved alongside societal challenges since the first law on the protection of natural sites, landscapes and natural monuments that was enacted in 1906, up to the 1993 Landscape Law on the protection and improvement of landscapes, which laid particular emphasis on so-called “ordinary” landscapes. In February 2025, the Committee of Ministers of the Council of Europe adopted the Recommendation on Landscapes and Health, drawing from a report that highlighted the interdependency between landscape and health, whether physical, mental, or social. In the light of the major challenges we are facing today as to the livability conditions of the planet's myriad living entities, we could certainly hope for a law that would call for the recognition and governance of eco-social landscape systems. More largely, the recognition of the rights of nature would be a collective legal progress. We are no longer gazing at the landscapes of Loire, because they are part and parcel o who we are, just like the entirety of the living in the broadest sense of the term.

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CREATING A NEW REGIONAL PARKLAND

TOPIC: Guiding territories with legislative and social advances in planning: towards a right for nature

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Keywords: parklands, strategy, traditional owners, landscape architecture

Abstract
Jacksons Creek biik wurrdha Regional Parklands will span over 1,000 hectares and stretch along 26 kilometres from Sunbury to Diggers Rest. This presentation explores the preparation of the Jacksons Creek biik wurrdha Regional Parklands Plan by Fitzgerald Frisby Landscape Architecture, which sets out principles and directions for the progressive establishment and management of the new regional parklands. The plan responds to the critical need to protect and enhance biodiversity and cultural heritage, mitigate climate change, and contribute to improved community health and wellbeing. In addition, the project sets a new benchmark for the role of First Peoples in the development of regional parklands which not only includes their participation as a client and landowner but also proposes a return of Wurundjeri Woi-wurrung as future land managers.

The Parklands are an example of the Victorian Government's commitment to self-determination for Aboriginal Victorians. The plan embeds the rights and values of the Wurundjeri Woi-wurrung people and supports them in caring for significant places and objects, practicing Cultural land management, recording knowledge, walking Country, and ceremonial practices.

This project is an example of the benefits of landscape architects leading projects of this scale. It also highlights the benefits of collaborative design with other professionals especially those working on behalf of clients and approval authorities.

1. Introduction

Sunbury is a town located approximately 40km north-west of Melbourne. Like other parts of metropolitan Melbourne, the area is experiencing significant population growth. In the 1990's the population of Sunbury was around 10,000, today it is closer to 40,000 and is expected to more than double to 85,000 people by 2041. The need for the parkland was identified more than 20 years ago as part of regional planning processes and township strategic planning. As part of these planning processes, the creation of the Parklands was identified to protect sites of ecological, cultural, scenic, and historic significance. The Parklands will be created alongside new residential communities proposed for Sunbury.

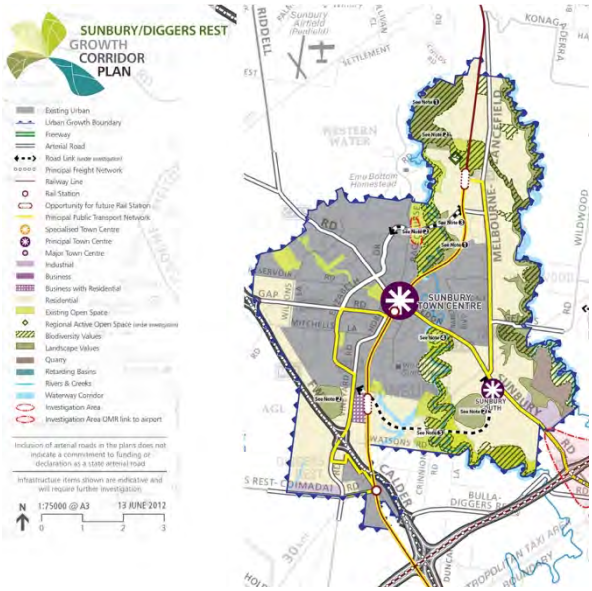


Figure 1: Extract of Sunbury/Diggers Rest Growth Corridor Plan [1]

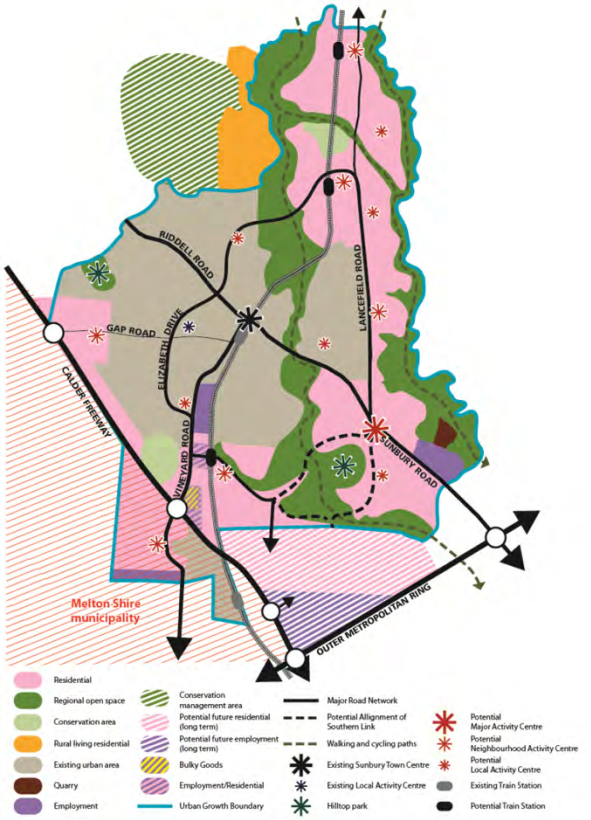


Figure 2: Proposed land uses outlined in Sunbury HIGAP Strategy [2]

The Lancefield Road and Sunbury South Precinct Structure Plans (VPA, 2019) outline the long-term plan for urban development in the areas adjacent the Parklands.. These Precinct Structure Plan propose the following outcomes:

- Development that sensitively responds to, improves community access to, and protects the fragile creek valley of Jacksons Creek.
- The protection and recognition of the important and valued cultural significance of the area.
- Protection of habitat for matters of national environmental significance.
- Protection of Growling Grass Frog populations.
- Enhanced local mobility for existing communities including opportunities for active transport.
- Urban development that responds appropriately to the undulating landform.
- Development of a network of open space along the Jacksons Creek.
- Delivery of essential infrastructure including road networks, creek crossings, services, and drainage.

These key planning documents have been incorporated into the Council Planning Scheme and will guide future land use, subdivision and development.

Jacksons Creek biik wurrdha Regional Parklands will span over 1,000 hectares and stretch along 26 kilometres from Sunbury to Diggers Rest. The Jacksons Creek biik wurrdha Regional Parklands Plan (Fitzgerald Frisby Landscape Architecture, 2022) sets out the principles and directions for the progressive establishment and management of the new regional parklands. The plan responds to the critical need to protect and enhance biodiversity and cultural heritage, mitigate climate change, and contribute to improved community health and wellbeing. In addition, the project sets a new benchmark for the role of First Peoples in the development of regional parklands which not only includes their participation as a client and landowner but also proposes a return of Wurundjeri Woi-wurrung as future land managers.

The following objectives we established to guide the preparation of the Jacksons Creek biik wurrdha Parklands Plan.

Cultural

- Protect and enhance the significant ancient, historical and ongoing cultural values of the parklands
- Promote and explain the cultural, environmental and heritage features of the parklands
- Support Traditional Owners to continue their connections to their traditional lands

Environmental

- Protect and enhance the biodiversity and connected landscape values of the parklands
- Protect the geology, escarpments and scenic landscapes
- Protect waterways and minimise impacts of urban stormwater runoff
- Increase climate change resilience

Enjoyment and Access

- Create opportunities for immersion in nature, social connection and physical activity to enhance the health and wellbeing of the community and visitors
- Create a network of trails which provide opportunities for community connection and appreciation of the parklands
- Provide opportunities for nature and cultural based learning, volunteering and tourism
- Facilitate visitor access to parklands via public transport, cycling, walking and driving

- Manage the visitor activities within the parklands to ensure risks to cultural and environmental values and to visitor safety are minimised

Management

- Establish a partnership structure for the shared future management of the parklands
- Provide a leading example of cooperatively managed metropolitan open space by Traditional Owners and public land managers

2. *Ecological values*

An ecological survey was completed at the start of the project to map the current biodiversity and habitat values of the proposed parklands. A specific focus of the conservation areas in the Parklands is the protection and enhancement of habitat for nature conservation and Growling Grass Frog in accordance with the Australian Government Environment Protection and Biodiversity Conservation Act 1999.



Figure 3: Vegetation existing quality assessment [3]

3. *Traditional Owners*

The Woi-wurrung people have been the owners and custodians of the land for thousands of years. The Elders seek the protection of this culturally significant landscape for future generations. Jacksons Creek flows across Wurundjeri Woi-wurrung land and is known as 'biik wurrdha' meaning 'land of many' in Woi-wurrung language.

The Parklands are an example of the Victorian Government's commitment to self-determination for Aboriginal Victorians. The plan embeds the rights and values of the Wurundjeri Woi-wurrung people and supports them in caring for significant places and objects, practicing Cultural land

management, recording knowledge, walking Country, and ceremonial practices.

Prior to the commencement of the Parklands Plan, the Wurundjeri Woi-wurrung Cultural Heritage Aboriginal Corporation prepared a Cultural Values Study [4]. The study captured the Connection to Country and included the following key findings:

- The Parklands are rich with Cultural artefacts, important view lines, and significant meeting places of different Aboriginal groups.
- The area is significant for its history as a site of colonial accommodation, resistance, and efforts for self-determination at the interface of colonisation 1835-1863.
- It is likely that John Batman explored the area known as Redstone Hill, where he set out to negotiate a transfer of deed of title (known as the Batman Treaty) between the Wurundjeri Woi-wurrung and the first European settlers of Melbourne.

The Cultural Values Study played an important role in empowering First Peoples by being able to articulate their relationships with the Parklands and beyond

"The landscape is the Country of our ancestors. It is where they walked and we walk now. That is why it needs to be protected, preserved and kept healthy. We need these places to exist to keep their journey going." Elders of the Wurundjeri Woi-wurrung Corporation

4. History and Heritage

The Parklands area has a rich post-settlement history which includes physical references to the past as well as social history. The following are elements of historic significance in or adjacent to the proposed Parklands.

- Wurundjeri Woi-wurrung Country. Wurundjeri Woi-wurrung people have inhabited traditional Woi-wurrung Country for at least 35,000 years.
- 1835 – 1863 Encroachment of settlers on Wurundjeri Woi-wurrung Country. The year 1835 marked the encroachment of people with pastoral interests into Woi-wurrung Country, formalised by the Port Phillip Association's limits of settlement. This immediately diminished Indigenous people's access to their Country and resources. After 28 years of active colonial resistance on Country, the year 1863 marks the removal of the remaining Woi-wurrung people onto the Coranderrk Aboriginal Reserve in Healesville.
- 1836, Emu Bottom Homestead. Emu Bottom Homestead is located on a property settled by George Evans in 1836. Evans was in the party which first settled at Batmans Hill (later to become Melbourne) and was, later, a prominent figure in early Melbourne and the first settler at Sunbury. The run was established in the earliest days of settlement in Victoria and is one of if not the oldest surviving homesteads in Victoria (Victorian Heritage Register Number H0274)
- 1860's, Sunbury wineries. Eighnane, Goonawarra, Craiglee and Springvale wineries established along the creek.
- 1865, Caloola (former Sunbury Mental Hospital) Caloola, Sunbury consists of buildings set in extensive grounds with plantings of mature trees and remnant farmland. Caloola commenced in 1864 as an Industrial School and was redeveloped in 1879 as a Lunatic Asylum.
- 1874, Rupertswood Mansion. Rupertswood built for Sir William Clarke at Sunbury in 1874-76 was one of the largest houses built in Victoria in the 19th Century.
- 1882, The Ashes. On Christmas eve, the touring English cricket team defeated a local team in a social game of cricket at Rupertswood. One of the burnt bails was placed in a small urn and was presented to the English captain.
- 1972 - 1975, Sunbury Music Festival. A property next to Jacksons Creek hosted the annual Sunbury Music Festival which was promoted as Australia's Woodstock.

These historic elements will become sites of significance within the Parklands.

5. Community engagement

Community engagement for the Parkland Plan was undertaken via a two-stage process:

- Community input was invited in November 2021 prior to writing the Parklands Plan.
- Community feedback on the Draft Plan was invited in March and April 2022.

The following community feedback was received and incorporated in the Parkland Plan.

- Walking and appreciating nature were identified as the two key activities the community would enjoy in the parklands

- Wurundjeri Woi-wurrung culture to be expressed within the parklands and Sunbury Earth Rings to be protected
- Protection and enhancement of natural environment including flora and fauna species, habitat, waterway health, and need for weed, pest and fire management
- Protection of parkland hilltops and escarpments
- Mitigation of bushfire risk
- Continued support for The Nook, Emu Bottom Wetland, Jacksons Hill Reserve, Apex Park,
- the Sunbury Music Festival site, Skyline Drive Reserve and Holden Flora Reserve are highly valued by the community
- Cycling paths that connect to regional trails. Designed to avoid conflict with walkers
- New trail links including Rail Trail linking key areas north of the township; link to Blind Creek; link from Maguire Street reserve to The Nook
- Wildlife passage within and beside the creek, and connecting with other habitat areas beyond the parklands
- Interest in educational activities and programming such as Scouts and Girl Guides, Friends
- Of groups and Junior Rangers, to promote stewardship and appreciation of the environment
- Consideration of signage to ensure the parklands are enjoyed and accessible for people from culturally and linguistically diverse communities

Structured open spaces and sporting facilities are not proposed within the Parkland as these facilities will be developed within new residential areas.

The Parklands Plan located proposed visitor facilities including indicative timelines for the creation of new infrastructure. The identification and location of these facilities assists with identifying construction costs and funding opportunities.

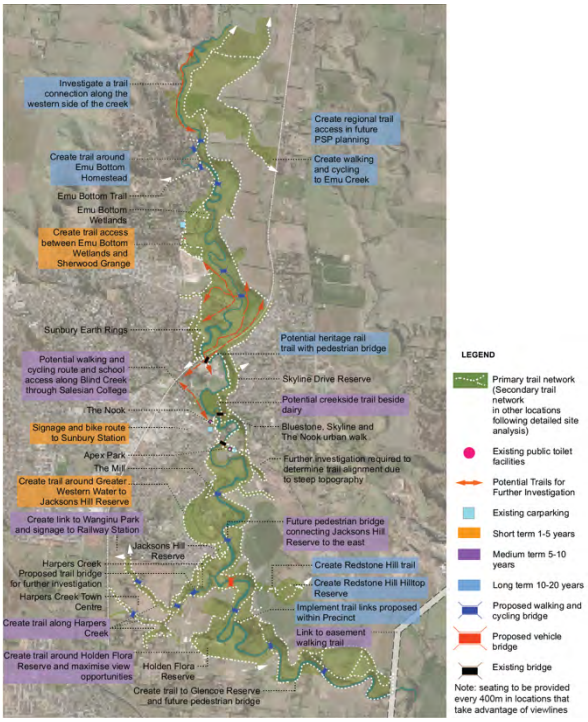


Figure 4: Proposed visitor experiences [5]

6. Climate change

Options to improve sustainability, visitor experience, and adaptive land management were explored with the client group during the initial visioning process. The result is the inclusion of climate resilience measures such as canopy cover, fire risk minimisation, stormwater management and reducing operational and greenhouse gases.

One of the measures investigated was canopy cover. In 2021, canopy covered 32% of the parkland area. New canopy plantings will provide shade along paths and visitor areas. Canopy planting will be limited to avoid priority grassland and growling grass frog areas due to different ecological habitat requirements. Vegetation will be managed to minimise fire risk.

Additional sustainability initiatives outlined in the Parklands Plan include:

- Implement adaptive management strategies for species and ecosystems to help respond to impacts of climate change and extreme events.
- Provide canopy trees at visitor nodes and along trails wherever appropriate to provide shade and comfort for visitors.
- Implement opportunities to reduce greenhouse gas emissions during the establishment and ongoing maintenance of the parklands.

7. Management and Implementation

The following management zones were created to guide the current and future management arrangements of the Parklands.

- Conservation Zone - primarily for the protection, maintenance and enhancement of significant environmental and cultural values, while promoting the enjoyment of these areas to appr
- Conservation and Recreation Zone –balancing the protection, maintenance and enhancement of environmental and cultural values while enabling passive recreation. Passive recreation includes activities such as picnicking, walking and cycling, scenic viewing, children's play.
- Special Use Zone 1 – area of restricted access that supports the activities of the water treatment plant within the Parklands while maintaining cultural and biodiversity values of the parklands
- Special Use Zone 2 – area of restricted access that supports the educational activities of Salesian College while maintaining cultural and biodiversity values of the parklands
- Restricted Cultural Access Zone – area of restricted access that protects cultural assets of Wurundjeri Woi-wurrung

Identification of these different management zones assists transitioning of land managers as the Parklands are progressively created.

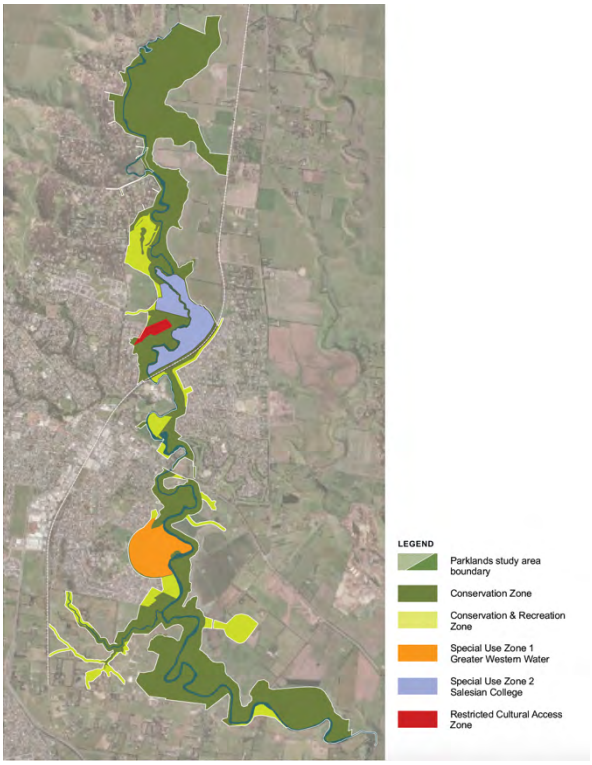


Figure 5: Proposed management zones [6]

The Parklands Plan also includes support for an expansion of Traditional Owner management of the parklands. The report notes, "…it is considered that any land managers (that are not the Wurundjeri Woi-wurrung Cultural Heritage Aboriginal Corporation) are managing the land as a transitional measure until such time that the Wurundjeri Woi-wurrung Corporation has been provided the capacity and resources to take on the land manager role".

8. *Role of the Landscape Architect*

This project is an example of the benefits of landscape architects leading projects of this scale. Landscape architect involvement is continuing through the detailed design and construction of the proposed parkland elements such as trails and visitor nodes. It is a project which highlights the benefits of collaborative design with other professionals for over 10 years. This includes landscape architects working on behalf of clients and approval authorities.

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COASTAL RIGHT WITH THE CLIMATE JUSTICE-DEEP ECOLOGY NEXUS: A HOLISTIC COASTAL MANAGEMENT FRAMEWORK FOR THE BODRUM PENINSULA

TOPIC: Guiding territories with legislative and social advances in planning: towards a right for nature

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Abstract

The impacts of climate change, which are severely experienced as a result of anthropogenic activities, are not equally distributed across societies at a global scale. The climate justice approach, which seeks solutions to this emerging inequality, prioritizes human benefits and interests. However, anthropogenic activities not only affect humans but also the natural and cultural landscape values. Activities such as tourism, industry, energy production, and settlement contribute to fragmentation in habitats, an increase in carbon levels, the transformation of fertile soils into artificial surfaces, eutrophication of flowing waters and wetlands, and the destruction and loss of coastlines and coastal life. When this situation is examined in the context of equality and the pursuit of rights, merely evaluating it from an egocentric justice perspective proves insufficient. Therefore, to address this gap, it is necessary to develop a 'biocentric' approach that encompasses all components of the landscape and considers the 'value of existence.' In this regard, the main aim of this research is to identify criteria by examining the deep ecology perspective, which offers a more holistic viewpoint than the climate justice approach, and to develop a biocentric justice model. This new model is intended to be integrated into the landscape management framework, with the Bodrum Peninsula, which is under the pressures of tourism and intense urbanization, chosen as the study area. This research aims to develop strategies for managing the natural and cultural landscape components of the study area within the scope of 'value of existence' and 'biospheric equality.' In this context, the shortcomings of the criteria presented by the climate justice approach are identified, the criteria of deep ecology are determined, and a survey based on pairwise comparison with experts has been conducted. A participatory and objective perspective has been provided by quantifying the criteria according to their importance priorities using one of the most current Multi-Criteria Decision-Making (MCDM) methods, the ARAS method. The ARAS method, which aims for proportional ranking, supports objectivity and an impartial analysis process by presenting a hybrid model that includes both absolute criteria metrics and relative comparisons in the evaluation of criteria. Thus, this method offers both a participatory and quantitative perspective. The methodology and results of this study address the gap in the climate justice approach by integrating deep ecology into climate justice, with the Bodrum Peninsula serving as a case study for rural landscapes. In this way, the study ensures the sustainability of both vulnerable and degraded landscapes under management or protection, while emphasizing the value of existence of the landscape and prioritizing its biotic, abiotic, and cultural equality. This holistic approach, presenting a participatory and quantitative landscape management model integrated with climate justice and deep ecology, provides an innovative framework not only for the coastal areas of Turkey but also for countries lacking sustainable coastal management.

Introduction

In the Anthropocene epoch—an era named after and profoundly shaped by human activities—global-scale adverse transformations are occurring due to anthropogenic pressures (Rockström et al., 2021). These changes are causing critical damage to fundamental life cycles and leading to irreversible

consequences on landscapes. Such unstable and critical changes represent triggering tipping points in landscape ecology (Biermann et al., 2020; Rockström et al., 2023). According to Rockström et al. (2023), these tipping points are defined as "Planetary Boundaries," and these safe thresholds are being exceeded. It is stated that due to excessive human interference in natural habitats, zoonotic host diversity—such as in the case of COVID-19—has increased (Gibb et al., 2020; Rockström et al., 2021). According to a report by the World Wildlife Fund (WWF, 2020), the Anthropocene epoch has witnessed a far greater loss of species than the average over the past 10 million years. Based on a 2024 survey conducted by the IPCC with relevant scientists, global temperatures are projected to increase by at least 2.5°C by the end of this century (Carrington, 2024; William, 2024).

The increasing demand for ecosystem goods and services exerts simultaneous and intense pressure on the natural and cultural resource values of landscapes (IPBES, 2019; DeFries & Nagendra, 2017; Neyret et al., 2023). Changing demands disrupt the balance of ecosystem services and lead to land use changes that cause conflicts among stakeholder groups (Neyret et al., 2023). Most of these negative transformations are driven by unsustainable resource extraction and consumption, promoted by capitalist economic and social systems (Biermann et al., 2020; Rockström et al., 2023). This situation creates rigid "winners" and "losers" among stakeholder groups in terms of access to ecosystem distribution and services (Lee & Lautenbach, 2016; Neyret et al., 2023). Furthermore, the qualities of available resource values lead to unequal and unbalanced conditions (Sultana, 2021). According to Hoegh-Guldberg et al. (2018) and Rockström (2021), a safe planet is a prerequisite for a just world. However, what matters is to ensure both a biophysically secure environment and one that protects human well-being and justice (Sachs et al., 2019). Since biophysical limits are inherently unequal, it is necessary for decision-makers and policymakers to establish a stable and safe management system that considers equality for all living beings (Lenton et al., 2019).

For nearly the past three decades, the climate justice approach has sought solutions to these inequalities. However, this approach prioritizes human benefits and interests. Therefore, it remains insufficient in addressing the Anthropocene epoch, which affects not only humans but also all living and non-living components of the Earth's landscape. Anthropogenic activities such as tourism, industry, energy production, and urbanization lead to consequences such as habitat fragmentation in natural landscape components, increased carbon emissions, transformation of fertile soils into artificial surfaces, eutrophication of rivers and wetlands, and destruction of coasts and coastal biodiversity. What matters is to ensure both a biophysically secure environment and one that protects human well-being and justice (Sachs et al., 2019). In this regard, when discussing equality and rights, an egocentric justice approach proves inadequate. Thus, a "biocentric" approach that considers the "intrinsic value" of all landscape components must be developed. Accordingly, the climate justice approach must evolve into a more comprehensive perspective that evaluates not only inter-human and intergenerational justice but also justice for other species (Tschakert, 2020).

In this context, the "Deep Ecology" approach, which advocates for a holistic view of the planet, argues that fundamental changes in human values, goals, policies, and lifestyles are necessary (Şakacı, 2018). The concept of deep ecology, developed by Arne Naess (1994), claims that today's global environmental problems—such as climate change and biodiversity loss—stem primarily from anthropocentric approaches that attribute instrumental value to nature. Deep ecology argues that confining the concept of "value" to humans alone constitutes speciesism. It proposes a "relational and holistic field" model to describe the relationship between humans and nature, asserting that all organisms are biologically interconnected (Şakacı & Günesen, 2023). As a principle, deep ecology embraces the rule of "biospheric equality" (Arıkan, 2020), meaning that all living beings in nature have equal rights to live and flourish. Accordingly, humans, like all other species, should interact with other living beings only to fulfill their vital needs (Demir, 2020).

The Bodrum Peninsula is located at the intersection of the Aegean and Mediterranean Seas and has been known for over 3,000 years as a seafaring settlement (e.g., Caria, Greek, Roman, Byzantine periods). Today, the rapidly developing Bodrum Peninsula is among the most affected coastal habitats in the Eastern Mediterranean due to intense pressures from construction activities for resorts and housing cooperatives, marine pollution (resulting from urban and aquaculture-related organic enrichment), and tourism activities (e.g., daily and weekly tour boats, private yachts). In

addition, since the early 1990s, hundreds of small and large-scale fish farms have been established in the northern part of Bodrum. The construction of holiday villages along the coastline has exponentially increased tourism pressure over the years, and recently, massive marinas have been constructed across the peninsula. Despite these pressures, Bodrum's coasts are home to ecologically significant species, such as seagrasses, Mediterranean monk seals, seahorses, sandbar sharks, angel sharks, common eagle rays, and thornback rays, which are rare and critically endangered cartilaginous fish. Despite such intense coastal degradation, no effective marine protected area or conservation planning exists around the peninsula.

The European Landscape Convention (ELC) emphasizes the necessity of legally recognizing landscapes. Article 6 of the Convention calls for the implementation of landscape policies aimed at the protection, management, and planning of landscapes (Jorgensen, 2016). The lack of a holistic perspective on landscapes, exploitative attitudes toward ecosystem services, and disregard for biospheric equality have prevented the Bodrum Peninsula from preserving its ecological value. In this context, the Bodrum Peninsula constitutes a biologically and socio-ecologically vulnerable area and represents a suitable case for the application of a biocentric justice model.

Material and Method

The Bodrum Peninsula possesses significant natural and cultural landscape qualities due to its Mediterranean climate and geomorphological diversity (Figure I). The peninsula harbors critical ecosystems along its coasts, such as Posidonia oceanica (seagrass), which holds ecological importance not only for Turkey but for the entire Mediterranean biogeographic region. Seagrass meadows provide essential ecosystem functions such as carbon sequestration, prevention of coastal erosion, and the provision of habitats for biodiversity. However, increasing pressures from tourism, marinas, coastal infill projects, illegal constructions, and marine pollution in recent years have posed serious threats to these habitats. Additionally, intense urban development and the consequent loss of natural areas are observed in terrestrial zones.

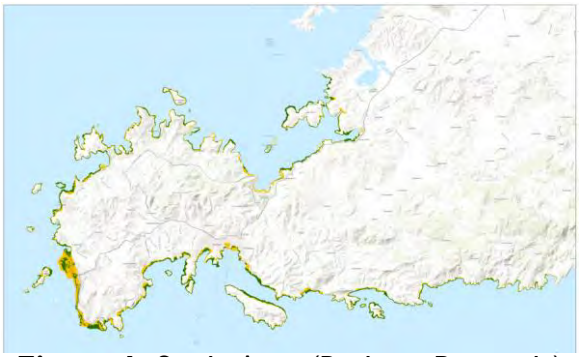


Figure I. Study Area (Bodrum Peninsula)

In the first phase of the research, the main material of the study—the current state of the case area—was examined in terms of its natural, physical, economic, socio-cultural, and administrative structures (1); the principles and approaches of climate justice were reviewed (2); and the criteria of the Deep Ecology approach were developed and analyzed (3). In the second phase, the Deep Ecology criteria were prioritized using the ARAS (Additive Ratio Assessment) method based on their degree of importance. In the final phase, landscape management strategies incorporating the holistic inclusiveness of justice were proposed for the Bodrum Peninsula (Figure II).

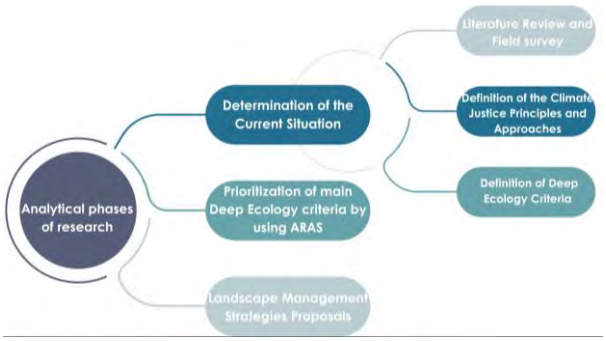


Figure II. Analytical phases of research

In this study, a comprehensive literature review was first conducted to examine the concepts of climate justice, deep ecology, and landscape management. Based on this review, criteria derived from the concepts of climate justice and deep ecology were defined and analyzed within the ethical framework of landscape management. These criteria were then transformed into a questionnaire and administered to 20 experts, including landscape architects, ecologists, sociologists, hydrologists, oceanographers, marine documentarians, climate activists, and tourism professionals.

The collected data were analyzed using the ARAS (Additive Ratio Assessment) method, one of the Participatory Multi-Criteria Decision-Making

(MCDM) techniques. Through this analysis, each criterion was quantitatively prioritized, thereby enabling the construction of a holistic landscape management framework.

Results

In this study, which aims to develop an integrated landscape management model by enriching the principles of climate justice through the lens of deep ecology, a survey was conducted with 20 experts to determine the prioritization of each criterion. Based on the survey results, each of the deep ecology principles was ranked using the ARAS (Additive Ratio Assessment) method, considering the optimal function degree (0.231).

According to the findings, the criteria for a holistic landscape management model were prioritized from "most important" to "least important" as follows: Holistic Approach (0.166), Biospheric Equality (0.165), Local Autonomy and Decentralization (0.150), Diversity and Symbiosis (0.113), Anti-Class Stance (0.090), and Relational and Holistic Field (0.082).

The analysis revealed that Holistic Approach and Biospheric Equality received significantly higher scores compared to the other criteria, with a noticeable break between them and the rest. Given their close conceptual scope and numerical proximity, these two were evaluated jointly and determined to constitute the foundational pillars of the proposed landscape management model for the Bodrum Peninsula.

Ranked as the highest priority, the Holistic Approach emphasizes the necessity of developing systematic and integrative solutions in ecologically and socio-culturally complex and vulnerable areas such as Bodrum. Considering issues like tourism-induced construction, coastal degradation, habitat fragmentation, and marine pollution across the peninsula, this approach is of critical importance for sustainable landscape planning.

The second-highest criterion, Biospheric Equality, denotes the principle of equal rights not only among humans but among all living beings. The existence of Posidonia oceanica seagrass meadows, Mediterranean monk seals, seahorses, and endangered elasmobranch species along the Bodrum coast further reinforces the significance of this principle. These conditions highlight the necessity of adopting a justice-based approach in landscape planning that respects the intrinsic rights of non-human species alongside human needs.

The prioritization achieved through the ARAS method demonstrates that in heavily pressured areas such as the Bodrum Peninsula, an ethical and sustainable landscape management model must be grounded in a holistic ecological perspective and a justice framework that upholds the equal right to life for all landscape components. These findings also provide a critical roadmap for the development of effective conservation strategies, which are currently absent in the region.

Discussion

In this study, a more holistic, participatory, and quantitative process has been developed by integrating the climate justice approach with the deep ecology perspective, aiming to ensure justice not only for human benefit but also for all living and non-living beings. The findings of the study indicate that conventional climate justice approaches fail to sufficiently consider the intrinsic value of nature. The Landscape Management Framework, constructed with a holistic perspective and grounded in deep ecology theory, emphasizes the equality of all beings within landscape governance and, in this respect, offers a more sustainable and ethically based framework.

In this context, a literature review on deep ecology was conducted to contribute to the concept of climate justice, and deep ecology criteria were identified. To assign quantitative value to these criteria, they were analyzed using the ARAS method, one of the Multi-Criteria Decision-Making (MCDM) techniques. This allowed for the objective prioritization of all deep ecology criteria and provided recommendations within the scope of climate justice. Although the ARAS method is one of the most up-to-date MCDM techniques, it has so far been primarily applied in fields such as economics, finance, and technology (Yıldırım, 2015; Ecer, 2016; Adalı & Işık, 2016; Ömürberk et al., 2017; Bakır & Atalık, 2018).

In regions such as the Bodrum Peninsula, intense tourism and urban development pressures have caused large-scale destruction of seagrass meadows. The loss of seagrass beds leads not only to the partial loss of primary production and the failure to prevent coastal erosion, but also to the resuspension of sediment, the disruption of nutrient and oxygen transport, and the substantial degradation of associated coastal functions and services (Duarte, 2012; Marba & Duarte, 2010; Fourqurean et al., 2012). Therefore, the utilitarian exploitation of cultural ecosystem services by

humans results in irreversible losses. In this regard, coastal areas must be protected and sustained in an equitable and just manner through appropriate policy and governance decisions.

This study confronts the utilitarian mindset—embedded in consumption systems—that dominates management approaches and public perception in coastal areas threatened by the impacts of climate change resulting from human activities. The climate justice literature reveals that most commonly expressed demands are centered on human benefit (Newell et al., 2021). Among these shared demands, the expression "opposing the commodification and commercialization of nature" directly contradicts current practices and highlights the inverse relationship between such actions and climate change. The primary driver of climate change is the commodification and exploitation of nature as an infinite resource. In light of this reality, under the umbrella of climate justice, discussions continue regarding the establishment of a nature-compatible way of living and the right to exist for non-human entities (Newell et al., 2021).

Although all beings have an equal right to live, humanity continues to establish a master–slave relationship with all non-human entities in an anthropocentric manner. This dynamic has alienated humans from the natural world in which they exist. Like all other beings, humans should only intervene in the lives and development of other species to meet vital needs (Price, 2021). A management model that considers the needs of all landscape components may disrupt the human-centered focus of climate justice. In the Bodrum Peninsula, it is necessary to restrict human activities such as tourism, hospitality, fisheries, and boat tours, which constitute the greatest threats, in order to restore natural resources and mitigate the damage caused.

Uncoordinated, irregular, and centrally imposed interventions and policies often result in highly detrimental outcomes (Arıkan, 2021; Şakacı, 2018). Recognizing that the commodification and commercialization of nature are among the primary drivers of climate change, this study emphasizes the inadequacy of current climate justice frameworks and highlights the need for a more balanced and egalitarian landscape management model aligned with the ethical philosophy of deep ecology.

Conclusion

Increasing demands on ecosystem goods and services—particularly those stemming from unsustainable resource extraction and consumption—are driven by capitalist economic and social systems. As a result of varying stakeholder demands, significant inequalities have emerged between "winners" and "losers" in terms of access to and distribution of ecosystems. This has led to the rise of the concept of climate justice, which brings ethical, equity, and rights-based concerns to the forefront regarding the causes and impacts of climate change, as well as issues of responsibility and compensation.

The deep ecology approach, in response to current environmental crises, argues that humanity must abandon its perception of nature as property. It advocates for a fundamental shift in how humans relate to the natural world.

This research demonstrates that the holistic landscape management framework developed for the Bodrum Peninsula introduces a new paradigm for both landscape planning and climate justice discourse. The proposed framework holds potential for adaptation in other coastal and tourism areas facing similar pressures. It is particularly recommended that local governments and experts utilize this framework to develop strategies focused on equity and inclusivity. In this regard, there is a growing need for self-sufficient local administrations capable of responding more effectively to ecological challenges, without being constrained by centralized political and economic systems.

In conclusion, the outputs and methodology of this research provide a new framework for participatory and quantitative landscape management that prioritizes the biotic, abiotic, and cultural equality of the landscape. It contributes to the academic literature through an integrated approach that combines climate justice and deep ecology.

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The Magpie-Mutehekau Shipu River in person: "with" the landscape?

TOPIC: Guiding territories with legislative and social advances in planning: towards a right for nature

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Abstract

By the late 2010s, between 2017 and 2020, numerous natural entities such as rivers and mountains were granted legal personhood in countries like New Zealand, India, Colombia, and Canada. This phenomenon, which may appear extraordinary within Western culture, is in fact an ordinary reality for Indigenous cultures.

It marks a profound paradigm shift for Western societies, where the perspective is gradually shifting from anthropocentrism to biocentrism, prompting a redefinition of the relationships between humans and non-humans. While Western cultures often frame the relationship between society and nature in terms of separation, other cultures—especially Indigenous ones—have always experienced this coexistence in a more integrated and interconnected way.

Initiatives such as the "Parliament of the Loire" or the "Call of the Rhône" in France illustrate this change in perspective in an era of global disruption. A particularly striking example is the recent recognition of the Magpie River, or *Mutehekau Shipu* (in Innu-Aimun, the language of the Innu), a tributary of the St. Lawrence River on Quebec's North Shore (Canada). In this case, Western activists from diverse backgrounds (environmentalists, legal experts, whitewater sports enthusiasts) joined forces with Indigenous Innu communities and local municipalities to defend this internationally renowned river from the threat of new hydroelectric dams.

In 2019, the Innu people and the Ekuanitshit Band Council, SNAP Québec (the Quebec chapter of the Canadian Parks and Wilderness Society), the Association Eaux-Vives, and the Minganie municipalities united their efforts to found the *Alliance Muteshekau Shipu*. This successful alliance demonstrates the possibility of bringing together two seemingly opposing worldviews to achieve a shared victory. In 2021, the Alliance announced the legal personhood of the Magpie River through two legally robust mirror resolutions—marking the first recognition of this kind in Canada.

The purpose of the proposed presentation is to introduce the river itself, the territory it flows through, and the coexisting values of existence (human and non-human); to present the contents of the legal file, including the river's rights and governance structures (mirror

resolutions, guardians, etc.); and finally, to explore how landscape and environment come together around the notion of beauty.

This three-voice presentation brings together two key actors from the field in Quebec (an Innu representative from the Ekuanitshit Band Council and an environmental activist/project coordinator) and a landscape architecture educator and researcher from a higher education engineering school.

Text

Introduction

Faced with the inherent challenges of protecting natural territories in countries like Canada—with vast expanses of public land—new legal mechanisms have emerged over the past decade to decentralize and reconcile conservation efforts with Indigenous perspectives. Pressures from resource extraction within a growth-driven economy, the multi-use nature of land, and Indigenous rights issues are all factors that complicate efforts to protect territory and achieve international goals, such as protecting 30% of terrestrial and marine areas by 2030, as laid out in the Kunming-Montreal Global Biodiversity Framework, which both Quebec and Canada have committed to.

In the specific case of Quebec's rivers, another issue arises: the energy transition. In Quebec, despite an installed electricity generation capacity of 41,000 MW—94% of which comes from hydropower—over 50% of total energy consumption still relies on fossil fuels (Canada Energy Regulator, 2021; Hydro-Québec, 2023). Electrification of transportation networks and commercial/industrial heating systems, to name a few, places additional pressure on the province's rivers.

It is within this context that the campaign to protect the Magpie River takes place. The river was targeted for an 850 MW hydroelectric development by Hydro-Québec, the state-owned utility responsible for energy production and transmission, in its 2009–2013 Strategic Plan. Despite the existence of a run-of-the-river dam at its mouth, built in the 1960s and rehabilitated in 2007, the Magpie River has gained international acclaim for whitewater activities. Its massive 7,600 km² watershed is 99% free of human impact (OBV Duplessis, 2014). The protection of the river against dam development was resolved by granting it rights—formally recognizing it as a legal person.

1 – The Power of the Magpie River– Mutehekau Shipu and the Existential Values (Human and Non-Human) it Embodies

Hydropower vs. Rafting?

Located on the North Shore of Quebec (Canada), the Magpie River originates in Labrador and flows south for 290 km through boreal forest, emptying into the maritime estuary of the Saint Lawrence River between the villages of Magpie and Ekuanitshit (Mingan). It carves out a watershed of more than 7,650 km² and is known for its many rapids and waterfalls, shaped by the geologic turbulence of the Canadian Shield.

Its powerful flow—250 m³/s [Nerberg, 2022]—makes it highly suitable for hydroelectric production, like nearby rivers that are already dammed, such as the Manicouagan, Outardes, and more recently, the Romaine rivers. But the river is also one of the world's top ten whitewater rafting destinations (National Geographic, 2010), attracting athletes from around the globe, with some sections accessible only by plane or helicopter.

Magpie River or Mutehekau Shipu?

The river flows through the ancestral lands of the Innu people, known as Nitassinan, a boreal forest landscape crisscrossed by rivers flowing to the sea. This hinterland, called Nutshimit by the Innu, includes traditional areas for fishing, hunting, and gathering. In Innu-Aimun, the Innu language, the river is called *Mutehekau Shipu*, a name that refers to its steep banks and cliffs. The name "Magpie" (referring to the bird) was given during European

explorations in the 19th century when ornithologist John James Audubon identified the Canada Jay.

This dual naming reflects the overlapping and sometimes competing colonial and Indigenous claims to the river, dating back centuries. European settlement in the region dates to the 16th century, anchored by cod fishing, which led to settler expansion along the Saint Lawrence River, Newfoundland, and Saint Pierre and Miquelon. By the 19th century, industrialization and colonization transformed the area, displacing Indigenous peoples from their lands, forests, rivers, and coastlines through forced sedentarization and the creation of reserves such as Ekuanitshit and Uashat Mak Mani-utenam.

In short, the Magpie River is a natural site of ecological, biocultural, and historical significance—cherished by the Innu, whitewater sport enthusiasts, and environmentalists, but also targeted by hydroelectric developers. It remains a living testament to a pluralistic relationship with nature, opening the door to a shared worldview—one that unites Indigenous and ecological values in opposition to future dam projects.

The Indigenous Values It Embodies: "The River is Alive"

While the river's recognition as a legal person surprised much of the Western world—Magpie is the third river globally to be granted this status—it is simply a reaffirmation of Innu belief systems and their vision of Mother Earth as animated and alive: *"The river is alive"* [Shanice, Ekuanitshit Band Council, in Joliet & Joliet, 2023].

According to animist ontology, Mother Earth contains a multitude of "animated" beings with agency and intention: *"It is the river that chose us"* [Rita, Innu Cultural House of Ekuanitshit, Joliet & Joliet, 2023]. In this worldview, the Magpie River has always been a living entity—an agent with will, thoughts, and voice. As described in *I Am Mutehekau Shipu* (Nerberg, 2022):

"*I am on my way to the sea when I hear the voice. At first it's faint, some static notes rising through the mist of a waterfall. As I approach the cliff forming the cascade, I see a human on a rocky spur. She wears a red and green bonnet like Innu women have worn for centuries, and she's drumming. She sings. I've heard this song before, especially since pale-faced men in suits started coming to these forests wanting to divert my waters and those of other rivers. They say it's for progress. But for me, progress stopped when they forced me into that concrete box with locks. Who is this sister calling out? Then I hear her. A healing song—for me, the river—for all of us, for the planet. I hear her, even though my voice is louder than her words. I roar. That's how I know I exist.*"

The river's legal personhood—original in the Western legal world, but intrinsic in the Innu worldview—testifies to a convergence between two understandings of nature: the animist Indigenous worldview and a Western ecocentric perspective. This convergence sparked a legal battle that ended in a true collective victory.

2 – The Legal Journey and Success of the River's Rights: Mirror Resolutions, Guardians, etc.

The campaign to protect the Magpie River began in 2009, following the announcement of hydroelectric dam construction projects on the Romaine River, located 250 km to the east. These massive developments raised serious concerns about the increasing environmental impact on Quebec's North Shore. As early as 2008–2009, the Association Eaux-Vives Minganie (AEVM), composed of non-Indigenous paddlers, took action to defend the river. Given the scale of the project, the association reached out to CPAWS Quebec (Société pour la nature et les parcs), which launched a national campaign to protect the river. This included initiating a petition and commissioning a study on the Magpie's rafting potential, ranked the second-best river in the world for this activity by *National Geographic* [2010].

The campaign continued with river expeditions, conferences, grassroots actions, and meetings with key stakeholders (government bodies, local elected officials, academia, businesses, etc.). In 2020, AEVM, CPAWS Quebec, the Minganie Regional County Municipality (RCM), and the Ekuanitshit Innu Band Council

officially founded the Mutehekau Shipu Alliance to work collectively toward the river's protection.

Meanwhile, the Government of Quebec set territorial protection targets (12% in 2015 and 17% in 2020), requiring identification of additional protected areas on the North Shore to meet provincial goals. However, the regional proposal to protect the Magpie River faced opposition from Hydro-Québec, which sought to avoid any permanent protection status that could interfere with future energy production.

Throughout the decade, several mobilization efforts took place, including a 2017 demonstration in front of Hydro-Québec's headquarters in Montreal. In 2018, CPAWS Quebec, tired of waiting for the government to act, explored the legal possibility of granting legal personhood to a Quebec river. The Magpie River was the ideal candidate due to its international reputation, growing consensus around its conservation, and biocultural importance for the Innu.

CPAWS Quebec formed a working group with Alliance partners, the International Observatory on the Rights of Nature (OIDN), and legal experts to grant the river legal personhood. This status would recognize it as a living entity with fundamental rights. In 2021, two mirror resolutions passed by the Minganie RCM and the Ekuanitshit Innu Band Council officially granted legal personhood to the Magpie River.

This status conferred fundamental rights on the river: the right to live, to flow freely, to maintain its biodiversity, and to be protected from pollution. Most importantly, the river can now be represented in court to defend its rights.

As a legal entity, the Magpie River received the 2022 Rights and Freedoms Award from Quebec's Human Rights and Youth Rights Commission. This milestone marked a significant step in recognizing river rights and strengthening Indigenous leadership in environmental stewardship.

In 2023, the river was also designated as an Indigenous and Community Conserved Area (ICCA), an international recognition of Indigenous-led conservation. In 2024, a formal proposal was submitted to the Government of Quebec for the creation of an Indigenous Protected and Conserved Area (IPCA).

3 – Nature Protection and a Shared Ecocentric Vision?

A Common Goal: Ecology and Decolonization

The ecological crisis and the planet's finite resources are reshaping how some Westerners—particularly environmentalists—relate to nature, toward a more equitable view of human–nonhuman relations. For Indigenous peoples, however, this shift reflects a long-overdue recognition of traditional animist worldviews long suppressed by colonization.

The Magpie River case illustrates both a response to environmental destruction and a decolonial act. Quebec's reverence for hydroelectricity clashes with Indigenous reverence for living ecosystems and ancestral territories. For the Innu, protecting the Magpie is both an act of environmental defense and cultural affirmation.

The initiative to grant the Magpie/Mutehekau Shipu River legal personhood is emblematic of a broader convergence between the global environmental crisis and Indigenous rights struggles. "Other local residents also stood up," said R. Mestokosho. "This time, we defended the river together." [Nerberg, 2022]

A Shared Ecocentric Vision

Granting legal personhood to the Magpie River signals an ontological shift: a redefinition of human–nonhuman relations that challenges the classical modern anthropocentric model. This new perspective, supported by environmentalists and Indigenous advocates alike, reconsiders nature not as a resource to be exploited, but as a sacred, living entity with intrinsic value—and as a legal subject. After all, Western legal systems already recognize non-living legal persons, such as corporations or religious entities.

By granting rights to the river, this initiative proposes a new paradigm: nature as a partner to be respected. This vision is ecocentric—perhaps even multicentric—emphasizing the interdependence of all living beings and the

preservation of natural cycles through a consensus that respects the aspirations of all parties.

This ontological reconfiguration, blending the rights of nature and Indigenous peoples, opens a path toward coexistence between humans and nonhumans on equal and respectful terms. The legal recognition of the Magpie River as a person represents a first step toward reconciliation between Indigenous and Western worldviews—and may serve as a model for global environmental struggles.

The shared mobilization around the river also coalesced around the aesthetic value of its threatened landscapes. Beyond the physical dams, the landscape faces two existential risks: flooding upstream, and drying downstream.

4 – A Shared "Sense of Wonder" in the Landscape?

Recognizing nature's rights reveals a deep synergy between ecology and landscape, echoing naturalist Rachel Carson's idea in *The Sense of Wonder* [2021]. In her collection of texts, Carson's aesthetic-naturalist advocacy shows how ecology and landscape are distinct yet complementary. This synergy has been noted since the 19th century by thinkers like Ralph Waldo Emerson and Henry David Thoreau, early precursors of modern ecological thought. As Besse [2018] notes, "It is precisely at the point of convergence between ecology and social sciences that landscape emerges." Likewise, the Council of Europe [2000] states, "Landscape significantly contributes to the general interest, culturally, socially, economically, ecologically, and environmentally."

The beauty of the Magpie River's landscapes—seen through both Indigenous and non-Indigenous lenses—became a second focal point of advocacy for its protection and legal personhood. The emotional response to the river's scenery, whether from Innu cultural values or environmentalist perspectives, was a powerful catalyst for collective action.

From the Innu viewpoint, the river's beauty is not merely aesthetic. It represents their living world, ancestral landscapes to which they are deeply connected and proud. Shanice, an employee of the Ekuanitshit Innu Council, emphasizes how the silence, water quality, surrounding mountains, and birdsong contribute to the river's spiritual and nourishing essence [Joliet & Joliet, 2023]. This sense of belonging to a sacred, animated nature motivated, among others, a group of young Innu women to advocate for the river after a rafting experience.

In this context, beauty becomes a source of pride and a reflection of the interdependence between the Innu and their environment. For the Innu, being human means being sensitive to the nature surrounding the community—recognizing the beauty and richness of even the smallest elements and acknowledging their sacred nature [Vega Cardenas & Turp, 2023]. As Chartier [2019] notes, Innu speech is filled with an urgency to express the beauty, complexity, violence, and hope of their world—a voice striving to preserve and transmit this richness.

From the non-Indigenous perspective—outdoor sports enthusiasts, whitewater paddlers, environmentalists—the radiance of the Magpie River is also championed. It evokes the mythical image of untouched, original nature, as reflected in media coverage by *Le Monde* and *National Geographic*, which highlight the river's majestic scenery and the awe it inspires. Descriptions of "untouched" landscapes and the physical challenges of the river, including class V rapids, echo a wilderness ideal—nature seen as a space of wonder and refuge.

Thus, the beauty of the Magpie River became a unifying driver of action. Despite culturally distinct modes of appreciation, shared emotional responses to the river's beauty transcended cultural divides and fostered collective will to preserve and value this unique natural environment. This shared "sense of wonder" also became the foundation for local recreational and tourism development.

Legal Resolution No. 025-21, which grants the Magpie River legal personhood, highlights its ecological, scenic, and recreational value. The Bureau d'audiences publiques sur l'environnement (BAPE) noted that the river's beauty holds major potential for adventure tourism development, particularly whitewater activities like rafting and canoeing, as well as

hiking and winter sports like cross-country skiing and snowshoeing. The river's aesthetic character thus becomes an economic driver for the Minganie region.

Conclusion

The initiative to grant the Magpie River legal personhood offers a notable example of recognizing the rights of a "thing" within Western legal frameworks. At the Quebec scale, through regional resolutions, it represents an innovative case of territorial protection via regional action. By leveraging the legal powers of an Indigenous Band Council and municipal authorities, members of the Muteshekau Shipu Alliance and their partners secured an additional legal tool to safeguard the river's intrinsic rights and integrity.

This approach complements other tools, such as designating the territory as an Indigenous Protected and Conserved Area.



Figure I. First and only dam built in the sixties ($©F.Joliet$)



Figure II. Second Fall, Spring ($©F.Joliet$)

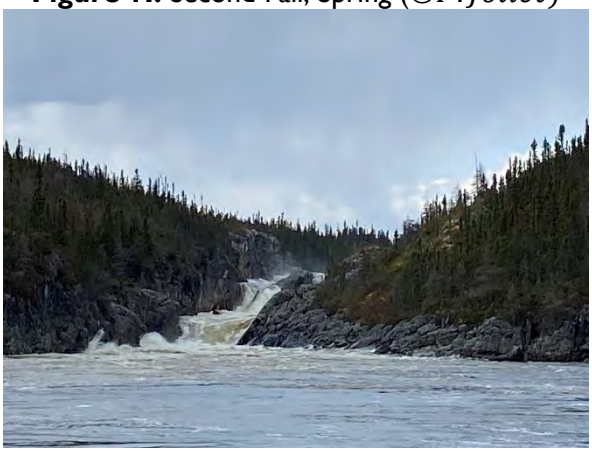


Figure III. Third Fall, Spring ($©F.Joliet$)

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Guiding landscapes
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Short papers

TOPIC 2
Guiding territories with legislative and social advances in planning: evolution of heritage landscapes

TEXT MINING-BASED SPATIAL MAPPING OF CULTURAL LANDSCAPE VALUES AND FEATURES FOR CULTURAL ROUTE OF TANG POETRY CONSERVATION: ANCIENT SHUDAO, CHINA

TOPIC: Guiding territories with legislative and social advances in planning: Evolution of heritage landscapes

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Keywords: The Road of Tang Poetry, Cultural Landscape, Spatial Patterns, Perceptions of Poets, Text Mining

Abstract

Cultural routes, as heritage networks, interconnect sites through shared cultural, historical, or natural themes, fostering sustainable development and cultural dialogue. A distinctive subtype of cultural route is the poetry-linked corridor—exemplified by the Road of Tang Poetry in the ancient ShuDao region, which integrates historic relics and landscapes that inspired Tang Dynasty poets. Recently, the Chinese government has aimed to preserve this heritage by connecting key poet-related sites and promoting sustainable tourism and education. However, rapid socioeconomic changes are causing the cultural landscape values along the route to be overlooked and remain unidentified, and the spiritual essence

embedded in the cultural landscapes is being eroded. Moreover, fragmented conservation approaches fail to adapt to the shifting socioeconomic environment that weakens the local identity of these landscapes. Such superficial engagement diminishes their cultural appeal and perpetuates fragmented practices. Existing research emphasizes Tang poetry's literary dimensions but neglects spatial analyses of cultural landscapes. Although scholars have mapped road systems and preserved relics, geographical methods to interpret the values of poetic landscapes remain underutilized. This gap impedes a comprehensive understanding of the region's multilayered cultural significance. Addressing this urgency requires systematic interdisciplinary strategies that bridge literary, geographical, and conservation perspectives to safeguard the Road of Tang Poetry in the Ancient ShuDao region's unique identity as both a historical corridor and a living cultural route.

This study aims to fill this gap by spatially identifying the multiple values and features of the cultural landscape along the Road of Tang Poetry in the Ancient ShuDao region, using the text mining of 2,153 poems by 195 Tang Dynasty poets. We performed kernel density analysis to identify four main routes of the Cultural Route of Tang Poetry in the Ancient ShuDao region and spatial patterns of the landscape values perceived by poets along these routes. We used correspondence analysis to elucidate key associations between landscape features and poets' landscape perceptions.

Furthermore, quantitative text mining revealed 205 poetically significant locations: 66 sites of natural appreciation and aesthetic value, 81 locations with religious significance, 34 historical heritages, and 24 tied to folk and sense of place perceived by poets along these routes. Correspondence analysis shows that farmlands are closely tied to folk and sense of place, while natural appreciation and aesthetic value connect with extremely high rolling mountains, high rolling mountains, grasslands, shrubs, rivers and impermeable surfaces. Historical heritage shows strong connections to lakes, plains and terraces, whereas religious significance associates predominantly with hills, low rolling mountains, and mid rolling mountains. This study enhances our understanding of integrating poetic texts with spatial pattern analysis that decodes cultural landscape values along the Tang Poetry Route and offers a framework to balance heritage preservation with adaptive reuse amid socioeconomic shifts. This will also provide valuable insights for planners involved in the holistic protection and management of the Tang Poetry Cultural Route and contribute to future cultural tourism corridor planning. Ultimately, this transdisciplinary effort establishes a replicable protocol for balancing cultural preservation with sustainable development goals across World Heritage Cultural Landscapes.

1. Introduction

Cultural Routes have emerged as dynamic heritage corridors that integrate physical landscapes, cultural narratives, and collective memory into territorial systems. Serving as platforms, these routes not only connect heritage sites but also enhance sustainable development, regional identity and intercultural dialogue [1]. In recent decades, cultural routes have gained global recognition—exemplified by Spain's Routes of Santiago de Compostela and Japan's Shikoku Pilgrimage—which offer immersive landscape experiences that continue to inspire contemporary reflection. These cultural routes embody deeply rooted cultural values while illustrating how adaptive planning and governance mechanisms can ensure their continuity amid accelerating socioeconomic change [2].

Despite their growing prominence, many potential Cultural Routes remain vulnerable to spatial fragmentation, diminished coherence, and the erosion of cultural meaning. These challenges underscore the need for integrative planning frameworks capable of identifying, interpreting, and sustaining the embedded values of cultural landscapes, while aligning with evolving social and regulatory agendas.

In China, cultural routes have attracted growing academic and policy interest, particularly following the UNESCO World Heritage inscriptions of the Grand Canal and the Silk Roads. Among these, a distinctive subtype of cultural routes is the poetry-linked corridor—exemplified by the Road of Tang Poetry in the ancient ShuDao region — which integrates historic relics and landscapes that inspired Tang Dynasty poets. Historically traversed by numerous Tang Dynasty poets—including Li Bai and Du Fu—the route inspired over a thousand poems that vividly articulated perceptions of landscape, cementing the region's reputation as a cultural and literary heartland.

Today, the region forms the focus of China's "Ancient ShuDao Cultural Tourism Corridor" initiative, which aims to harness both tangible and

intangible heritage assets to foster tourism, education, and regional development. However, current planning remains fragmented, owing in part to the absence of spatial frameworks that integrate poetic landscape perceptions into territorial analysis. While literary scholarship has extensively examined Tang poetry, its insights have yet to be meaningfully incorporated into landscape planning and heritage governance. Most existing studies remain confined to localized case analyses, failing to capture the interlinked and multiscalar character of the broader cultural landscape.

This study fills this gap by bridging literary analysis with GIS spatial modeling, using text mining to analyze 2,153 Tang poems by 195 poets. It categorizes poetic perceptions into four types of cultural landscape values—natural appreciation and aesthetic value, religious significance, historical heritage, and folk and sense of place—mapping them spatially and correlating them with land cover and geomorphological features. Our interdisciplinary framework proposed in this study deepens the integration of literary textual analysis with spatial pattern recognition, enabling the systematic decoding of cultural landscape values embedded in Tang poetry along the Ancient ShuDao route. Moreover, this will also provide valuable insights for planners involved in the holistic protection and management of the Tang Poetry Cultural Route and contribute to future cultural tourism corridor planning. Ultimately, this transdisciplinary effort establishes a replicable protocol for balancing cultural preservation with sustainable development goals across World Heritage Cultural Landscapes.

The research is guided by three questions:
1.What is the spatial pattern of Tang Dynasty poets' travel routes in the Ancient ShuDao region?
2.Where along the route do different categories of cultural landscape value emerge?
3.How do specific landscape features relate to the cultural landscape values embedded in Tang poetry?

2. Data and Methods

2.1. Research Area

The Ancient ShuDao region encompasses the historical network of roads that provided access to the interior of ancient Sichuan (Shu). Among the principal ingress routes into the Sichuan region are the Taurus Road, Yonekura Road, and Lychee Road, each accompanied by a network of interconnected subsidiary corridors. Collectively, these routes constitute the spatial foundation of the proposed conservation initiative for the Tang Poetry Road. Accordingly, the study area includes the contemporary administrative territories through which these historical routes once passed. The study region encompasses 18 administrative jurisdictions within Sichuan Province—including 17 prefecture-level cities (Ya'an, Mianyang, Deyang, Chengdu, Meishan, Leshan, Guangyuan, Nanchong, Suining, Ziyang, Neijiang, Zigong, Yibin, Luzhou, Bazhong, Dazhou, and Guang'an) and one autonomous prefecture (Aba Tibetan and Qiang Autonomous Prefecture)—as well as the Chongqing Municipality.

The regional landscape is shaped by major river systems—the Wei, Jialing, and Han Rivers—as well as the Sichuan Basin and the Qinling and Daba mountain ranges. Historically, ShuDao served as a critical corridor that connected the mountainous southwest with the rest of China, overcoming the natural barriers imposed by the surrounding ranges. The route played a pivotal role in military, political, cultural, and economic developments, leaving a rich legacy of literary works still embedded in China's cultural memory. These routes traverse diverse terrains and connect cultural landscapes marked by historic towns, Taoist and Buddhist temples, and heritage sites embedded within ecologically significant environments.

2.2. Research Collection

2.2.1. Extraction and Organization of Poetry Text Information

The primary textual dataset was derived from the Research on Tang and Five Dynasties Poetry and Ba-Shu Culture and was cross-referenced and validated using the Complete Tang Poems. A total of 2,153 poems composed by 195 Tang Dynasty poets were compiled and meticulously proofread to ensure textual accuracy and consistency with classical Chinese poetic conventions. All poetic content was systematically categorized into three dimensions: "person," "place," and "landscape." The "person" category refers to the poet. The "place" category captures the geographic locations referenced in the poems. The "landscape" category encompasses the cultural and environmental elements perceived and represented in the poems. Drawing on established classifications of public perception of landscape

values, these landscape references were further coded into four value dimensions: *natural appreciation and aesthetic value*, *religious significance*, *historical heritage,* and *folk and sense of place* (see Table 1).

Table 1. Four Value Dimensions of Landscape .

Perception	Description	N
Natural appreciation and aesthetic value	Refers to landscapes associated with natural environments, emphasizing the region's topographic characteristics and ecological aesthetics. This category encompasses poetic depictions of mountains, rivers, and lakes, which were prominent sources of inspiration for Tang Dynasty poets.	66
Religious significance	Encompasses landscapes associated with religious sites and spiritual traditions, reflecting the historical presence and cultural influence of Buddhism and Taoism within the region.	81
Historical heritage	Refers to landscapes linked to historical figures, renowned literary figures, or sites embedded in well-known historical narratives and legends.	34
Folk and sense of place	Encompasses landscapes associated with local livelihoods, artisanal practices, and vernacular traditions, reflecting the socio-economic dynamics and cultural vitality of the region.	24

2.2.2. Establishing the Tang Poetry Route in the Ancient ShuDao Region Based on Key Access Routes to Shu and the Trails of Poets

Data on the trails of Tang poets were sourced primarily from *Examination of Tang and Five Dynasties Literati Entering Shu* and *Research on Tang and Five Dynasties Poets Entering Shu and Ba-Shu Culture* [4,5]. Building upon the spatial configuration of transportation networks historically documented in ancient ShuDao travel maps, we integrated georeferenced information on the creative activities of 195 poets. All spatial references were digitized and mapped using ArcGIS Desktop (version 10.2) to reconstruct the broader configuration of the Road of Tang Poetry in the Ancient ShuDao region. Based on the frequency of poet-associated activities along individual trails, we established a hierarchical classification of routes, distinguishing between primary and secondary pathways within the overall network.

2.2.3. Spatial Distribution Patterns of Cultural Landscapes Along the Tang Poetry Route Based on Tang Poetry Texts

All textual data were digitized and georeferenced within a Geographic Information System (GIS) environment. Spatial entities corresponding to "pl aces" and "landscapes" extracted from the poetic corpus were mapped using historical-geographical references. To examine the spatial distribution of cultural landscape values along the Tang Poetry Route, we employed nearest neighbor analysis and kernel density estimation. These spatial statistical methods allowed for the identification of clustering patterns across five thematic categories: overall cultural landscapes, landscapes of natural appreciation and aesthetic value, religious significance, historical heritage, and folk and sense of place.

2.2.4. Correlation Between Landscape Values and Features

To contextualize the spatial distribution of cultural landscape values, we integrated land cover data with geomorphological classifications to construct a region-specific typology of landscape features for the Ancient ShuDao area. These features were spatially overlaid with the geocoded occurrences of each cultural value category, producing a cross-tabulation matrix that quantified the frequency of associations between cultural landscape values and physical landscape types. This matrix formed the analytical basis for correspondence analysis, which enabled the interpretation of the strength and directionality of relationships between perceived cultural values and specific landscape features.

2.3. Data Analyses

2.3.1. Kernel Density Estimation

Kernel density estimation (KDE) calculates the point density of each feature on a smoothly curved circular surface and accumulates these values in grid cells to clearly reveal spatial clustering patterns. We applied kernel density analysis to generate a surface layer from the point data [6]. The kernel density f(x) equation (Eq. 1) is:

$$\hat{f}(x) = \frac{1}{\mathrm{nh}^{\mathrm{d}}} \sum_{\mathrm{i}=1}^{\mathrm{n}} K\left(\frac{\mathrm{x} - x_i}{h}\right) \quad (1)$$

Where *n* represents the number of data points, *h*

is the bandwidth (smoothing parameter), *d* refers to the spatial dimension, and *K* is the kernel function, specifically the Gaussian kernel. Higher kernel density values indicate a greater degree of clustering of the geographic features.

2.3.2. Nearest Neighbor Analysis

We employed nearest neighbor analysis to assess the spatial distribution of point elements, categorizing them as clustered, random, or regular. The spatial arrangement of these elements is quantified using the nearest neighbor index *R*, the equation (Eq. 2) is:

$$R = \frac{D_o}{D_e} \quad (2)$$

In this equation, D_o is the observed mean distance between each point and its nearest neighbor, while D_e is the expected mean distance assuming random spatial distribution. The interpretation of the nearest neighbor index is as follows:

R<1: Clustering (points are closer together than expected),

R=1: Random distribution (points are distributed randomly),

R>1: Regular dispersion (points are more spread out than expected).

2.3.3. Correspondence Analysis

In correspondence analysis, the Chi-squared statistic X^2 is used to assess the association between landscape values and landscape features [7]. The expected frequency E_{ij} for each cell in the contingency table is computed as (Eq. 3):

$$E_{ij} = \frac{(R_i \cdot C_j)}{N} \quad (3)$$

Where R_i is the row total for the *i*-th feature type, C_j is the column total for the *j*-th landscape feature category, and *N* is the total number of observations. The Chi-squared statistic is then calculated as (Eq. 4):

$$X^2 = \sum_{i,j} \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \quad (4)$$

Where O_{ij} represents the observed frequency in the contingency table. This statistical measure is followed by Singular Value Decomposition (SVD), which extracts the principal components. These components are plotted to reveal the strength and direction of the associations between landscape features and landscape values.

3. Results

3.1. Analyzing the Tang Poetry Route in the Ancient ShuDao Region Based on Textual Information from the Poet's Journey

The Tang Poetry Route in the Ancient ShuDao region is predominantly organized along four principal paths. The first originates in Lizhou and follows the Taurus Road southwest toward Chengdu. From Chengdu, two distinct routes extend to Yuzhou: one proceeds overland via Zizhou, Puzhou, and Hezhou before transitioning to waterborne travel; the other follows an overland path to Jiazhou, then shifts to the Min River, continuing through Rongzhou and Luzhou, ultimately arriving at Yuzhou. From there, the route proceeds upstream along the Yangtze River, passing through Zhongzhou and ultimately reaching Kuizhou. Among these pathways, the "Lizhou–Mianzhou–Hanzhou–Chengdu" and "Fuzhou–Yuzhou–Zhongzhou–Kuizhou" segments were the most frequently traversed by Tang Dynasty poets and thus constitute the core corridors of literary activity. Two additional secondary branches—"Chengdu–Zizhou–Puzhou–Hezhou–Fuzhou" and "Chengdu–Jiazhou–Rongzhou–Luzhou–Fuzhou"—also supported poetic travel, though with comparatively lower intensity.

3.2. Spatial Distribution Patterns of All the Landscape Values Based on Information from Poetic Texts

The corpus of 2,153 Tang poems was systematically categorized into four primary dimensions of cultural landscape values: natural appreciation and aesthetic value, religious significance, historical heritage, and folk and sense of place. Spatial analysis of the locations referenced in the poems, based on nearest neighbor indexing, yields a z-value of –39.81 and a

p-value < 0.001, with a nearest neighbor index (R) of 0.19, indicating a significantly clustered distribution of poetically perceived cultural landscapes across the Ancient ShuDao region. Kernel density estimation further reveals four notable clusters of poetic landscape representation. High-density concentrations are observed in the "Jiazhou–Chengdu–Hanzhou–Mianzhou–Lizhou" corridor and the "Hezhou–Tongzhou–Fuzhou–Yuzhou–Zhongzhou" corridor. In contrast, the "Songzhou–Maozhou" and "Kaizhou–Kuizhou" areas exhibit comparatively lower densities. These spatial patterns suggest a differentiated intensity of cultural landscape perception and literary production along distinct sub-regions of the Tang Poetry Route (see Figure 1(a)).

3.3. Spatial Distribution Patterns of Natural Appreciation and Aesthetic Value

Among the 2,153 poems analyzed, 66 distinct references to natural landscapes were identified. The majority of mountain depictions correspond to high-altitude and topographically dramatic formations including Mount Emei, Goddess Peak, and Mount Jianmen. Water-related scenes predominantly feature the Yangtze River and its major tributaries in the Ancient ShuDao region, including the Min River, Jialing River, and Qian River. Nearest neighbor analysis of these natural landscape references yields a z-value of –31.84, a p -value < 0.001, and an R-index of 0.21, indicating a highly clustered spatial distribution. Kernel density analysis identifies two major centers of concentration: the "Pengzhou–Hanzhou–Chengdu –Shuzhou" corridor and the "Kuizhou" region. The "Pengzhou–Hanzhou–Chengdu–Shuzhou" cluster is characterized by frequent references to mountains such as Mount Heming, Mount Yulei and the Twenty-four Peaks, as well as hydrological features including Mohe Pool and the Jin River. The "Kuizhou" cluster primarily features high-relief mountain landscapes such as Kui Gorge, Qutang Gorge, Wu Mountain, and Wu Gorge, highlighting the poetic significance of dramatic topography in this area (see Figure 1(b)).

3.4. Spatial Distribution Patterns of Religious Significance

Among the 2,153 poems, there are 81 references to the poets' perceived value of religious significance including Buddhist and Taoist landscapes. Nearest neighbor analysis reveals a z-value of –17.82, a p-value < 0.001, and a nearest neighbor index (R) of 0.04, indicating a highly clustered spatial distribution of religiously significant landscapes. Kernel density estimation further delineates two prominent clusters of Buddhist–Taoist sites along the Tang Poetry Route: a primary concentration within the "Pengzhou–Hanzhou–Chengdu–Shuzhou" corridor and a secondary cluster near Jianzhou. Within the "Pengzhou–Hanzhou–Chengdu–Shuzhou" corridor, temples such as Lingshan Temple, Gao Temple, Bijian Temple, Qingyang Palace, and Daci Temple are located in close proximity, forming a dense religious landscape. Similarly, in the Jianzhou region, sites including Longchang Temple, Upper Longchang Temple, Baoli Temple, and Caoxian Baolin Temple constitute a distinct religious cluster (see Figure 1(c)).

3.5. Spatial Distribution Patterns of Historical Heritage

A total of 34 cultural landscapes referenced in Tang Dynasty poetry are associated with sites of historical heritage. These include prominent locations such as Du Fu's Thatched Cottage, Xue Tao's Former Residence, Fang Creek and Tang Youzhe's Manor. Ten additional sites—including Zhang E's Temple, the Confucian Temple, Zhuge Wuhou Temple, and Jishun Shrine—were constructed in commemoration of historical personages and ancestral families. Notably, Du Fu's southward journey during a period of displacement is recorded across 12 distinct locations in the Ba-Shu region, infusing these sites with enduring literary and historical significance. Spatial analysis using the nearest neighbor index yields a z-value of 1.09, a p-value < 0.001, and an R -index of 1.00, indicating a statistically random spatial distribution (see Figure 1(d)).

3.6. Spatial Distribution Patterns of Folk and Sense of Place

The landscape values associated with folk and sense of place in Tang poetry are reflected in 24 documented instances referencing sacrificial rituals, local legends, and folk arts. The region's distinctive natural environment has given rise to a diverse set of cultural narratives, including legends related to water management, nature spirit offerings, and land worship practices. The Ba-Shu region is also home to several ethnic minority groups—including the Qiang, Yi, and Tujia—whose

traditional attire and customs contribute significantly to the richness of the local folk cultural landscape. The spatial distribution of these folk cultural elements is presented in Figure 1(e). Nearest neighbor analysis yields a z-value of –11.28 ($p < 0.001$) and an R-index of 0.42, indicating a significantly clustered spatial pattern. Kernel density estimation further reveals a pronounced concentration of these cultural features along the Tang Poetry Route, particularly within the "Pengzhou–Hanzhou–Chengdu–Shuzhou" corridor.

3.7. Associations Between Landscape Values and Features

Correspondence analysis was employed to assess the associations between 12 categories of landscape features — including farmland, plain and plateau, hill, low, mid, high, and extreme high rolling mountains, grasslands, shrubs, lakes, rivers, and impermeable surfaces — and the cultural landscapes as perceived by Tang poets. Landscapes categorized as 'folk and sense of place' exhibit a strong association with farmland. In contrast, the value dimension of 'natural appreciation and aesthetic experience' is closely linked to features such as extreme high and high rolling mountains, grasslands, shrubs, rivers, artificial forests, and impermeable surfaces. Furthermore, lakes and plains/plateaus are predominantly associated with historical heritage, while hills and low to mid rolling mountains correspond more strongly to religiously significant sites.

4. Conclusion

This study spatially identified Tang poets' landscape perceptions, mapping cultural values and linking literary imagination with tangible geography. It offers theoretical insights and practical tools for holistic heritage management, aligning with UNESCO's cultural landscape conservation goals. Ultimately, our framework supports the sustainable preservation of the Tang Poetry Route and provides a replicable model for global Culture Route management.

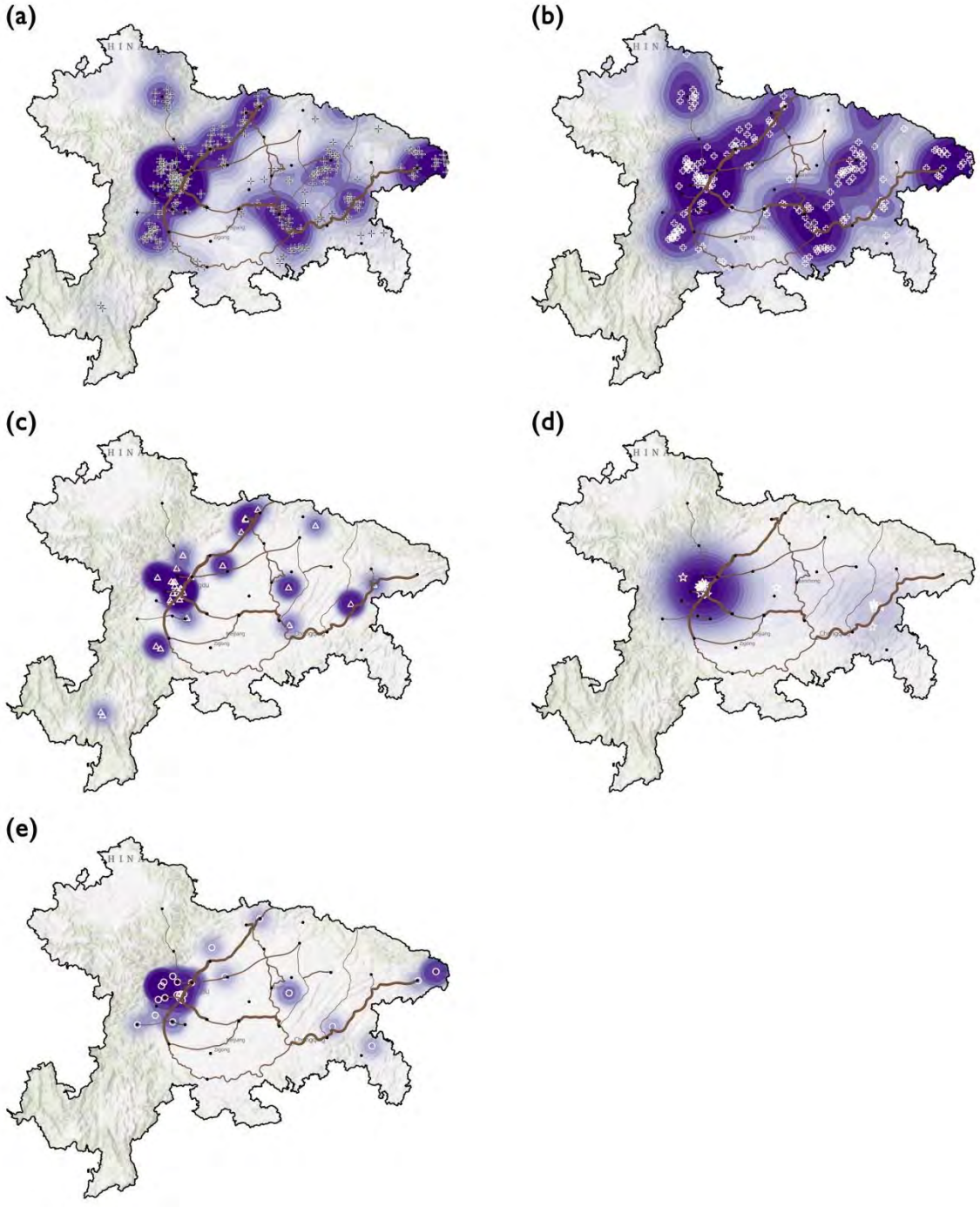


Figure 1. (a) Spatial distribution patterns of all the landscapes values (b) Spatial distribution patterns of natural appreciation and aesthetic value (c) Spatial distribution patterns of religious significance (d) Spatial distribution patterns of historical heritage(e) Spatial distribution patterns of folk and sense of place

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CLIMATE CHANGE CHALLENGES FOR HISTORICAL GARDENS AND MANAGEMENT PLANS

TOPIC: Guiding territories with legislative and social advances in planning: Evolution of heritage landscapes

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Keywords: historic gardens, climate resilience, management plans, vulnerability assessments, risk analysis methodologies.

Abstract

Historic gardens and cultural landscapes face unprecedented challenges due to climate change, including threats from sea-level rise, extreme weather events, flooding, and temperature pattern changes. These challenges pose significant risks to the preservation of cultural heritage sites, threatening their physical integrity and cultural significance. Landscape architects and conservation managers must prepare Management Plans to develop effective strategies for identifying and addressing climate-related risks while maintaining the historical authenticity of these valuable sites.

The methodology involved a systematic review that analysed 30 research papers to understand how experts identify and mitigate climate change-related risks to historical gardens and cultural landscapes. This was completed through a comprehensive analysis of case studies, empirical research, policy analyses, and theoretical papers, examining their approaches to risk assessment, mitigation strategies, and management solutions. The reviewed studies were conducted in diverse geographic locations, with a predominant focus on European sites (18 studies), followed by North America (6 studies), and limited representation from Australia, Africa, and the Asia-Pacific region.
The results revealed several key insights. First, vulnerability assessments, as described in the "Climascape project", [1] and methodologies, as well as risk analysis methodologies, emerged as the primary tools for identifying climate risks, with particular attention to sea-level rise, flooding, and extreme weather events. Second, mitigation strategies encompass both preventive measures and adaptation techniques, including climate-resilient plant selection, landscape modification, and improved water management systems. For example, the Melbourne Botanic Gardens has implemented a strategic approach to transition 75% of its species to climate-suitable varieties by 2036 [4].

The analysis identified several management challenges, including institutional barriers, resource constraints, and complex decision-making processes. Solutions emphasise collaborative approaches, innovative assessment tools such as the Storm Risk Assessment and Management Tool [10], and the integration of traditional preservation methods with modern adaptation strategies.

The review concludes that successful climate change adaptation in historic gardens requires a balanced approach that combines structured risk assessment, adaptive management strategies, and stakeholder engagement. The findings emphasise the need for flexible, context-specific solutions that can evolve with an improved understanding of climate impacts while preserving heritage values. Future management approaches must integrate traditional preservation principles with innovative adaptation strategies, supported by sustainable funding mechanisms and policy frameworks that facilitate long-term resilience. This research provides valuable insights for the elaboration of Management Plans by landscape architects

and conservation managers seeking to protect historic gardens and cultural landscapes in an era of climate change.

1. Introduction

Historic gardens and cultural landscapes face unprecedented challenges due to climate change, including threats from sea-level rise, extreme weather events, flooding, and changing temperature patterns. These challenges pose significant risks to the preservation of cultural heritage sites, threatening their physical integrity and cultural significance. Landscape architects and conservation managers must prepare Management Plans to develop effective strategies for identifying and addressing these climate-related risks while maintaining the historical authenticity of these valuable sites.

2. Theoretical framework

The Florence Charter for Historic Gardens [6] is an international conservation document adopted in 1982 by the International Council on Monuments and Sites (ICOMOS), specifically by its International Committee for Historic Gardens (ICOMOS-IFLA). It establishes guidelines for the protection, conservation, and restoration of historic gardens, recognising them as living monuments that combine natural and cultural elements. The Florence Charter has helped formalize the idea that landscapes and gardens are part of cultural heritage, not just buildings or archaeological sites. It has also influenced heritage conservation policies globally, particularly in Europe.

A historic garden, as defined in the Charter, is considered a monument and a living work of art, shaped by human design but also subject to change due to natural growth and seasonal cycles. Gardens reflect the cultural, philosophical, artistic, and social values of their time, and their preservation is crucial for maintaining historical continuity. Conservation must respect the original layout, plant species, and materials used in the garden. Any restoration or maintenance should preserve the garden's authentic character. Because gardens are living structures, they require ongoing care (such as pruning, replanting, and seasonal work), and maintenance is as essential as restoration. The preservation of historic gardens as cultural assets in the face of climate change must have an interdisciplinary approach that combines art history, natural sciences, and social sciences to develop strategies for their long-term preservation. (Hüttl, 2019). Historic parks and gardens face challenges due to climate change, which threatens archaeological information crucial for their accurate repair and reconstruction, necessitating monitoring and mitigation strategies to preserve historical integrity. (Dix, 2019). The conservation of historic gardens is crucial for safeguarding various values and services, but they face threats from unhealthy plants and structural instability, necessitating awareness and a multidisciplinary approach to address these challenges [2].

However, nowadays, 40 years after its adoption, some authors [5] question the Charter's recommendations, particularly concerning authenticity in the maintenance and restoration of historic greenery. They discuss various interpretations and shortcomings of the Charter, highlighting the importance of source research and the need for a more comprehensive approach that integrates sustainable development and modern technologies, such as laser scanning and geophysical methods. The author advocates for a new document that addresses contemporary challenges, including climate change, and redefines authenticity for historic gardens as "*opera aperta*" or "a place of changes", emphasising the need for interdisciplinary discussion and a nuanced understanding of their evolving nature.

Management plans for historic gardens are comprehensive documents designed to ensure the long-term conservation, maintenance, and sustainable use of gardens recognised as part of the cultural heritage. These plans balance the historical, aesthetic, ecological, and social values of the garden with practical needs, such as visitor access, funding, and climate adaptation. They ensure coherent and consistent stewardship over time, balance preservation with access and use, help meet legal and international obligations (e.g. those of UNESCO or under the Florence Charter), and encourage interdisciplinary collaboration (landscape architects, botanists, historians, etc.). Conservation plans include guidelines for preserving or restoring elements such as original planting schemes, historic paths, walls, fountains, sculptures, key views, visual relationships, policies on plant replacement, use of authentic materials, and pest/disease control. They also define management plans with schedules for routine care (such as pruning, mowing, replanting, irrigation) and seasonal management actions. Conservation managers identify climate risks by

conducting structured assessments that focus on measurable hazards. Vulnerability assessments, as described in the "Climascape project" [1] and methodologies, as well as risk analysis methodologies, have emerged as the primary tools for identifying climate risks, with particular attention to sea-level rise, flooding, and extreme weather events. Solutions emphasise collaborative approaches, innovative assessment tools such as the Storm Risk Assessment and Management Tool [10], and the integration of traditional preservation methods with modern adaptation strategies. Vulnerability frameworks and risk analysis methodologies guided evaluations of sea-level rise, flooding, extreme weather events, and, less frequently, temperature changes and coastal erosion. Multi-criteria decision tools, including the Analytic Hierarchy Process and climate simulations [8], support these assessments in various settings, such as coastal historic landscapes and UNESCO sites.

Mitigation strategies encompass both preventive measures and adaptation techniques, including climate-resilient plant selection, landscape modifications, and improved water management systems. For example, the Melbourne Botanic Gardens implemented a strategic approach to transition 75% of its species to climate-suitable varieties by 2036 [4].

Efforts such as climate-resilient plant selection, targeted landscape modifications, improved water management, and infrastructure upgrades are needed to address the challenges. Management plans often integrate traditional conservation approaches with modern tools (e.g. digital documentation and risk management frameworks) to balance heritage preservation with adaptation needs. Collaborative interdisciplinary approaches involving local stakeholders and flexible policy integration further enhance effective risk mitigation [9].

3. Methodology

The methodology involved, firstly, a systematic review of thirty (30) research papers to understand how experts identify and mitigate climate change-related risks in historical gardens and cultural landscapes.

The starting questions were as follows: i) What are the climate change challenges in historic gardens?

The search was conducted on the Scopus, Web of Science, and Google Scholar platforms. The main search was conducted in February 2025. We selected papers that met the following criteria.

- *Dates:* From year 2000 to nowadays
- *Language:* Available in English language
- *Methodology:* Relevant policy analyses, case studies, mitigation strategies, management solutions, methodologies, and risk analysis tools were included.
- *Study Setting:* Does the study focus on historic gardens, heritage landscapes, or cultural landscape sites (not modern or contemporary landscapes)?
- *Climate Change Focus:* Does the study examine both climate change impacts and management/adaptation responses for historic landscapes.
- *Professional Perspective:* Does the study involve or address the perspectives of conservation managers, landscape preservationists, or heritage site managers?
- *Practical Application:* Does the study describe practical risk assessment methods, adaptation strategies, or implemented management responses.
- *Landscape Elements:* Does the study address the preservation of outdoor historic landscape features (not exclusively building preservation)?
- *Study Type:* Is the study a case study, observational study, systematic review, or expert guideline with documented preservation strategies?

Secondly, for the data extraction phase, we asked a large language model to extract each data column from every paper. We provided the model with the extraction instructions listed below for each column.

Table 1. Data extraction instructions.

Study Type and Methodology	Geographic Location	Type of historic garden	Climate Change Risks Identified	Adaptation and Mitigation Strategies
Empirical research	Country	Specific garden	Temperature changes	
Case study	Region/city	landscape name	Precipitation patterns	Plant species selection
Policy analysis		botanical garden	Extreme weather events	Landscape modification

Theoretical/ conceptual paper	heritage landscape	Biodiversity impacts	Water management
		Landscape degradation	Conservation techniques

This was completed with a comprehensive analysis of case studies, empirical research, policy analyses, and theoretical papers, examining their approaches to risk assessment, mitigation strategies, and management solutions.

4. Results

4.1 Results for the Characteristics of Study Type and Methodology

The reviewed studies were conducted in diverse geographic locations, with a predominant focus on European sites (18 studies), followed by North America (6 studies), and limited representation from Australia, Africa, and the Asia-Pacific region.

Table 11. Characteristics of Study Type and Methodology.

Study Type	Geographic focus	Garden Type	Assessment method
Case study, Empirical research	Northern Australia	Heritage landscape	Risk analysis methodology
Theoretical/ conceptual paper	Global	Historic gardens	Literature review
Case study, Empirical research	Greece	Archaeological sites	Vulnerability assessment
Case study	USA (Virginia, Florida/Mississippi, California)	Cultural landscapes	Institutional analysis
Case study, Empirical research	USA (Gulf Coast, Virginia, California)	Cultural landscapes	Institutional analysis
Policy analysis	United Kingdom	Historic environment	Scoping study
Empirical research, Policy analysis	Not specified	Historic buildings, parks, gardens	Literature assessment, questionnaire, site visits
Case study, Empirical research	West Wales	Historic landscape	Vulnerability framework
Case study, Policy analysis	Melbourne, Australia	Botanical garden	Landscape Succession Strategy
Case study	Scottish Highlands, UK	Woodland gardens	No mention found
Case study, Policy analysis	Cornwall, UK	Managed landscape	Policy document analysis
Case study	United Kingdom	Heritage gardens	Interviews
Case study	Wales, Norway, Scotland	Historic places	Risk and vulnerability assessment
Empirical research	East Germany	Heritage landscape	Interviews, content analysis
Case study	Germany	Historic gardens	Interdisciplinary
Case study, Empirical research	Alberta, Canada	Living cultural landscape	Digital preservation, 3D modelling
Empirical research, Case study, Policy analysis	Ireland	Coastal archaeological sites	Coastal-zone assessments
Case study, Empirical research	Southwest Florida, USA	Cultural resources	Vulnerability assessment
Empirical research, Case study	Southeastern United States	Cultural resources	Analytic hierarchy process
Empirical research, Case study, Theoretical paper	Germany	Cultural heritage sites	Climate simulations
Policy analysis	Greece	Archaeological sites and monuments	Policy integration
Case study, Empirical research	Sweden	Heritage landscape	Climate change adaptation risk tool
Case study	Senegal	UNESCO World Heritage Site	Vulnerability and suitability analyses
Empirical research (Systematic review)	Asia-Pacific region	UNESCO World Heritage cultural properties	Systematic review of conservation reports
Case study	Multiple European countries	Cultural heritage sites	Risk assessment and management tool
Case study, Theoretical paper	Bratislava, Slovakia	Historic gardens and parks	No mention found
Theoretical/	United States	Cultural resources	Framework development Vulnerability assessment
Case study, Empirical research	Europe	UNESCO World	Vulnerability assessment

		Heritage Sites	
Policy analysis	United Kingdom	Heritage landscape	Policy review
Theoretical/ conceptual	Rome, Italy	Heritage landscape Archaeological parks	Policy

Based on our analysis of the included studies, we obtained the following results:

Study Types: Case studies were the most common type of study (21 studies), followed by empirical research (14). Policy analysis (7 studies) and theoretical/conceptual papers (5 studies) were also included in this review. One study was identified as a systematic review.

Geographic Focus: Most studies focused on Europe (18 studies), followed by North America (6 studies). We found two studies on Australia and one each for the Global, Africa, and Asia-Pacific regions. One study did not mention a specified geographic region in the available data.

Garden Types: The studies covered a diverse range of gardens and landscapes. The most frequently studied topics were historic gardens, heritage landscapes, and archaeological sites (four studies). Cultural landscapes, cultural resources, and World Heritage Sites were the focus of three studies each. We found two studies on cultural heritage sites, and various other types (e.g. botanical gardens and woodland gardens) were represented in individual studies.

Assessment Methods: Vulnerability assessment was the most common method (five studies), followed by risk and policy analyses (three studies). We found two studies that used historical analysis and mixed methods. Various other assessment methods have been used in individual studies, including literature reviews, institutional analyses, digital methods and climate simulations. For two studies, we did not find any mention of a specified assessment method in the available information.

4.2 Results for the Risk Assessment Frameworks

We then proceeded to analyse only the Risk Assessment Frameworks and selected the following:

Table III. Risk Assessment Frameworks.

Study	Assessment type	Key indicators	Implementation context	Outcomes
Carmichael et al., 2018	Risk analysis	Sea-level rise	Indigenous-	Community-scale
Cartalis, 2021	Vulnerability assessment	Heatwaves, floods, droughts, fires, sea level rise	UNESCO archaeological sites	Multi-criteria platform for risk assessment
Cook, 2019	Vulnerability framework	Sea-level rise, coastal erosion, flooding	Coastal historic landscapes	Landscape Vulnerability Framework
Hermann, 2017	Risk and vulnerability assessment	No mention found	Historic places in Northern Europe	Comparison of assessment methods
Kangas et al., 2024	Vulnerability assessment	Rising sea levels, flooding, storm surges, erosion	Cultural resources in coastal areas	Prioritization of sites for adaptation
Kibria et al., 2024	Analytic Hierarchy Process	No mention found	Cultural resources in coastal areas	Decision-making framework for adaptation
Kotova et al., 2023	Climate simulations	Extreme weather events, rising temperatures	Cultural heritage sites in Germany	Methodology for tailoring climate information
Ravankhah,2020	Risk assessment and management tool	No mention found	Cultural heritage sites in Europe	STORM Risk Assessment and Management Tool
Sesana	Vulnerability assessment	No mention found	UNESCO World Heritage Sites in Europe	Integrated vulnerability assessment methodology

The analysis of risk assessment frameworks reveals several key approaches to risk assessment.

The most common was vulnerability assessment, which was used in five of the studies. They typically consider multiple climate-related factors and their potential impacts on heritage sites. Three studies employed risk analysis methodologies, focusing on identifying and quantifying potential threats to cultural landscapes. Two studies [8, 9] developed decision-making tools and frameworks to aid in prioritising adaptation actions, such as the Analytic Hierarchy Process and climate simulations to tailor climate information for heritage site management.

5. Discussion

The literature review revealed significant challenges in managing heritage sites under the pressure of climate change, including institutional obstacles, limited resources, and complex decision-making processes. Recent research has increasingly emphasized the integration of traditional preservation methods with climate change adaptation strategies, highlighting the importance of balancing the maintenance of historical authenticity with the need for resilience. To address these issues, several innovative tools for risk assessment and management, such as the STORM Risk Assessment and Management Tool [10] and the Analytic Hierarchy Process [8] and incorporating climate change concerns into overarching heritage management frameworks through flexible, adaptive strategies. Further measures include implementing capacity-building initiatives—such as training programs and educational efforts targeting site managers and conservation staff—and developing sustainable financial models to support ongoing adaptation efforts.

For this approach to succeed, the following factors should be considered: i) interdisciplinary collaborations among conservationists, climate scientists, policymakers, and other experts; ii) the active engagement of local communities and inclusion of traditional knowledge holders in decision-making processes; iii) the development of flexible policy frameworks that accommodate climate considerations while upholding preservation principles; and iv) long-term planning that both addresses immediate threats and anticipates future climate scenarios.

Vulnerability assessments and risk analysis methodologies have become essential tools for identifying climate-related risks, while mitigation strategies now encompass both preventive measures and adaptation techniques, such as the selection of climate-resilient plants and the implementation of improved water management systems. In the context of historical gardens, the effective integration of climate change adaptation into management plans requires the establishment of clear management goals that prioritize the protection of key garden elements; comprehensive assessments of site-specific climate vulnerabilities; the development of targeted adaptation strategies based on those assessments; and the implementation of a clear action plan supported by ongoing monitoring and evaluation. Ultimately, conservation efforts must remain flexible and responsive over the long term to ensure the continued protection of heritage sites in the face of climate change.

6. Conclusion

The review concludes that there is no common adaptation strategy and that successful climate change adaptation in historic gardens requires a balanced approach that combines structured risk assessment, adaptive management strategies and stakeholder engagement. The findings emphasize the need for flexible, context-specific solutions that can evolve with an improved understanding of climate impacts while preserving heritage values.

Future management approaches must integrate traditional preservation principles with innovative adaptation strategies, supported by sustainable funding mechanisms and policy frameworks that facilitate long-term resilience. This research provides valuable insights for the elaboration of Management Plans by landscape architects and conservation professionals, highlighting the importance of a holistic and integrated approach to managing the impact of climate change on historic gardens and cultural landscapes.

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CEQUES IN INCA TIME IN CUZCO. CONTEMPORARY READING OF THE LANDSCAPE AS A SYSTEM

EVOLUTION OF HERITAGE LANDSCAPES

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Abstract

Pre-Hispanic civilizations have left numerous archaeological remains throughout America, which show interventions that shaped the landscape and territory for administrative, residential, sacred, or productive purposes. South America has many sites related to the last notable pre-Columbian civilization, the Inca State (15th and 16th centuries).

Within this framework, other vestiges coexist that range from their beginnings in pre-Inca times (before 1200 AD), passing through the Inca period (1200-1533 AD), the Inca-colonial transition (1533-1572 AD), and the subsequent evolutionary phases that lead to the current urban landscape.

This study focuses on Cuzco, the capital of the Inca State (Peru), based on colonial records from the 16th and 17th centuries. The sites examined show diverse settlement patterns within the territory and landscape, influenced by the varied geography crossed by the Andes. This study delves into the Ceque system of the Inca State, which served as a structure for the territory of Cuzco, the capital of Tahuantinsuyo.

The Ceque system is a radial network of 42 invisible lines. Although its abstract conformation could resemble the spokes of a wheel, its adaptation to geography means that the axes are not perfectly straight but related to existing elements (water courses, geographical features, roads).

The network extended approximately 10 or 15 kilometers around, starting from the center of the city, possibly from the vicinity of the Coricancha [temple of the sun], according to the chroniclers Bernabé Cobo and Cristóbal de Molina.

This way of organizing space was related to the various areas of the life of the *ayllus* and *panacas*, mainly in terms of their distribution in the territory, tenancy, and production, the care and maintenance of canals, land, and the presence and care of sacred elements or enclosures called *huacas*.

Therefore, various aspects such as the social, symbolic, infrastructure, productive, and territorial structure were interconnected.

It is relevant to keep in mind that the central starting point of this system coincided with the point of origin of the division of the Inca State into four regions or, in addition, with the point of origin of the four main royal roads—towards the four regions—that made up the Qhapac Ñan network.

The reasons for the existence of the ceque system seem to be primarily of a religious and sacred nature, understanding that the Inca State was governed by the Sapa Inca (the son of the Sun god), having the divine mandate to bring order and civilization to the rest of men.

The relevance of this endeavor is to understand the current Andean territory through a contemporary lens. Despite the extensive research on ceques within archeology and history, there is still the opportunity to analyze them from a spatial and landscape perspective, considering them as a model of territorial organization. Its purpose is to interpret them within their spatial and landscape framework and to inspire possible applications in contemporary rural environments or as strategies for territorial planning, such as irrigation management and agricultural organizations.

1. Introduction

The Ceque System during the Inca period was an exercise in territorial and political organization, considering the unique and theocratic power held by the Sapa Inca (governor). Although the Inca state lasted just over a hundred years—between the 15th and 16th centuries—it came to dominate an area of approximately two and a half million square kilometers, encompassing parts of modern Ecuador, Colombia, Peru, Bolivia, Argentina, and Chile. Furthermore, the different cultures adhering to the Inca state spoke different languages, had different deities, cultural traditions, and even distinct trades; one could imagine a Babel of Wari, Tiahuanaco, Huanca, Chanca, Colla, and Chincha populations, among many others.

It would have been impossible to domesticate a territory with such characteristics without a strategy of political-territorial intelligence that could dominate, unite, and connect such a vast and varied geography. The network of royal roads—Qhapaq Ñan—was fundamental to achieving these goals, in addition to the systems of political negotiation, infrastructure organization, and productive, religious, and social affairs, where the ceque system played a fundamental role. In the absence of a writing system (no evidence exists to date), it is also proposed that this system was a way of "writing in the territory," allowing the Sapa Inca to govern a vast territory as a tool to bring their subjects together.

2. Information on materials and methods

The methodology deals with a discursive analysis of primary colonial chronicles from the 17th century, juxtaposed with studies conducted by scholars Tom Zuidema (Inca calendar, royal lineages), Brian Bauer (organization of *huacas* -sacred places- in physical space), Jeanette Sherbondy (lineages, and water canals), and Donato Amado (lineages, and roads).

We have worked with archaeological technical reports from the Ministry of Culture of Peru, the Decentralized Directorate of Cusco, and the Qhapaq Ñan (Inca Trail) project, thus using data from the Inca-era vestiges found within the ceque system. The objective is to identify landscape and architectural settlement patterns that can be adapted to contemporary contexts.

The archaeological sites reviewed present diverse settlement logics within the territory and specific ways of constructing landscapes determined by a diverse geography crossed by the Andes Mountain Range. However, writing did not exist during the Inca period, and primary information was scarce. In most cases, it is the product of studies based on the legacy of colonial chroniclers and modern archaeological excavations and research, which often decontextualize the findings from their space and territory to study them in a specific way.

2.1. State of the Art

The Inca State, also known as the Tahuantinsuyu Empire, flourished in South America during the 15th and 16th centuries under Pachacutec Inca Yupanqui, the ninth Inca governor or Sapa Inca.
The city of Cuzco is in the southeastern Peruvian Andes, within the central region of the Department of Cuzco. It lies 3,555 meters above sea level and belongs to the Quechua ecological zone, which ranges between 2,500 and 3,500 meters above sea level. It was the capital and nerve center of the Inca Empire. The city's layout was defined by roads leading to four regions, with urban development radiating outward from its core. The city was divided into Hanan (upper Cuzco) and Hurin (lower Cuzco).



Red vial Inca propuesto por John Hyslop 1992

Figure 1. Map of the Inca Trail according to J. Hyslop. National Institute of Culture of Peru (1992).

The road system was an essential element of urban design. The network of pre-Hispanic roads, such as the Royal Road, the Inca Road, and the Qhapaq Ñan, demonstrated the city's strategic organization. The Aucaypata esplanade, in the center of Cuzco, was the focal point of this road network.

Pachacutec, a visionary and strategic planner, reigned from 1438 to 1471 AD. He transformed the small town into a planned metropolis, diverting rivers to prevent flooding. He successfully united several kingdoms and states in the Andean region, with Cuzco as its focal point.

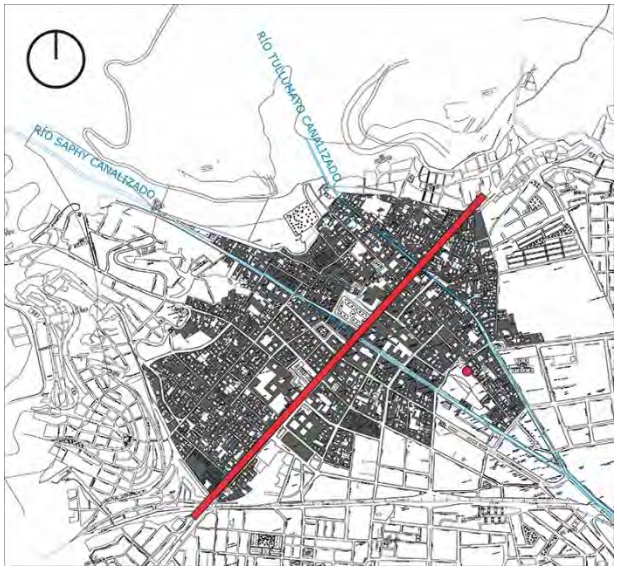


Figure 2. The current map of Cusco with the bipartition line and the possible starting point of the Ceque System are shown in red. It is based on the cadastral map of the Municipality of Cusco.

The Quechua name Tahuantinsuyo, derived from "Tawa" (four) and "suyu" (region), reflects its division into Chinchasuyo (north), Contisuyo (west), Collasuyo (south), and Antisuyo (east), hence its name as the Empire of the Four Regions. From the Ancasmayo River in the north (present-day Colombia) to the Maule River in the south (present-day Chile) and eastward to the Gran Chaco region of the Amazon. Its western border was the Pacific Ocean, encompassing territories now part of Argentina, Bolivia, and Ecuador.

Spaniard colonization led by Francisco Pizarro began in 1532, and both power structures coexisted for more than a century.

A review of the literature and the construction of the state-of-the-art have allowed us to find data linking the ceques to the following areas: hydrology, topography, production, roads, and communication, infrastructure, politics, and government, distribution of lineages in the territory, and the network of sacred spaces. All of this is based on a review of colonial chronicles and the positions of the most prominent contemporary researchers: Donato Amado (2011) on the road system and lineages; irrigation ditches, proposed by Jeanette Sherbondy (1986) and studied by José Alejandro Beltrán Caballero (2013); and geographical and territorial relationships proposed by Brian Bauer (2000, 2023). Fernández & Fernández (2021), Franco (2017), and Donato Amado have worked on the Inca roads and the Chakan micro-basin area for over ten years. Archaeological excavations have been carried out and are recorded in the documents of the Ministry of Culture of Cusco by Carranza (2012), Durand (2010), Esenarro (2008), and Rodríguez (2004 and 2009).

2.2. Previous Studies on the Ceques in Cusco

The ceques comprised 42 radial lines of sanctuaries (*huacas*) and even spaces that housed critical historical events. This system adapted to geography with a relatively regular geometric radial layout.

Invisible to the naked eye, they linked the empire's territory with its center and organized the people living in the vicinity of each ceque from a social, infrastructural, administrative, productive, communication, and sacred representation perspective. Although their origin is near the Coricancha (Temple of the Sun), due to its proximity to Aucaypata, they could refer to the same urban context.

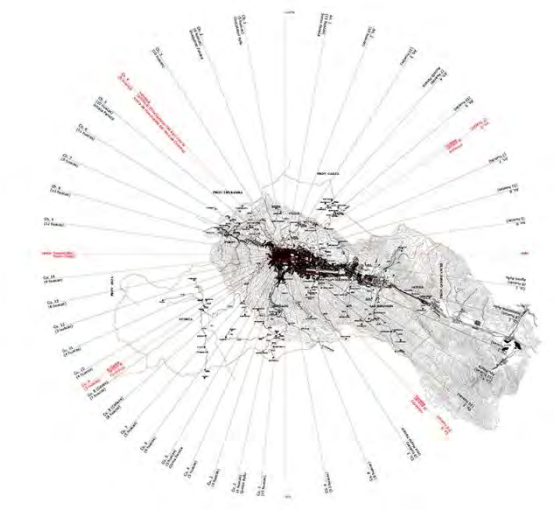


Figure 3. Ceque system and province of Cuzco. Based on: Bauer, Brian S. *The Sacred Space of the Incas*. Cuzco: Centro de Estudios Regionales Andinos Bartolomé de las Casas, 2000.

As shown in Figure 3, based on Brian Bauer's studies, there were four *suyos* or regions: 41 *ceques* (Zuidema), 42 *ceques* (Bauer), and 328 *huacas* or sacred places spread across the 41 *ceques*. Ninety-six are springs or water sources (29%); 95 are intervened rock outcrops (29%); 32 are hills and mountain passes (10%); 28 are palaces of Inca kings and temples (9%); 28 are fields and flat places (9%); 10 are graves (3%); 7 are ravines (2%); 3 are caves (1%); 3 are quarries (1%); 3 are stone seats or chairs (1%); 3 are *sucancas* or sunset markers (1%); 2 are trees (1%); 2 are roads (1%).

3. Results. The case of the Ceques in the northwest area of Cuzco (Hanan Cuzco)

According to verified literature, the Chinchaysuyo and Antisuyo ceques have a significant number of archaeological investigations to support an architectural and landscape interpretation study (Bauer, Sherbondy, Amado, Beltrán-Caballero, Ortega, Guardapuclla & Delgado). This sector—and the nearby roads—was chosen because it supports the hypothesis that the ceque system functions as a territorial planning network.

The three micro-basins in the study area originate at the highest point within the present-day Sacsayhuaman archaeological park, descending through three micro-ravines whose waters reach the center of the present-day city of Cusco. Of the three micro-basins, the central one, Chakan, contained sacred waters that irrigated the holy gardens of Coricancha. That is, waters from the Hanan (upper) Cuzco River irrigated the lands of Hurin (lower) Cuzco, a fact that reinforces the ritual path and canal hypothesis proposed by Amado (2011).

Another key reason for selecting the case study was the connection between Sacsayhuaman, where the sun temple of the Hanan-Cuzco dynasties (military and planning Incas) was located, and Coricancha, the sun temple of the early Hurin-Cuzco dynasties (mythical or sacred Incas). Furthermore, Pachacutec's royal *panaca* (royal lineages) and the special buildings he ordered erected were in this sector, at the confluence of the Chinchaysuyo and Antisuyo roads and ceques. Within the Chakan River micro-basin, 17 archaeological sites have been identified, of which five have been partially studied, although it is believed that there may be as many as 50. A group of archaeological sites located under the undergrowth and in areas difficult to access due to the depth of the ravine remain to be discovered.



Figure 4. Negruyoc archaeological site -huaca-, Chakan River micro-basin. Image by the author (2025).

3.1. Ritual Roads of Hanan Cuzco:
During Pachacutec's reign, the roads to the Chinchaysuyo and Antisuyo regions were consolidated. These roads originated from Coricancha—the sun

temple of the Inca dynasty of Hurin Cuzco—and headed northwest to the site of Sacsayhuaman, where the sun temple of the Inca dynasty of Hanan Cuzco was located. Roads are often associated with natural waterways, ditches, canals, fountains, springs, and small lagoons, just as the streets and ceques adapted to the topography. They are also associated with cultivation terraces—called *andenes*—some used for soil stabilization and others for agricultural production.

Tahuantinsuyo urban planning began in the Imperial City of Cuzco. The roads to the *Suyos* (Four Suyos) originated from its center, which was configured around four main longitudinal roads and six transversal roads connected to the major roads.

For Santiago Agurto (1979), the planning of the city of Cuzco had an agricultural-religious inspiration, and its layout adapted to the topography it encountered. In that sense, designing "in and with the topography," incorporating traces of nature, is one of the wisest lessons we can learn from pre-Hispanic urban planning. Considering Santiago Agurto's observations, the existence of *huacas* integrated into the city's fabric and the rest of the territory also corresponds to the ancestral relationship with the landscape and the Andean worldview, based on the belief that elements of nature were animated, respected, and worshipped, as they were considered divinities. This researcher maintains that "[t]his attitude, based on animism, a deeply rooted belief among the Inca, required respect for rocks, springs, trees, etc. since the 'eyes of things' constantly monitored human behavior" (Agurto, 1979, p. 141).

Donato Amado (2011) referred to the organization and value of sacred spaces, buildings and objects, geographical features, waterways, rock outcrops, and other elements that were located linearly, "…ordering the geographic and visual space with a specific orientation. Along each ceque, a variable number of ceremonial sites were connected by a system of trails or ritual roads, whose starting point was the Coricancha or Temple of the Sun" (Amado, 2011, p. 41).

3.2. Ceques and huacas of Hanan Cuzco, within the Chakan ravine area:
According to chronicler Bernabé Cobo (1653), the road to Antisuyo (Road to the Andes) would be linked to the seventh *huaca* of the first ceque of Chinchaysuyo, which could have coincided with the house of Amaru Inca Yupanqui (tenth Sapa Inca).

These huacas, or sacred sites, were interrelated. Having explored the micro-basin on foot in mid-2025, we obtained clear evidence of the visual and spatial relationships between the archaeological sites. This work is intended to be further explored with drone flights—towards the end of 2025—and planned for publication in 2026.

3.3. Ceques, *panacas (royal lineages)*, and *ayllus (family groups)* of the Chakan River micro-basin:
Ayllu Patallaqta was the family group linked to the Sapa Inca Pachacutec. This area belonged to the first ceque of Chinchaysuyo, where the house and, later, the mausoleum of this governor were located—the boundary between the regions of Chinchaysuyo and Antisuyo. Bauer (2000) considers it the tenth huaca of the first ceque, also the area where Pachacutec lived.



Figure 5. Huacas within the ceques of the case study. Image by the author from Google Earth, 2025.

3.4. Ceques and hydraulic systems:
Regarding hydraulic systems, the two authors agree on several points. In the case of Jeanette Sherbondy (2017), she detects a strong relationship between the water system and irrigation management with the ceques.
Brian S. Bauer agrees with Sherbondy's (1982, 1982 b) perspective, indicating that traditionally in the Andes, *ayllus* were linked to a water source, be it a

canal, spring, lake, or river (*huaca*) because their ancestors had emerged from them. Therefore, it was an inalienable and non-transferable lineage, from the right to use the water and the right to irrigate their lands. Land and water were a territorial unit: "the right to worship a source and the right to use the water that emanates from it go together," says Bauer. Sherbondy and Bauer agree that this type of administration continues today.

3.5. On the production of the Chakan River micro-basin during Inca times:
Bauer (2008) mentions that Kallachaca was a sector controlled by royal panacas who held land. He found remains of food stores near the present-day San Sebastián sector on the northwest slope of the Cuzco Valley. There were possibly more than thirty stores (*colcas*). Kallachaca was considered an important nature reserve and possessed many trees.

4. Discussion

The Inca state was fundamentally military and political—as well as theocratic—that is, for the Sapa Inca, the most important thing was to have control of the territory, the people who inhabited it, and the qualitative and quantitative information handled—through their circle of trust—because this way they were also able to collect tributes and keep their people working without disrupting the political, administrative, and social order. However, a latent question remains before our contemporary eyes: How did they manage to dominate such a large expanse of territory and such diverse culturally attached peoples?

Geographer Jorge Oleína (2017) refers to the Tahuantinsuyu, based on the chronicles of Inca Garcilaso de la Vega, as a "theocracy with natural roots," and perhaps this is one of the key points for understanding the importance of territorial management and its physical reality. The ruling caste's ability to control, manage, and connect people with the space they needed to maintain and domesticate is remarkable in the absence of written language, and the evidence available to date regarding quipus—as a phonetic or writing system—is still insufficiently conclusive.

Chronicler Inca Garcilaso de la Vega referred to the organization of geographic space through land ownership, the geography of food, the exploitation of mineral resources, the geography of transportation, and the organization of urban areas. He also referred to the mountain range, coasts, climate, lakes, rivers, fauna, vegetation, and mineral resources. On the other hand, he also refers to the physical integration of new peoples, where spatial planning was fundamental.

5. Conclusions

Although this work is still in progress, we can infer that the Inca Ceque System, based on the references consulted and compared, both from 16th and 17th-century chroniclers and scholars primarily in the fields of anthropology, archaeology, history, and ethnography from the 20th and 21st centuries, encompasses territorial organization, which incorporates the exercise of power, the productivity, and organization of labor, water management, communication systems, and the distribution and organization of lineages.

The ceque system had several scales of intervention: architectural, landscape, and territorial, and a model that was not only applied to Cusco as the center of the Inca state but also served as a model of political control in a vast territory for just over a hundred years, until the arrival of the Spaniards.

The area between the Ukuku, Chakan, and Cachimayo micro-basins (Chinchaysuyo and Antisuyo) allows us to compare the data obtained from archaeological excavations and research with the hypothesis, particularly based on the work of the Decentralized Directorate of Culture of Cusco carried out on the Ñustapakana-Coricancha ritual path and the subsequent publication of the book of the same name in 2025.

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RESERVOIR LANDSCAPES: SPACE, MEANING, AND CLIMATE ANXIETY WITHIN HISTORIC WATERSCAPES

Guiding territories with legislative and social advances in planning: Evolution of heritage landscapes

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Abstract

Although primarily recognised for their most evident components at water impounding sites, reservoirs within the UK have figured prominently across wider rural and urban areas since at least the late 18th century. Initially constructed to feed canal networks in the early industrial period and before the emergence of railways, water impounding schemes extended via aqueduct lines into industrial metropolises to transform living standards, modes of production, and ultimately open spaces of Britain's cities in a direct display of the underlying concerns of health, economy, and a rapidly changing public life. Planning of large-scale water schemes continues into the present, but many of the earliest reservoirs remain part of the water supply system in the UK and of the historic environment. Apart from current anxieties around water security against ongoing and anticipated droughts, reservoirs play a role in mitigating flood risk as well, whereas recent policy reports have put the historic stock of these landscapes into a discourse on disuse and efficiency. Reservoirs are dynamic landscapes, offering uses beyond the primary one, and their continued function in water supply, coupled with the extensiveness of the networks and the novel set of conservation challenges faced, requires a rethinking of what reservoir landscapes offer in terms of the history of societies' interaction with the natural environment. The notion of cultural landscapes provides several clues on how to approach a complex site (series) whereby the questions of resource management, diachronic space, as well as spatial dynamics, are yet to be addressed in the context of reservoir construction within both cities and river valleys. Water impounding systems are epitomes of cultural landscape as expressions of an evolving relationship with scarcity and supply, and are therefore catalysts of change, both positive and less so. Whilst having revolutionised people's access and right to clean drinking water, as well as facilitated industrial development alongside other resources for more than two centuries, reservoirs have not always been a symbol of progress – indeed, schemes put forward by the city of Manchester towards the water-rich area of the Lake District in the late 19th century, altogether led to some of early environmental movements and to a rethinking of water access for communities along main water distribution lines. As reservoirs have additionally given rise to new ecosystems locally, the re-evaluation of their documentary value is timely in an era in which the extensive water bodies are subject to inevitable political, environmental and social scrutiny. How these issues have been translated into reservoir projects historically and the way they have negotiated environmental challenges over time may help resituate them within ongoing discussions on both natural and manmade waterscapes.

Text

1. Introduction

Water impounding structures, together with distribution components in the form of conduits and service facilities, constitute only part of the reservoir equation: local topography, watershed, weather patterns and underlying geology altogether act as the natural agents in both design and process flow of water supply systems. As a marked presence in the British landscape since the late 18th century, reservoirs in the modern sense have acted as depositories of a radically changed and an evolving relationship with the environment: instead of the previous reliance on seasonally fluctuating

river flows, water impounding schemes led to a renegotiated attitude towards resources, now artificially manipulated for constant and predictable supply. Pre-empting and controlling droughts being the main reason of reservoir construction, provision of water on industrial scale introduced administrative, economic and engineering standards following newly emerging trends in water consumption and forecast supply. In addition to the varied domains, standards in managing water materialised at multiple scales as well, as reservoir infrastructure affected design of building stock and city planning subject to sanitary standards in parallel with improved access to water.

Advancement of water industry positioned the city as, although not sole, a major agent in reservoir development, as attested by Manchester's successive adaptation of nearby and more distant natural landscapes for securing supplies during industrial and modern periods. Upon the completion of the Longdendale scheme in the city's vicinity in the mid-1800s, it was soon evident that additional resources would be necessary in the near future, eventually resulting in the conversion of Thirlmere in the Lake District into a reservoir by the end of the century. With urban areas locked into managed hydrological systems, even droughts would at times turn out to be at least partially a consequence of altered supply and consumption trends[1]. However, current anxieties surrounding recent and expected stresses to water cycles invite questions on what the existing stock of reservoirs across the UK, virtually all of them of historic character, hold in terms of previous understanding of natural capacities, and of approaches to negotiating these within designed space.

Data on other types of environmental change brought about by reservoirs are also discernible in the form of replaced or recreated ecologies. The latter are detectable within several examples of discontinued water-impounding schemes, whereas future changes to reservoirs are subject to environmental guidelines on draining or repurposing reservoirs[2].
The extensive character of water supply systems altogether – the impounding site, aqueduct routes, and distribution and service reservoirs – as such anticipate an approach to the infrastructure as landscapes holding documentary evidence on the history of human-water relations in the UK and elsewhere.

2. Defining values

Reservoirs in their industrial form, and as a phenomenon of the modern era, are hardly an expression of sustainable interaction with land, or of an intimate, local connection to space considered common to cultural landscapes. Despite water provision being the main aim of reservoir construction, the displacement of communities and submerging of historic settlements were not infrequent within the execution of reservoir schemes, whereas city-led commodification of natural areas has often raised questions on hierarchy in ownership and access to both water supplies and to land itself. In cultural terms, landscapes representative of other historic industries have been subject to more extensive research and designation, with several sites in the UK such as the Blaenavon Industrial Landscape and the Derwent Valley Mills included on the World Heritage list. The intrusive character of manmade lakes, and the history of local opposition to reservoir projects have as such obscured a more thorough analysis of spatial and intangible implications of their construction.

Approaching reservoirs as a medium between natural and artificial water cycles brings into discourse a number of cultural landscape notions, with resource management translating into systems designed to manage and predict excess and surplus in water supply. Secondly, reservoir schemes have at times been executed as phased projects, or have been subject to change in site perimeter or discontinuation, as an expression of layered, diachronic systems evocative of other industrial landscapes. Lastly, reservoir infrastructure went on to introduce new spatial dynamics among end users of water supply within an extended economic hierarchy of urban-ness.

3. Reservoir dynamics

Development of water infrastructure on industrial scale has manifested in evolving attempts at negotiating hydrological with urban systems. The successive execution of reservoir projects by the Manchester Corporation Waterworks (1848 - 1971) in the Longdendale Valley and the Lake District ran in parallel with increasing demand in the city upon existing water resources and those potentially available in the future: following the first yield of the Longdendale scheme in 1851, it was concluded that the supplies against the growing local demand would be insufficient within several years' time[3]. Ensuing inquiries into conditions at

Thirlmere showed markedly more robust yield potential of the Lakeland site in comparison to the existing one at Longdendale, extractable within a smaller drainage area.

Despite fierce local opposition on aesthetic grounds, the completion of the Thirlmere scheme saw rural communities along the aqueduct and towns surrounding Manchester becoming enmeshed within a hierarchy of resource provision gravitating around the city as seat of an extended administered waterscape. Today part of the Greater Manchester area, the town of Oldham submitted a public appeal for reassessment of its access to Thirlmere aqueduct in 1920[4], as Manchester Corporation Waterworks exceeded its local per capita provision from both Longdendale and Lake District supplies at the cost of nearby townships. Discrepancy in provision would occur in communities further up the supply chain, and even in the more recent 1976 drought, places directly linked to the aqueduct ended up being markedly less affected than towns in Manchester's immediate surroundings (Taylor et al., 2009). Conduit-based provision could also lead to an inverted waterflow: reduced consumption during the 1930s economic depression led to the flooding of certain areas close to Thirlmere[5].

Municipal administration of water and the initiation of reservoir projects represented part of an evolving legal landscape as well. Although Victorian-era schemes such as that of Thirlmere required parliamentary approval and were marked by petitions from dissatisfied locals, the 200-year long period of reservoir construction in the UK is reflective of shifting approaches to comprehensive administration of water. The Water Act of 1973 formalised water responsibilities in a breakthrough policy, before being cut short by the wide-scale privatisation during the 1980s. While the short-lived period of centralised water administration managed to encompass water supply, flood control and some aspects of effluence disposal under ten regional authorities in England and Wales, the preceding and subsequent periods are characterised by commodifying approaches to water, with reservoirs sitting at the intersection of administrative dynamics. Although the legal provisions of the 1973 Act did not lead to the consolidation of each environmental, economic and social aspect of water management, and as a reflection of one hydrological reality, approaches to the same issue at present are marked by a distinct separation of environmental dimensions of reservoirs between the public Environment Agency and the commercialised supply on behalf of private water undertakers.

In addition to negotiating the social and economic dimensions of water, reservoir infrastructure has also led to lasting environmental change locally. Ecologies within places already significantly impacted by human activity, such as suburban areas accommodating service reservoirs, saw the development of habitats of high scientific value as a byproduct of new water surfaces; successively developed from the mid-19th century and into the postwar period, the chain of 13 reservoirs in the Lee Valley within Greater London is a Site of Special Scientific Interest, whereas reservoirs away from built up areas are part of functioning, albeit modified ecosystems and are integral elements of managing sites with natural designation.

A handful of cases of discontinued water schemes, on the other hand, provide clues for the extents of post-reservoir environmental restoration, not considered to necessarily lead to improvement in ecosystems compared to those of active reservoirs (Atyeo, M. et al., 2024). These include sites of historic incidents at dams and ancillary structures, where the eventual closure of reservoirs has resulted in a reversion to previous landscape agents, albeit with the added effects of temporary water impounding on site. In addition to these conditions providing opportunity for research on alluvial behaviour and habitat health, environmental engineering at former reservoir sites may be necessary for re-establishing local ecosystems [6] [7]. In the case of discontinued flood-control schemes, long-term hydrological monitoring may also be required for the safety of areas downstream (Atyeo, M. et al., 2004). Drained reservoirs have also been appropriated as areas for development, and went on to be claimed by already established urban tissues in the vicinity as opposed to a more nature-bound trajectory of impounding schemes in river valleys. Two discontinued service reservoirs in Prestwich within Greater Manchester, originally designed as part of the Victorian-era projects, are nowadays detectable in the outline of building blocks on site.

Introduction of new vegetation at reservoir sites has also represented an important component in the design. Planned both as visitor amenity and as a provision for maintaining site conditions, afforestation, or limits thereof, has featured prominently in reservoir debates since well before their iterations in the modern period. Although conversations surrounding woodlands within

earlier reservoir projects centred predominantly on their aesthetic impact, 20th-century approaches to the issue went on to consider the effects of tree mass on preventing erosion, and on controlling sediment and water supply stability within the reservoir; these have been recognised in parallel with the economic value of timber industry, which in the case of reservoirs in the Derwent Valley also gained prominence as a provision justifying the productivity of reservoir grounds[8].

4. Conclusion

Early opposition to reservoir construction in the UK made evident the concerns surrounding landscape protection and inequality in water supply. The introduction of artificial water bodies into urban and rural geographies has been marked by the complementing of natural water cycles with that of a manmade, and administered hydrology. A system tapping into its natural counterpart imposed the tendencies of wider built and economic landscapes enabled by new standards of water provision, but also of an updated understanding of drought and flood control, occurring naturally only to a certain extent. Manmade waterscapes at present are the result of an accumulated engineering prowess, socio-economic aims, and of successive breakthroughs and shortcomings in understanding environmental capacities. The latter may very well prove as the most substantial challenge in approaching water management, as the climate crisis continues to put pressure on both historic reservoirs in the UK and on the planning of new ones[9].

Despite the urgency surrounding water security at present, attitudes to developing and managing reservoirs throughout the 19th and 20th centuries are not entirely unrelated to anxieties caused by unprecedented conditions at present. Fragmented approach to different aspects of water management is reflective of a longstanding nature-culture divide – not least so within the consolidation of a dual hydrology of manmade reservoir systems and the natural cycles they are embedded in.

Incidental outcomes of reservoir construction on the existing, and the creation of new ecosystems within both natural and built up areas are likewise considerable. The continued presence of historic water schemes are thus of interest in the design and execution of anticipated reservoir projects, whereby both hydrological and ecological processes at existing sites may yield information valuable for the design of future water resources.

Although not as immediately prominent as other industrial landscapes, reservoir infrastructure is a primary conduit of a built metabolism which, although centring on the city, is ultimately enabled by hydrological realities managed through a technical interim. Understanding the extent of environmental data deposited in reservoirs as systems historically accommodating both the perceived capacities of nature and the exponentially increasing demands upon it may very well add to pressing debates surrounding attitudes to the environment at present – and to the cultural significance of these systems as well.

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THE "CHAMELEON CHALLENGE" OF THE ROCHE DE SOLUTRÉ

Guiding territories with legislative and social advances in planning: Evolution of heritage landscapes

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Keywords: limestone, waterways, rainmanagement, thrifty, panorama



Figure 1. A large view over the iconic "Roche"

The Roche de Solutré is a memorable site, marked with the print of History. This limestone escarpment embodies a certain blink over French culture. Of course it dominates the well-known Burgundy wineyard, but it also carries the weight of the past, as it's been an frequented by humans for centuries. Even during Prehistory times, people would hunt horses to the top of its cliff. Until the year he died, former French president Mitterrand would climb the Roche every year, making it a little political ritual of his.

Nowadays, the site, welcomes about 150 000 visitors each year. Neighboring infrastructures needed a refreshment, so as to be integrated to the landscape. This is why **arpentère** studio has been charged of developing several areas surrounding the Roche, from the relocation of its parking lots to the upgrading of the walking promenades that leads to its top. The idea was to help visitors take a step back from the site in order to gain perspective. Discretion has been our main tool: that is to say enhancing the existing qualities of this site goes through melting into them, as a chameleon would do. In other words, and as the beauty of the Roche speaks for itself, **arpentère**'s work has privileged sobriety, a study of local patterns, as well as an in-depth reflection on panoramas.

A thrifty conception of the project has been implemented. This doesn't mean we chose to lower our standards, but rather to adapt our strategy to environmental and esthetic requirements. The aim was to embrace existing features, and to work with local materials. Mineral and vegetal resources of the region served as a basic palette: a cover of indigenous plants punctuates the area, limestone blocks from a local quarry are used as large paving stones, sand from the Saône River cover the parking lots and some trails, acacia vineyard stakes are used both as tables and as benches, always oriented towards the majestic panorama that offers the Roche. On another hand, soil sealing has been kept to a minimum.

Widespread weed control in wine-growing plots usually leads to severe soil erosion that prevents rainwater from being captured. Here, collection and canalization of these floods has been a major issue we answered to by settling waterways and ditches all along the paths. As for light rainfalls, they will naturally infiltrate thanks to the dense planting on site. The mass of the latter, reinforced with new hedges and trees, hide cars on the parking, no matter the season.

After the rain always comes the sun, and with it, bright views over the Roche and the surrounding countryside. The Voie Romaine, or Roman path, has been thought to prioritize pedestrian accessibility, and it swiftly connects parking lots to the bottom of the Roche, with multiple scenic stops along the way. All this encourages to enjoy this unique geological monument through different angles, and to take time. After all, this big rock is older than mankind!



Figure 2. The high « chaintre » agricultural road



Figure 3. The terrace, a key stop for pedestrians, offers a panorama upon the Saône valley



Figure 4. The area is surrounded by a multitude of vineyards

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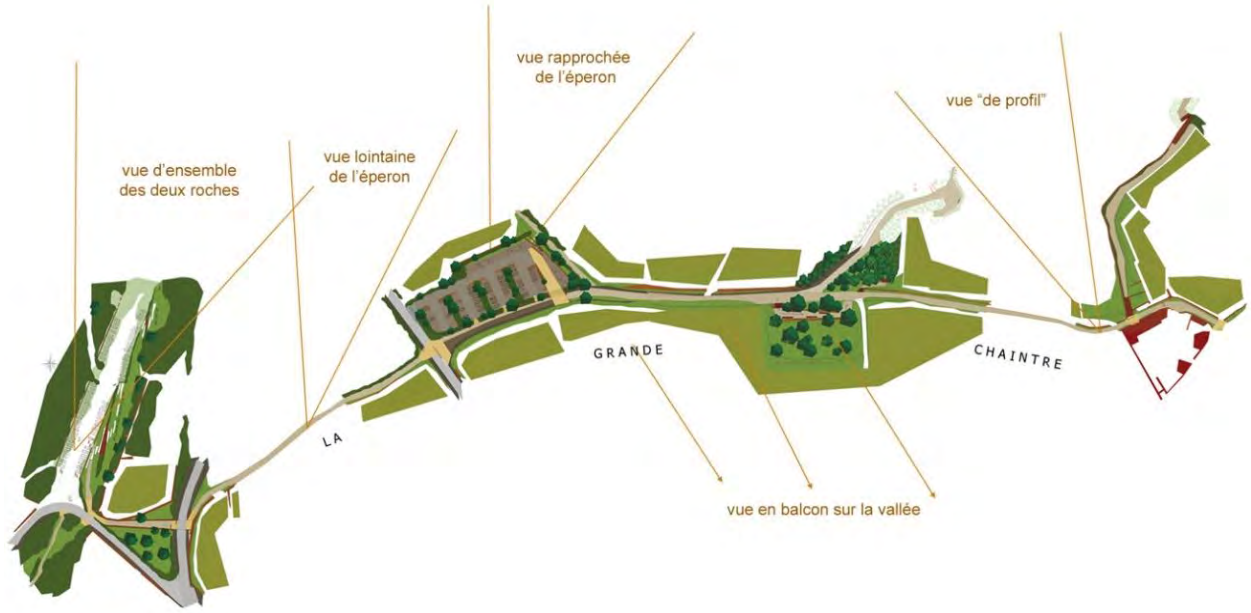


Figure 5. Scenic trails were incremented into the greater landscape, in order to encourage exploration through walking

Acknowledgments
Syndicat mixte pour la valorisation du Grand Site, photos © Vincent Rieusset

THE EVOLUTIONARY CONSERVATION OF THE CULTURAL LANDSCAPE THROUGH FIRE ECOLOGY: A LANDSCAPE STRATEGY FOR WILDFIRE RISK MANAGEMENT IN ISCHIA

TOPIC: Guiding territories with legislative and social advances in planning: Evolution of heritage landscapes

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Keywords: Evolutionary conservation, Landscape-based strategy, Fire ecology, Wildfire risk management, Ischia Island.

Abstract
The progressive abandonment of the terraced vineyard landscape of the Island of Ischia—historically shaped through the art of dry-stone walling (parracine)—significantly contributes to the increasing wildfire risk across the island's territory. These landscapes, recognized as UNESCO Intangible Cultural Heritage since 2018, exemplify an "organically evolved landscape," born of a deep interrelationship between humans and nature, and already acknowledged as essential in preventing landslides, soil erosion, and biodiversity loss.

This paper proposes an adaptive and ecologically responsive wildfire risk reduction strategy for Ischia, grounded in a renewed interpretation of the heritage values of the local cultural landscape, aligned with the island's current socio-economic context. The proposed approach moves beyond the traditional concept of conservation as a return to an original state, instead promoting an evolutionary, dynamic perspective aimed at enhancing the resilience of both territories and local communities.
In the case of Ischia, adopting the cultural landscape perspective in wildfire risk management has enabled the development of a more systemic and integrated vision of the territory—one capable of addressing multiple challenges and contributing fresh insights to the broader discourse on the aims, objectives, and innovative tools for adaptive conservation of cultural landscapes.

The paper is structured in four sections: the first (Introduction) outlines the interactions in Ischia between climate change, cultural landscape abandonment, and wildfire risk; the second (Materials and Methods) presents the methodology developed to construct the landscape strategy and the main design-research activities involved; the third (Results) describes the key features of the strategy; and the fourth (Conclusions and Discussion) highlights some of the advantages brought by the proposed landscape approach compared to the current wildfire governance system. These considerations are believed to be generalizable to other contexts and types of risk, making them relevant to the ongoing evolution of regulatory frameworks and tools for heritage conservation.

1. Introduction

In Ischia, in the heart of the Mediterranean Sea, the abandonment of the cultural landscape of parracine interacts with the ongoing effects of climate change, significantly increasing the island's territorial vulnerability—particularly in relation to the growing wildfire risk [1].

Ischia is located at the center of the Mediterranean basin, one of the world's major climate change hotspots [2]. Rising temperatures and decreasing rainfall, especially in summer, make this area particularly vulnerable to desertification, water scarcity, and consequently, wildfires. As is well known, the water stress experienced by vegetation during increasingly prolonged and intense heatwaves not only raises the probability of wildfires but also affects their duration, extent, and modes of spread [3]. While the past six years have seen the highest number of extreme wildfires globally, in the Mediterranean alone their frequency has increased tenfold over the same period [4]. Ischia, too, is witnessing a steady rise in the frequency of large fires. Between 2010 and today, the western slope of Mount Epomeo—the island's main peak—has been repeatedly scorched during the summers of 2011, 2015, 2017, 2021, 2022, and 2023 (Figure 1).

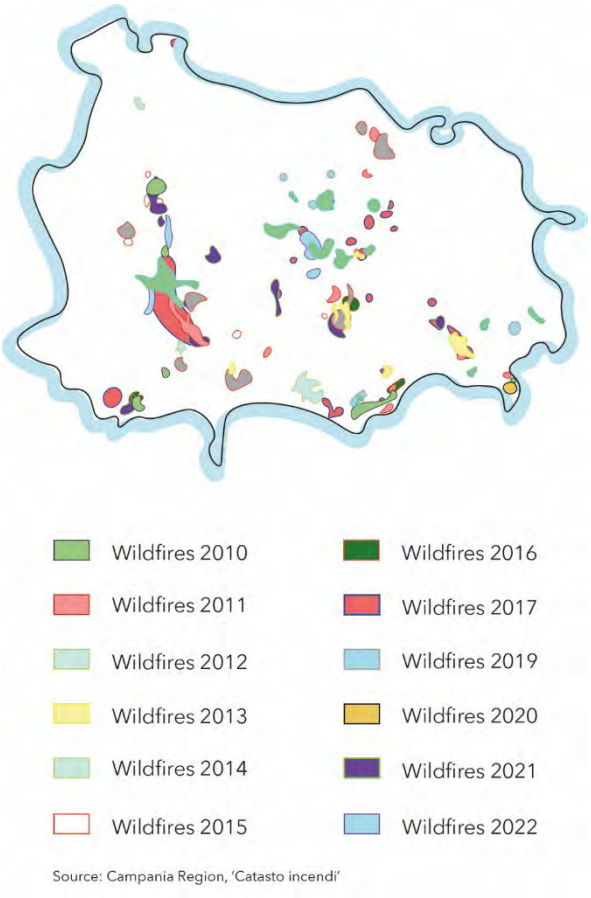


Figure 1. Map of recent wildfires in Ischia.

Within this already concerning context, the abandonment of resilient mosaic cultural landscapes has been identified as one of the key human factors increasing the likelihood that fire ignitions will coincide with extreme weather events [5]. There are two main reasons for this: first, the vegetation biomass that grows in formerly cultivated lands becomes more flammable over time; second, the lack of maintenance in these areas, coupled with the reduction in the diversity and complexity of elements that once characterized the original mosaic landscape, facilitates the rapid spread of fire. In Ischia as well, the traditional terraced winegrowing landscape defined by parracine has been undergoing gradual abandonment for several decades. Historically, only the steepest, least accessible slopes and the few chestnut woodlands on Mount Epomeo were excluded from viticulture (Figure 2).



Figure 2. Ischia, Citara, circa 1950. Source: Delizia I., edited by, *Ischia d'altri tempi*. Naples: Electa, 2004.

But since the 1960s, the tourism-driven construction boom has triggered significant transformations in the traditional cultural landscape. These include the contraction and replacement of agricultural land with coastal development, the uphill shift of farming activities followed by the abandonment of terraced fields at higher elevations. While in 1929 vineyard cultivation covered 2,395 hectares—roughly 50% of Ischia's total area—by 2010 it had shrunk to just 450 hectares [6][7] (Figure 3).

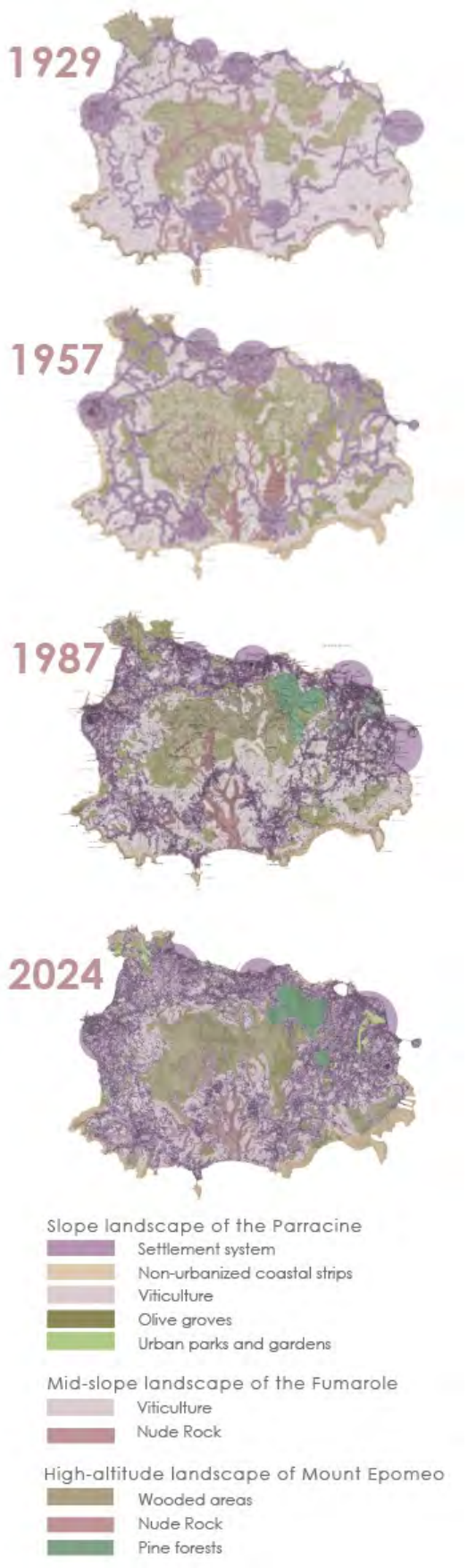


Figure 3. Recent transformations in Ischia's landscape system.

From a wildfire risk perspective, this dual dynamic of landscape erasure and substitution has resulted not only in the loss of the cultural values associated with traditional agrarian systems but also in heightened territorial vulnerability. This is due both to changes in ecological succession and to the progressive expansion of the wildland-urban interface—the zone of contact between urbanized and natural areas—where ignition risk is particularly high.

2. Materials and methods

The interactions between climate change, the abandonment of cultural landscapes, and wildfire risk have led to a rethinking of the *parracine* landscape as a renewed—and increasingly necessary—space for the expansion of the current wildland-urban interface. At present, emergency response plans in force on the island define the urban-rural interface as a buffer zone ranging from 50 to 200 meters in width [8], adjacent only to the most densely built-up areas. This approach, however, does not account for the more diffuse urban sprawl that has progressively climbed the island's slopes over the past sixty years, incorporating historical terraces into the fabric of development.

The wildfire risk management strategy designed for Ischia thus considers the terraced cultural landscape—beginning with its already abandoned and degraded portions—as a key operational space for reducing the island's vulnerability. This is to be achieved through the experimental implementation of innovative approaches to the restoration, conservation, and renewal of the cultural values embodied in historic landscapes. In this context, re-establishing a constructive feedback loop between landscapes and local communities becomes a central objective [9]. The underlying hypothesis is that such a relationship—which, as mentioned, is crucial to the future of Ischia's terraced landscapes—may be reactivated through the application of the principles of so-called fire ecology. In this sense, several practical tools emerge directly from the understanding of survival strategies developed by many Mediterranean plant species in response to fire. These strategies serve as key foundations for the design of new, fire-adapted landscapes—vibrant and highly resilient not only in terms of ecosystem function but also in support of the communities who inhabit them [10][11][12].

Any effective strategy for reducing territorial vulnerability requires a more conscious management of human actions within the

ecosystems in question [13]. Specifically, in the context of wildfire risk, it is essential to gain a detailed understanding of the environmental factors that influence fire propagation—such as the type, quantity, and spatial distribution of available fuels, terrain slopes, proximity to infrastructure, and more [14].

To this end, a detailed study was conducted on the structural characteristics of the *parracine* landscape, its current state, and the anthropogenic (Section 2.1) and vegetational (Section 2.2) transformation dynamics currently underway. The analysis was carried out at multiple spatial scales and across different time intervals. The results presented here stem from the integration and critical synthesis of data and knowledge drawn from diverse sources: field observation and surveys, thematic and historical cartography, specialized studies in botany, statistics and geography, as well as photographic documentation and historical iconography.

2.1. Recent Evolutions of Ischia's Cultural Landscape

Viticulture in Ischia has long played a fundamental role in shaping the island's landscape forms and ecological functioning. Until about sixty years ago, even the development of settlements, road networks, and port infrastructure was closely aligned with the needs of the wine economy. The agro-environmental mosaic of the cultivated terraced landscape defined by *parracine* followed precise compositional rules [15]. The terraces, built from volcanic stone without the use of mortar, performed crucial ecological functions such as overflow management, proper soil drainage, and aeration. The height and width of the terraces varied according to the slope: on the steepest inclines (in Ischia, terraced slopes reached gradients of up to 70%), they were built so narrow and tall that they could accommodate only a single row of vines. These terraces were connected by an intricate system of ramps and stairways running perpendicular to the direction of the retaining walls. The layout of the walls, the pattern of the terraces, and the rhythm of the paths and steps together formed a true example of rural engineering.

This system was complemented by numerous rock-cut structures carved into the tuff: wine cellars for vinification, storage rooms for preserving wine, and dwellings for farmers. In addition to vineyards, the terraces also supported small patches of crops that served the needs of viticulture: chestnut coppices, which provided the posts for the vine trellises; yellow willows, typically grown as coppice in cooler and more humid gully areas, supplying twigs used to tie vines to the trellis posts; and reed beds, usually located along vineyard edges and cultivated to produce canes used in the construction of trellises [16].

Since the 1960s, however, construction linked to tourism has severely disrupted the *parracine* cultural system: at least 1,000 hectares of agricultural land have been lost to development, while uphill, formerly cultivated areas have become fragmented and subsequently abandoned. In these zones, terraces once planted with vines have given way to dense shrublands which, though often held in check at early xerophilous stages by recurrent fires, contribute to the degradation of both the terraces and the dry-stone retaining walls that support roads and paths—thus also reducing accessibility [17]. On the steeper slopes, sparse shrub xeric grasslands are advancing, while lower, uncultivated ridgelines are now covered with mixed brambles, bracken ferns, and broom species (Figure 4).



Figure 4. Regrowth of Mediterranean shrubland along abandoned *parracine.*

Finally, in the lower bands closest to built-up areas, much of the current vineyard landscape has evolved into mixed-use cultivation systems. While vines still dominate, there is a notable increase in the presence of fruit trees and vegetable crops—introduced in response to rising local demand for produce driven by tourism. Among the most frequent tree species are citrus, walnut, and olive trees, typically found near old wine cellars and storage houses or along the edges of former threshing floors and courtyards of rural homes.

2.2 Bio-resilience patterns along the slopes of Mount Epomeo

Building on the knowledge gained from recent macro-scale evolutive dynamics of Ischia's landscape, a vegetation survey was carried out in May 2024 along a portion of the western slope of Mount Epomeo. This area spans the transition between the *parracine* terraced landscape and the high-altitude grasslands, bordering the lower edges of the chestnut woods. The aim of this field survey was to provide a detailed and up-to-date picture of the vegetation status, directly informing the development of landscape strategies for wildfire risk reduction.

The delineation of the selected survey area was based on multiple considerations. Firstly, the western slope of Mount Epomeo is representative of the landscape evolution processes previously described for the island [15]. The critical comparison of recent satellite imagery—captured at short intervals (Google Earth 2016, 2017, 2019, 2023)—with historical maps produced between the late 19th century and the 1980s revealed patterns of terrace abandonment, forest and spontaneous vegetation encroachment, as well as urban expansion.

Secondly, in recent years, this area has been repeatedly affected by wildfires. As such, it offers a particularly valuable setting for close observation of vegetational succession patterns linked to both agricultural abandonment and fire disturbance.

The field data were cross-referenced with the most recent systematic botanical studies on the flora of Ischia [18]. Furthermore, comparisons with official thematic cartography proved instrumental in constructing a critical reference legend for drafting a vegetation landscape map.

The direct survey significantly enriched the understanding of current species composition and distribution across the study area. For instance, in the upper altitudinal zones, it was possible to characterize the grassland based on the recurrence of specific shrub species such as *Ferula communis* (giant fennel), *Spartium junceum* (Spanish broom), and *Euphorbia characias* (Mediterranean spurge), growing over a matrix of perennial and pioneer herbaceous species (Figure 5).

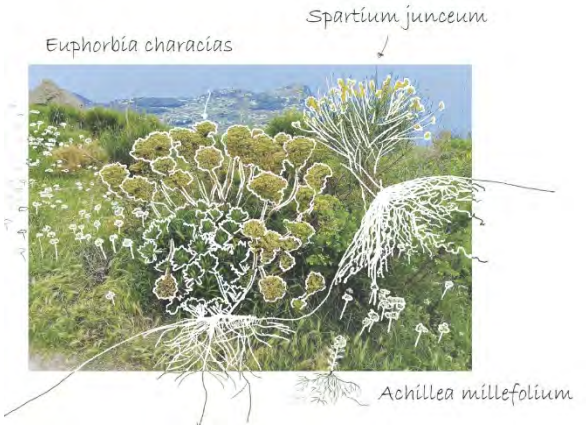


Figure 5. Concentration of shrubs (*Ferula communis, Spartium junceum, Euphorbia characias*) in the high-altitude grassland zone.

Outcropping rocks were also mapped, and a noteworthy finding emerged in the form of a small depression on the slope hosting an unexpected population of Woodwardia radicans (chain fern), a rare native species of giant fern.

In the peripheral zones of areas officially designated as holm oak and cork oak woodlands, species not typically associated with Mediterranean shrublands were identified, such as *Ailanthus glandulosa Desf.* (tree of heaven) and *Robinia pseudoacacia L.* (black locust). These species likely established themselves in place of native vegetation following fire disturbances (Figure 6).



Figure 6. Unexpected establishment of *Ailanthus glandulosa Desf.* and *Robinia pseudoacacia L.* in the outermost areas of officially classified holm oak and cork oak forests.

In the lower portion of the survey area, adjacent to the settlement zone, the fieldwork also yielded a much more refined picture of land-use patterns than traditionally mapped. This included detailed assessments of the presence and condition of dry-stone walls and agrarian structures associated with the traditional *parracine* landscape.

3. Results

Based on the two families of knowledge briefly outlined above, the cultural landscape of the parracine was interpreted by identifying three distinct but contiguous zones, each characterized by a homogeneous level of wildfire vulnerability.

By integrating information on the presence and condition of anthropogenic and vegetational elements in the area under investigation (cultural landscape remnants, habitats, and dominant species) with key factors influencing wildfire propagation—such as slope gradient, degree of infrastructure development, and proximity to built-up areas—specific landscape transformation objectives were defined for each homogeneous zone.

3.1 Abandoned and enclosed cultural landscape

This zone corresponds to the terraced piedmont belt of the island, up to approximately 200 meters above sea level, characterized by a maximum slope of 15%. It is a landscape undergoing significant transformation, where abandonment and replacement dynamics are active and relatively recent. In this area, remnants of the historical agro-mosaic—including vineyards, olive groves, citrus orchards, mixed fruit trees, and vegetable plots—intermingle with species typical of the early and intermediate stages of Mediterranean meso-macchia vegetational succession, such as *Smilax aspera* (rough bindweed), *Arbutus unedo* (strawberry tree), *Ceratonia siliqua* (carob), *Pistacia lentiscus* (mastic), *Phillyrea latifolia* (mock privet), and *Verbascum sinuatum* (sinuate-leaved mullein).
In this context, the wildfire risk reduction strategy involves a non-conservative but evolutive approach to the recovery of the parracine landscape. This includes a functional reinterpretation of the original agro-mosaic, both in terms of species selection (e.g., favoring fire-adapted species) and in composition and structure (e.g., gradually reducing biomass in areas near residential zones) (Figure 7).

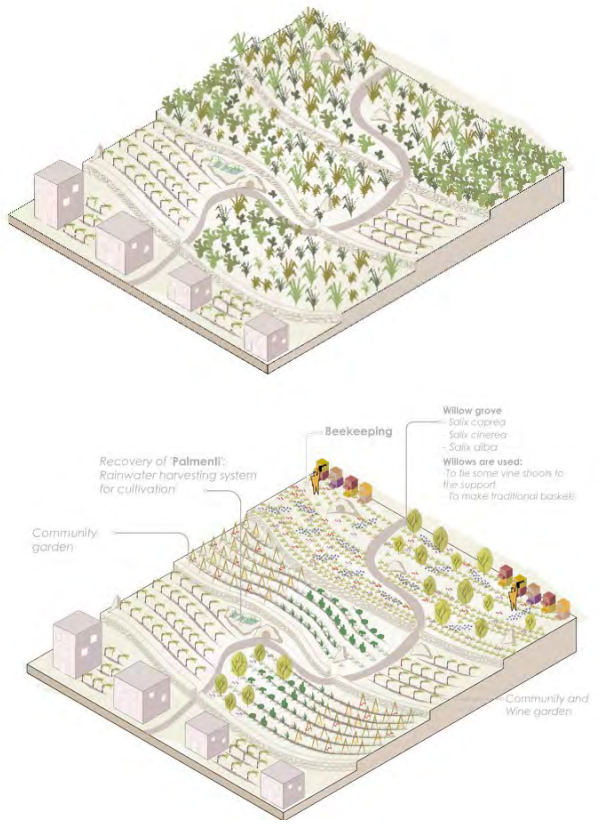


Figure 7. Vulnerability reduction strategy for the enclosed abandoned cultural landscape.

Regarding the restoration of anthropogenic features, particular importance is given to the recovery of rock-cut *palmenti*—ancient tuff-carved structures once used for winemaking—which can be repurposed as water supply points. This action is considered transversal across all three landscape vulnerability zones, with the dual aim of supporting both irrigation and emergency water availability.

3.2 Abandoned and proximal cultural landscape

This zone corresponds to the terraced hillside between approximately 200 and 350 meters above sea level, with slope gradients ranging from 15% to 30%. Here, the abandonment of terracing is well-established, and the landscape is dominated by downy oak woodlands, with prevailing species such as *Quercus pubescens* (downy oak), *Quercus virgiliana* (Virgil's oak), *Fraxinus ornus* (manna ash), and *Ulmus minor* (field elm), underlain by a shrub layer composed of *Ruscus aculeatus* (butcher's broom) and *Hedera helix* (ivy).
This represents an intermediate-to-advanced stage of secondary succession, resulting from the natural recolonization of former agricultural or pasture lands, or areas previously affected by wildfire,

where Mediterranean shrubland has gradually given way to more demanding tree species. The landscape strategy in this zone consists of a range of targeted silvicultural interventions, including:
– selective thinning and controlled pruning of canopies and lower branches to enhance woodland resistance to fire spread;
– clearing and understory management to reduce fuel continuity;
– structural and compositional diversification, aimed at promoting uneven-aged forests with a preference for Mediterranean fire-adapted species.
Here too, landscape-based actions focusing on vegetation management also support the restoration of connectivity between terraced fields—now largely collapsed or overgrown with spontaneous vegetation—with the aim of improving accessibility for both regular use and emergency response (Figure 8).

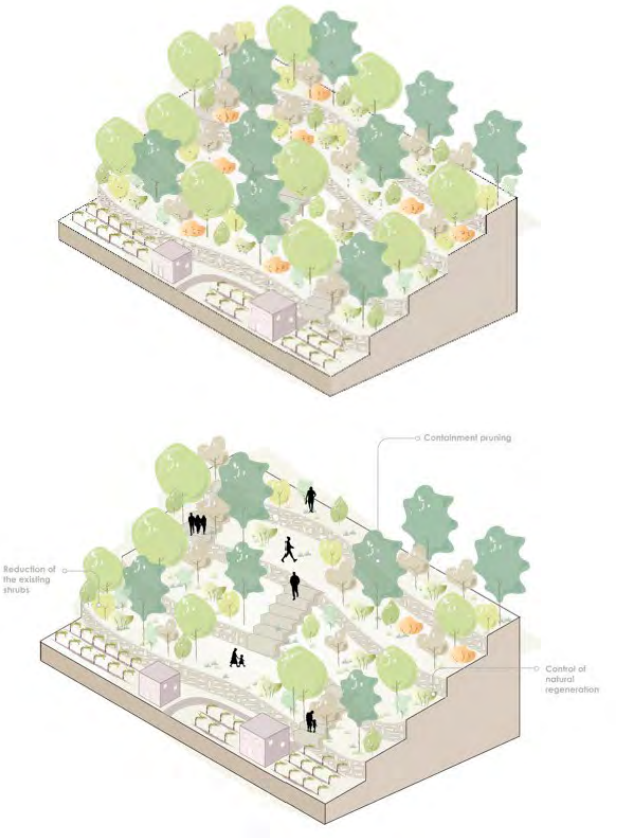


Figure 8. Vulnerability reduction strategy for the proximal abandoned cultural landscape.

3.3 Abandoned and separated cultural landscape

This zone includes the terraced hillside between approximately 350 and 500 meters above sea level, with slopes ranging from 15% to 30%. It is an area frequently affected by wildfires and dominated by Mediterranean meso-macchia vegetation formations (Section 3.1).
Given its high vulnerability to fire, the unsustainability of traditional agricultural practices, and the growing potential for innovative forms of sustainable tourism that offer immersive, nature-based experiences, this zone appears especially well-suited for the development of a large-scale experimental fire park (piroparco). This would serve as a test site for integrated approaches to wildfire prevention and landscape management—potentially replicable in other Mediterranean contexts. Additionally, the space could host research and educational initiatives, including studies on fire-adapted Mediterranean species, permanent environmental training courses, and public education campaigns targeted at local communities (Figure 9).

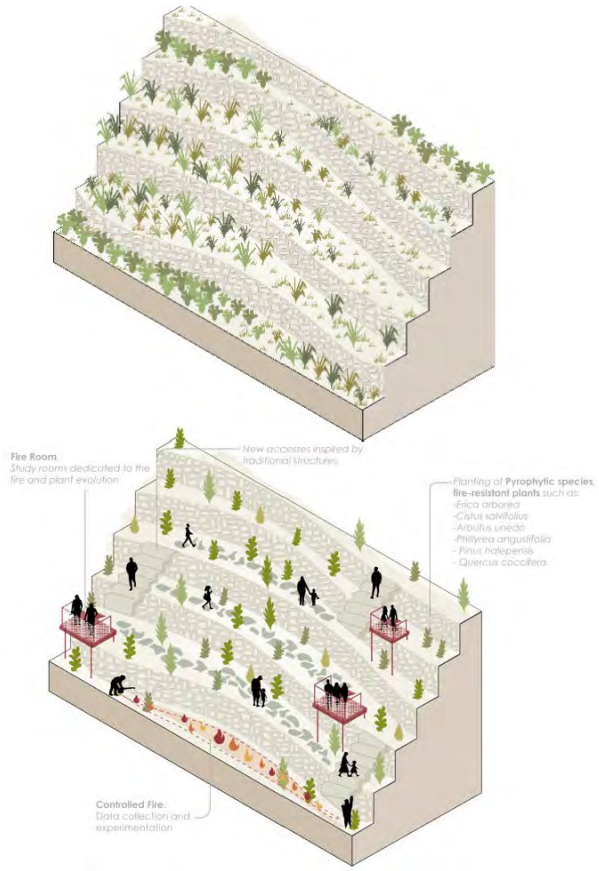


Figure 9. Vulnerability reduction strategy for the separated abandoned cultural landscape.

As part of the wildfire mitigation strategy, a fourth local landscape type is also considered: the secondary Mediterranean grasslands and abandoned pastures, which lie in continuity with the

abandoned and separated cultural landscape and are likewise frequently affected by fires—sometimes more than once per year.
This habitat is now dominated by numerous pioneer herbaceous and shrub species that form the basic vegetational structure. Notable examples include *Spartium junceum* (Spanish broom), *Achillea millefolium* (common yarrow), *Bituminaria bituminosa* (pitch clover), and *Cynosurus echinatus* (bristly dogstail). In terms of wildfire vulnerability, the presence of dense shrub vegetation and the rapid regenerative capacity of herbaceous species are critical risk factors. For this reason, the strategy in this area proposes the reintroduction of controlled grazing—either by domesticated livestock or via extensive grazing systems using wild or semi-wild herbivores—with the long-term goal of developing local livestock supply chains actively involved in wildfire prevention.

4. Discussion and conclusion

The terraced vineyard landscape of the Island of Ischia is recognized as an example of the "art of dry-stone walling," a practice inscribed on the UNESCO Intangible Cultural Heritage List since 2018. The cultural value of the *parracine*, understood as an "organically evolved landscape," lies in their ability to embody the deep relationship between humans and nature, while also playing a crucial role in preventing landslides, floods, and avalanches, as well as in counteracting soil erosion and desertification. Today, however, much of the *parracine* landscape is in a state of abandonment, and the resulting changes in land use and cover are amplifying the effects of climate change, increasing the vulnerability of the entire territory of Ischia to wildfire risk.
In response to this situation, the paper proposes an adaptive and ecologically responsive wildfire risk reduction strategy, based on the landscape and, in particular, on a contemporary reinterpretation of heritage values more consistent with the island's socioeconomic context.
This proposal serves as a starting point for a broader reflection on renewed goals, objectives, and tools for the conservation of cultural landscapes, moving beyond the logic of merely restoring an original state in favor of a more dynamic and evolutionary vision. An approach that aligns with the current, essential need to develop resilient territories capable of adapting to multiple ongoing crises.
In the case of Ischia, adopting the perspective of the cultural landscape in risk management has enabled the development of a more systemic and integrated vision of the territory, capable of addressing, through targeted interventions, a wide range of change factors, challenges, and socioeconomic interests that go far beyond the risk dimension alone. In line with this perspective, the proposed strategy introduces key correctives to the current risk management system—elements that are central to a new generation of more effective and integrated regulatory and operational tools. First, the adoption of a landscape-based approach has led to a more effective remodulation of the urban–rural interface, shaped not only by the current territorial configuration, but also by ongoing dynamics and the concrete potential for transformation of anthropic and vegetative systems. Second, the active risk prevention interventions have been directly derived from the forms of the landscape itself, which integrates the reduction of vulnerability as a structural component of its own goals for transformation and quality. Finally, starting again from the landscape has made it possible to jointly address the economic and social feasibility of physical transformations of the territory. This represents, for instance, an opportunity to systematize the multiple funding streams, policies, and European instruments available—beginning with prevention strategies such as the Common Agricultural Policy and the Nature Restoration Law.

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RESEARCH ON THE LIVING CULTURAL INHERITANCE OF THE GRAND CANAL HERITAGE LANDSCAPE

TOPIC: Guiding territories with legislative and social advances in planning: Evolution of heritage landscapes

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Keywords: The Grand Canal; Heritage Landscape; Living Cultural Transmission; Landscape Regeneration; Spatial Reconfiguration

Abstract

The Grand Canal, a luminous gem interwoven into Earth's azure hydrological network, stands as an unparalleled engineering feat among global artificial waterways, renowned for its monumental scale and profound historical significance. Spanning 1,794 kilometers, this UNESCO World Heritage Site traces its origins to the Spring and Autumn Period (770–476 BCE), with subsequent expansions under the Sui (581–618 CE) and Yuan (1271–1368 CE) dynasties. The Grand Canal is distinctive for its Caoyun transportation system (transportation of grain and strategic logistics) {Qingwen Rong & Jianguo Wang 2024}. It remains one of humanity's earliest, largest, and most complex hydraulic engineering systems—a timeless tribute to premodern innovation. Linking China's Yellow, Yangtze, Huai, and Qiantang Rivers, it forged the historic "south-north grain corridor and north-south governance axis," driving cultural and economic exchange. Buddhism and Islam spread via its currents, exemplifying early globalization. Today, navigable segments such as the Shandong-Zhejiang stretch persist, while its critical role in the Eastern Route of the South-to-North Water Diversion Project underscores its status as living cultural heritage. The canal's harmonious fusion of historical legacy and contemporary utility exemplifies adaptive resilience. Inscribed on the UNESCO World Heritage List (2014), it endures as a testament to humanity's enduring ingenuity.

The Grand Canal, far more than a "National Business Card" of China, stands as a shared treasure of humanity. It is not merely a witness to history but a living testament to civilizational continuity, technological adaptability, and cultural inclusivity. Amidst the tides of globalization and urbanization, the canal's preservation and adaptive reuse offer the world a Chinese paradigm for the modern revitalization of historic heritage. Today, heritage conservation has evolved from static preservation to a value-driven dynamic journey, forging cognitive bonds between the past, present, and future. The canal's living culture thrives through a three-dimensional value framework—cultural inheritance, ecological resilience, and innovative reuse—achieving synergistic enhancement and optimization.In the cultural dimension, the application of historical stratification theory enables deep analysis of the site's spatiotemporal evolution, establishing a regeneration framework of systematic protection, innovative reinterpretation, and living heritage transmission. This approach revitalizes heritage landscapes through contemporary design languages. For

ecological resilience, nature-based solutions (NbS) restore harmony between the canal and its natural surroundings, reviving riparian ecosystems. In reuse practices, historic structures are artfully transformed into vibrant public cultural hubs, reimagining traditional canal spaces as engines of social engagement.
In the context of globalized urbanization, the conservation and revitalization of the Grand Canal unfold as an epic of modern transformation for ancient heritage, showcasing China's paradigm of "modern metamorphosis for historic legacies." This study employs the landscape design of the Suzhou Sericulture College Former Site Cultural Park (Xiling Hall Park) at the XuShuguan Section of the Grand Canal as a practical exemplar. By exploring the breadth of cultural integration, scope of ecological-urban governance, and precision of engineering techniques, it proposes multidimensional strategies for living heritage transmission and landscape regeneration, offering innovative pathways for the sustainable development of linear heritage corridors.

1.Introduction

1.1. Research Background

The Beijing-Hangzhou Grand Canal is the longest artificial waterway in the world with a total length of 1794 km crossing eight provinces in China {Chen Y.2022}. As the most extensive and ancient canal of its kind globally, its construction origins trace back to the Spring and Autumn Period (c. 771–476 BC). Having evolved over more than 2,500 years, this monumental Linear Cultural Heritage resource forms a vital north-south axis, intricately linking China's five major river systems. Throughout history, it has served as a critical artery for water transport, notably the Caoyun system (primarily for grain tax transport to the capital), commercial exchange, and cultural diffusion, embodying the ingenuity and industry of the Chinese civilization. Celebrated for its exceptional hydraulic engineering achievements, the Beijing-Hangzhou Grand Canal stands as a treasure of ancient Chinese engineering prowess, occupying an indispensable position in the trajectory of Chinese civilization. To this day, it retains functional vitality in irrigation, navigation, and ecological services, consistently radiating irreplaceable cultural significance. It acts not only as a spiritual conduit bridging past and present but also as a repository of cultural genes for future generations.

From a global perspective, the heritage conservation discourse is undergoing a significant paradigm shift – moving away from static preservation towards dynamic adaptation. Early conservation efforts prioritized the authenticity of physical forms, such as historic buildings and archaeological sites. Presently, with a deepening understanding of heritage values, there is increased emphasis on fostering interaction and integration between heritage and contemporary social, economic, and ecological systems. This evolution recognizes that safeguarding cultural heritage fundamentally requires upholding its core historical and cultural values, while simultaneously enabling functional optimization and adaptive management strategies to cultivate a symbiotic relationship with modern society. The core principle is to ensure heritage remains functionally relevant and continues to play a dynamic role in contemporary life, thereby transforming conservation goals from merely preserving physical structures towards the in-situ transmission of intrinsic values and ensuring long-term continuity.

Within China, the Beijing-Hangzhou Grand Canal manifests as a prime exemplar of living heritage, demonstrating unique characteristics of technical complexity, cultural syncretism, and enduring functionality. As a benchmark for dynamic adaptation, its distinctiveness concentrates on three dimensions:

Technical Complexity: This encompasses not only systemic innovations in historical water level regulation and channel engineering but also the remarkable continuity of this engineering wisdom applied across millennia.

Cultural Syncretism: Reflected in the transregional symbiosis fostered along its course, integrating diverse northern and southern cultures, multi-ethnic religious practices, and mercantile traditions, thereby weaving a dynamic tapestry of intangible cultural heritage.

Enduring Functionality: This aspect has transcended historical constraints, extending

its relevance into a modern multifunctional nexus comprising navigation, ecological regulation, and cultural heritage transmission, representing an organic transformation from traditional to contemporary values.

However, amidst rapid globalization and urbanization, the conservation of the Beijing-Hangzhou Grand Canal faces substantial threats. Numerous heritage landscapes associated with the Canal are succumbing to multi-faceted pressures, including spatial encroachment, ecosystem degradation, and erosion of socio-functional roles. This predicament situates Canal conservation squarely within the tension between preserving historical authenticity and achieving contemporary adaptability. The critical challenge lies in simultaneously safeguarding the historic character and cultural essence of the Canal while enabling its adaptation to the demands of modern societal development.

1.2. Research Significance Based on the "Guiding city" Concept

The concept of "Guiding Landscapes" takes ecosystem integrity and social inclusivity as its core, guiding urban development through landscape design to achieve organic integration of ecological, cultural, and socio-functional systems. This study pioneers its introduction into the field of living heritage conservation along China's Beijing-Hangzhou Grand Canal. By conducting localized expansion that aligns with China's national conditions and the Canal's characteristics, we enrich and refine this theoretical system, providing new perspectives and approaches for theoretical research in Chinese landscape planning and heritage conservation.

Deeply integrating the "Guiding Landscapes" concept into the Territorial and Spatial Planning System enables the systematic conservation and revitalization of the Beijing-Hangzhou Grand Canal through landscape design strategies. This generates mutually empowering effects across macro and micro scales – strategically promoting synergy between heritage conservation and urban development through regional spatial structure optimization at the macro level, while activating cultural vitality and ecological value of micro-scale carriers such as riparian spaces and hydrological networks through site-specific design interventions.

1.3. Research Innovations

This paper focuses on coordinating ecological restoration with social objectives through landscape guidance, particularly seeking balance between climate regulation, biodiversity corridor reconstruction, community participation, and cultural identity reinforcement. Through the Suzhou Sericulture College Former Site Cultural Park (Xiling Hall Park) project, we explore a new pathway based on the three-dimensional value framework of "Cultural Inheritance – Ecological Resilience – Innovative Reuse", with the transmission and innovation of living culture and cultural heritage at its core. This framework provides an innovative model for the sustainable development of linear heritage corridors, offering replicable practical solutions for reconciling heritage conservation with urban development.

2. Theoretical Evolution and Innovative Pathways for Living Heritage Conservation

2.1. Evolution of International Heritage Conservation Theory

From the early 20th century to the 1970s, the static preservation phase relied on physical isolation methods to maintain historical authenticity (e.g., encapsulation strategies for Rome's ancient city ruins), essentially constituting "freezing-style conservation". The adoption of the "Convention Concerning the Protection of the World Cultural and Natural Heritage" (1972) for the first time incorporated natural and cultural conservation within a global governance framework, reconstructing the understanding of heritage's pluralistic values. By the late 20th century, UNESCO's World Heritage Committee introduced the concept of living heritage for World Heritage sites, emphasizing the dynamic use and intergenerational transmission of cultural heritage within local communities. As understanding of cultural heritage deepened,

conservation perspectives expanded beyond tangible assets. Intangible cultural heritages consist of non-physical intellectual wealth, such as folklore, customs, beliefs, traditions, knowledge, and language, which are crystals of wisdom created by humans' production and life {Li L, Tang Y.2023}. which are living and not static. Intangible heritage is therefore sometimes rightly equated with living heritage {Von Truetzschler W.2005}. Entering the 21st century, accelerated urbanization and environmental crises have driven a shift toward the dynamic adaptation paradigm, prioritizing the continuous vitality of heritage. This approach stresses maintaining core values, ensuring sustained transmission through community praxis, and conducting functional adaptations to achieve symbiotic evolution with modern society.

2.2. Current Research Status of Living Heritage in China

With deepening engagement in living heritage practice, scholars have extensively investigated the historical origins, evolutionary trajectories, cultural connotations, and ecological values of canal heritage. This unique heritage form now transcends its role as a mere repository of cultural memory, actively enabling multifunctional engagement in socio-economic development, sustaining the living transmission of cultural genes, and pioneering models for cultural tourism development. Through cultural-tourism integration and ecosystem service provision, it participates in modern economic circulation, with its sustained vitality and epochal adaptability emerging as critical new themes in heritage conservation.

Nevertheless, current research exhibits limitations. Theoretically, few systematic studies integrate living heritage conservation with landscape design methodologies. Practically, numerous conservation and development projects fail to balance protection and utilization adequately, manifesting in over-commercialization and inadequate cultural interpretation. Using Grand Canal conservation as a case study, two primary contradictions are identified:

"Spatial Governance Fragmentation"– The theory of living heritage transmission remains insufficiently embedded within the Territorial and Spatial Planning System, causing disjunction between ecological restoration projects and community cultural engagement, thereby impeding systemic conservation synergies.

"Multi-Scale Disjunction"– Protective policies exhibit diminished efficacy when transitioning from macro-level frameworks to micro-level implementation, resulting in the failure to reactivate local cultural memory within historical spaces along the canal. The disconnect between local knowledge systems and conservation strategies undermines the equilibrium between holistic conservation and place-based revitalization.

2.3. Theoretical Innovation: Construction of the Three-dimensional Value Framework "Cultural Inheritance–Ecological Resilience–Innovative Reuse"

Conventional heritage conservation paradigms rigidly adhere to principles of "freezing-style preservation" and "minimal intervention", maintaining original states through physical immobilization. The significance of heritage is not only in the fabric, but in the values ascribed by the stakeholder groups to the heritage. The aim of conservation, therefore, is not simply the preservation of the fabric but the protection of the values imputed to it {Poulios I.2010}. However, the core contradiction in current practice lies in value-stripping caused by the traditional paradigm's excessive focus on physical fabric preservation.

The proposed three-dimensional value framework addresses this through three pathways of value reintegration: Cultural Inheritance Dimension: Activates socio-cultural connotations to enable non-material value transmission among stakeholders; Ecological Resilience Dimension: Employs Nature-based Solutions (NBS) to sustain the ecosystem service value; Innovative Reuse Dimension: Triggers regeneration of public value through functional transformation. Centered on values-based conservation, this framework transcends traditional limitations, offering a globally

relevant Chinese perspective centered on community-based empowerment.

3. Shaping Living Canal Heritage

3.1. From Historical Memory to Contemporary Narrative

The cross-cultural osmosis driven by the Beijing-Hangzhou Grand Canal's Caoyun system and tea-silk trade constitutes its core historical memory as a World Heritage site. Its significance lies in its flowing and living cultural heritage{Li Y, Zheng N. 2020}. By reconstructing narrative spaces, historical memory is transformed into shared community narratives—a process embodying its living heritage attributes and propelling the essential transition from "historical witness" to "contemporary discourse". For instance, establishing Canal Cultural Corridors showcasing traditional crafts and folk customs along the route, or utilizing digital technologies to immerse visitors in historical contexts, ensures the perpetuation and dissemination of historical culture in modern society.

3.2. Place-making Guided by Ecological Resilience

Ecological resilience-oriented placemaking requires integrated consideration of ecology, urban governance, and technological innovation. Centered on Nature-based Solutions (NbS), this approach employs river morphology remodeling, native vegetation restoration, and biodiversity corridor rehabilitation to systemically enhance ecological resilience in heritage areas. Concurrently, promoting multidimensional transformation of functional spaces integrates ecological restoration, heritage conservation, and contemporary socio-economic needs. This catalyzes heritage zones into symbiotic blue-green infrastructure that strengthens ecological security functions while sustaining living cultural continuity and generating diversified social co-benefits, ultimately achieving organic unity of ecological integrity, cultural value, and social welfare.

3.3. Localized Construction through Multidimensional Interaction

For the Grand Canal's conservation, community engagement and cultural identity are pivotal to place-based construction. In fact, a landscape plays a dual role: as part of the cultural heritage, which has to be preserved for its values, and as a "living" site, where individuals and groups live and work {Settimini E.2021}. Through participatory landscape design, communities become co-creators of heritage protection while symbolic recreation of historical motifs repositions heritage as a carrier of modern cultural identity, fostering residents' sense of belonging and cultural confidence, thereby advancing localized heritage revitalization.

4. Case Study: Landscape Design Practice of the Suzhou Sericulture College Former Site Cultural Park (Xiling Hall Park) at the Xushuguan Town Section of the Grand Canal

4.1. Site Background and Cultural Value

The Suzhou Sericulture College Former Site Cultural Park (Xiling Hall Park) received an Honourable Mention in the IFLA AAPME Awards 2024, Culture and Traditions category. Situated along the Beijing-Hangzhou Grand Canal, this site constitutes a heritage node of significant historical and cultural significance. It preserves historical structures and facilities of the former sericulture college, whose tradition-centered silk industry legacy encapsulates rich historical and cultural narratives reflecting China's transition from traditional sericulture to modern industrialization. President Xi Jinping's directive that "Protecting the Grand Canal is a shared responsibility of all regions along its route, requiring creative transformation and innovative development of cultural heritage" aligns fundamentally with UNESCO's concept of "living cultural heritage transmission".

The sericulture college played a pivotal role in modern China's silk industry development. Its distinctive architecture, educational functions, and industrial context render it a critical repository for studying the convergence of

modern Chinese industrial culture, educational heritage, and canal civilization, endowing it with exceptional historical, cultural, and artistic value. Anchored within this World Heritage landscape, the project systematically integrates traditional Chinese sericulture culture to construct a multidimensional heritage value framework. This approach both manifests historical continuity and highlights cultural diversity, achieving synergistic enhancement between natural and intangible cultural heritage. Through the superimposition of cultural values and symbiosis of functional spaces, it injects cultural co-creative momentum into living heritage transmission, establishing a novel paradigm that interweaves tradition with modernity while harmonizing preservation and development.

4.2. Synergistic Design Strategies for the Three-dimensional Value Framework

The landscape design of Suzhou Xushuguan Grand Canal Sericulture College Former Site Cultural Park (Xiling Hall Park) embodies distinctive innovations across cultural fusion, ecological governance, and engineering precision. In cultural integration, the design team extensively explored canal culture and sericulture heritage, creating a polycultural presentation by preserving historic elements like the college gate and teaching buildings. The adaptive reuse of Xiling Hall as the "Grand Canal Sericulture Culture Exhibition Hall" displays institutional history and silk reeling tools, while the rehabilitated Silkworm Egg Incubation Building serves as a Sericulture Field Classroom. This drives the transformation from historical memory to contemporary narrative, reactivating the cultural vitality of heritage spaces.

For ecological and urban governance, the design adheres to ecological resilience principles employing Nature-based Solutions (NbS) for hydrological restoration. Constructed rainwater gardens, bioswales, and other green infrastructure enhance the site's stormwater retention and purification capacities. Through spatial transformation and multidimensional coordination, it balances heritage conservation, ecological systems, and contemporary needs. Concurrently, cooperative mechanisms with municipal authorities and communities establish sustainable park management protocols to ensure long-term ecological integrity.

Regarding engineering precision, delicate restoration techniques preserve the historical character of the college gate and Xinyuan Garden landscape. By integrating Republican-era architectural styles and sericulture craft motifs with modern functionalities, the design evokes the spatial ambiance of its historical period while strengthening cultural continuity. Modern landscape engineering technologies further realize high-quality public spaces that unify cultural, ecological, and functional dimensions organically.

4.3. Sustainable Development Pathways Through Multidimensional Benefits

The Suzhou Xushuguan Grand Canal Sericulture College Former Site Cultural Park (Xiling Hall Park) delivers sustainable outcomes across three dimensions. Culturally, its heritage rehabilitation and adaptive reuse perpetuate cultural memory, enhancing public awareness and identity with community heritage. Ecologically, the integration of rainwater gardens and ecological restoration designs augments climate resilience and biodiversity while reducing stormwater runoff, thereby improving urban environmental quality. Socially, community-engaged cultural programming creates public spaces for recreation and cultural education, fostering social cohesion and strengthening residents' sense of belonging. Concurrently, the park catalyzes local economic development through elevated land value and tourism, amplifying the social value of cultural continuity and public space. This integrated approach simultaneously achieves cultural continuity, ecological integrity, and socioeconomic vitality – fulfilling the core objectives of multidimensional sustainability.

5. Insights and Recommendations

5.1. Significance and Challenges of Living Cultural Transmission in Grand Canal Heritage Landscapes

The Grand Canal can be considered as a linear heritage attraction linking many individual heritage sites {Jiang, S.; Scott, N.; Tao, L.; Xiong, S.; Qin, Y. 2023}. These heritage resources carry the spiritual genetic codes of Chinese civilization while serving as vital bonds for cultural identity and social cohesion, perpetuating dual functions of cultural transmission and spiritual unification throughout history. The living cultural transmission within Grand Canal landscapes acts not only as a critical vehicle for promoting China's exceptional traditional culture and strengthening national cultural confidence, but also as a catalyst for continuous cultural vitality and innovative development in contemporary society. Nevertheless, significant challenges persist with tourism commercialization leading to symbolic reduction of heritage that erodes historical authenticity, compounded by fragmented management systems across provinces resulting in disjointed cultural presentations. Establishing dynamic equilibrium between living transmission and systemic conservation while overcoming cross-jurisdictional barriers to create whole-basin collaborative protection frameworks has therefore become essential for sustainable advancement.

5.2. Implications of Landscape Regeneration and Spatial Reconfiguration for Linear Heritage Corridors

Landscape regeneration and spatial reconfiguration provide novel methodologies for conserving linear heritage corridors. Systemic strategies integrating ecological restoration, cultural integration, and functional reprogramming can simultaneously reactivate historical values and adapt heritage to modern needs, transforming conservation and urban development toward mutually reinforcing synergy. Practically, regionally differentiated approaches must preserve heritage authenticity while incorporating contemporary functions; cross-regional coordination mechanisms should dismantle administrative fragmentation to enable resource circulation through shared governance networks that achieve protection through development.

5.3 Future Research Directions

Future research should advance living cultural transmission through interdisciplinary innovation: technologically leveraging big data analytics, virtual reality (VR) and artificial intelligence (AI) to enhance cross-scale monitoring and public engagement; institutionally developing multi-level governance frameworks addressing heritage continuity while pioneering community-driven models to empower local stewardship; theoretically synthesizing cultural-ecological-social values into adaptive frameworks ensuring conservation transcends physical preservation; internationally facilitating knowledge exchange to elevate China's Grand Canal conservation globally.

6. Conclusions

6.1 From Historical Stratification to Future Empowerment

The core achievement of living heritage transmission along the Beijing-Hangzhou Grand Canal lies in the creative transformation of historical stratification. This transformation perpetuates cultural memory while, according to a living heritage approach, the actual authenticity is continually created and defined by a site's core community {Poulios I.2021}. This practice profoundly demonstrates that ecological resilience and technological innovation constitute contemporary modalities through which core communities dynamically sustain authenticity. Moreover, by adopting a systems-thinking approach to resilience, it integrates ecological conservation, social participation, and economic development into a synergistic sustainable ecosystem. These experiences further reveal that heritage's vitality stems from community-led value reconstruction—where modern design and technological innovation catalyze renewal, enabling iterative value enhancement through responses to diverse needs of habitation, culture, and economy. This ultimately achieves organic articulation and symbiotic

empowerment between traditional heritage and future development

6.2 From Static "Freezing" to Dynamic "Vitalization"

Global heritage conservation is transitioning from traditional static "freezing" preservation to dynamic "vitalization" utilization, fostering the co-prosperity of cultural, ecological, and functional values. The conservation practices of the Beijing-Hangzhou Grand Canal exemplify this shift, demonstrating how innovative models adapt heritage to contemporary societal demands, transforming it into an enduring cultural and ecological carrier. This evolution not only expands theoretical perspectives in heritage conservation but also validates, through practice, the epochal significance of China's vision of a "human-nature life community" within the heritage domain.

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BEYOND PRESERVATION: RETHINKING THE MARRAKESH PALM GROVE AS A LIVING CULTURAL LANDSCAPE

TOPIC: Guiding territories with legislative and social advances in planning (Evolution of heritage landscapes)

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Abstract

The Marrakesh Palm Grove (MPG), a historically and ecologically significant landscape, is currently facing severe environmental and socio-economic challenges due to rapid urban expansion, unchecked tourism development, and climate change-induced degradation. Recognized as an integral part of Marrakesh's identity and cultural landscape, the palm grove is now at a critical juncture between preservation and transformation. While conservation efforts are being implemented, their effectiveness remains debatable, and traditional preservation strategies often struggle to address the dynamic socio-economic and environmental forces shaping the landscape. Drawing on UNESCO's concept of "organically evolved landscapes" (Rössler, 2006), this paper investigates MPG as a living cultural landscape rather than a pure natural surrounding of the Marrakesh old city.

This research is based on a mixed-method approach, including (1) a Synthetic Controls Method (SCM) comparing MPG's land cover change with the other palm groves in the Mediterranean context (n=20) from 2000 to 2020, (2) semi-structured interviews (n=24) with administrative staff, planning experts, and local residents, and (3) survey-based participatory mapping exercises (n=120). The objective is to analyze MPG's landscape changes and public perceptions of its boundaries, value, and evolving conditions. Results show a recent slowdown in deforestation in MPG in comparison to the other Mediterranean palm groves, driven by the conservation efforts from the Observatoire de la Palmeraie de Marrakech (OPM). Findings also reveal a sharp contrast in perspectives: while experts perceive MPG as a fragile and deteriorating ecosystem, driven by pollution, desertification, and the pressures of real estate and tourism expansion, local residents exhibit a more ambivalent stance, acknowledging both the economic benefits of tourism and the loss of ecological integrity. Moreover, survey data highlight discrepancies between institutional restoration efforts and community engagement, with many residents unaware of or uninvolved in conservation initiatives. These insights align with prior scholarship on the tensions between heritage tourism, conservation, and community participation (Graham, Ashworth, & Tunbridge, 2000; Taylor, 2009).

By integrating perspectives from cultural landscape theory (Mitchell, Rössler, & Tricaud, 2009) and ecological restoration (Higgs, 2003), this paper proposes a reimagined conservation framework that moves beyond conventional heritage preservation. It advocates for an adaptive and participatory approach incorporating digital tools, such as Participatory GIS (PPGIS) and social media data mining, to enhance community involvement in decision-making and improve transparency in landscape governance. Additionally, the study suggests that virtual and augmented reality technologies can serve as tools for reinterpreting the landscape's heritage value, bridging the gap between its historical significance and contemporary transformations (Fouseki & Cassar, 2015).

Ultimately, this research contributes to the evolving discourse on the management of heritage landscapes, proposing that the survival of cultural landscapes like MPG hinges on their ability to dynamically adapt to socio-economic and climatic shifts. By fostering collaborative governance, leveraging digital heritage tools, and embedding conservation efforts within a sustainable tourism model, MPG can be repositioned as a resilient and evolving heritage landscape, ensuring its ecological and cultural vitality for future generations.

1. Introduction

Drawing on UNESCO's concept of "organically evolved landscapes" (Rössler, 2006), this paper investigates MPG as a living cultural landscape rather than a static heritage relic.The objective is to analyze MPG's landscape changes and public perceptions of its boundaries, value, and evolving conditions. By integrating perspectives from cultural landscape theory (Mitchell, Rössler, & Tricaud, 2009) and ecological restoration (Higgs, 2003), this paper proposes a reimagined conservation framework that moves beyond conventional heritage preservation. It advocates for an adaptive and participatory approach incorporating digital tools, such as Participatory GIS (PPGIS) and social media data mining, to enhance community involvement in decision-making and improve transparency in landscape governance. Additionally, the study suggests that virtual and augmented reality technologies can serve as tools for reinterpreting the landscape's heritage value, bridging the gap between its historical significance and contemporary transformations (Fouseki & Cassar, 2015).

To understand MPG's transformation as both an ecological and cultural process, we adopt a mixed-methods approach. While remote sensing and SCM help detect measurable landscape changes, qualitative interviews and participatory mapping capture the lived experiences, values, and memory practices often overlooked by spatial data.

Ultimately, this research contributes to the evolving discourse on the management of heritage landscapes, proposing that the survival of cultural landscapes like MPG hinges on their ability to dynamically adapt to socio-economic and climatic shifts. By fostering collaborative governance, leveraging digital heritage tools, and embedding conservation efforts within a sustainable tourism model, MPG can be repositioned as a resilient and evolving heritage landscape, ensuring its ecological and cultural vitality for future generations.

2. Methods

2.1. Study area

The MPG [Figure 1], a historically and ecologically significant landscape, is currently facing severe environmental and socio-economic challenges due to rapid urban expansion, unchecked tourism development, and climate change-induced degradation. Recognized as an integral part of Marrakesh's identity and cultural landscape, the palm grove is now at a critical juncture between preservation and transformation. Observatoire de la Palmeraie de Marrakech (OPM) is a non-profit organization that works for the conservation and development of MPG. It also supports major projects for the maintenance and sustainability of the natural heritage, led by the Mohammed VI Foundation in partnership with local authorities and various public and private donors. However, while conservation efforts are being implemented, their effectiveness remains debatable, and traditional preservation strategies often struggle to address the dynamic socio-economic and environmental forces shaping the landscape.



Figure 1. The location of Marrakesh.

2.2. Comparative Deforestation Modeling

We applied the Synthetic Control Method (SCM) to compare MPG's deforestation with the other palm groves in the Mediterranean region. SCM is to create a weighted combination of untreated comparison units to approximate a counterfactual scenario (Abadie & Gardeazabal, 2003)—that is, the outcome that the treated group would have experienced in the absence of conservation intervention at MPG.

We collected a dataset of one dependent variable and four independent variables. The dependent variable is the total annual forest cover area (in pixels), derived from the Global 30-meter Land Cover Change Dataset developed by Zhang et al. (2023). This dataset provides consistent, high-resolution classification of land cover types based on satellite imagery. Forest cover includes coniferous, broad-leaved, evergreen, and deciduous forest classes, consistent with FAO definitions. Independent variables were selected to capture key environmental and human pressures influencing forest cover change. These include population size, nighttime light intensity, precipitation, and temperature. The panel dataset covers the period from 2000 to 2020 for both the treatment region MPG and 20 candidate control

regions. All data are spatially aggregated to the regional level and temporally harmonized on an annual basis. Data sources, units, spatial resolution, and time coverage are summarized in Table 1.

Table 1. Dependent and independent variables.

Variable	Description	Source	Resolution
Forest Cover Area	Annual total forest area (coniferous, broad-leaved, evergreen, deciduous)	Global 30-meter Land Cover Change Dataset	30 meters
Population Size	Estimated residential population per 100m × 100m grid	WorldPop Global Project	~100 meters
Nighttime Light Intensity	Annual mean of nighttime brightness (VIIRS-derived)	Global Annual Simulated NPP-VIIRS Dataset	~500 meters
Annual Precipitation	Total accumulated precipitation per year (mm)	ERA5 Monthly Aggregates, Copernicus Climate Change Service	~30 km (0.25°) grid
Average Temperature	Annual mean surface temperature (°C)	ERA5 Monthly Aggregates, Copernicus Climate Change Service	~30 km (0.25°) grid

This study regarded the establishment of the OPM organization and its subsequent social governance activities in MPG (M region) as a quasi-natural experiment, employing the SCM to observe J regions. Specifically, we assumed that the M region began to experience the influence of OPM social governance starting in period T0 (1≤T0< T), while the remaining J−1 regions, which were not exposed to this governance during the observation period, serve as the control group. Let the palm area in the M region be denoted by:

$$P_{\{Mt\}}$$

and the palm area vector for the control regions is denoted by:

$$P_{-M,t} = \left(P_{2t}, P_{3t}, \ldots, P_{Jt}\right)'$$

We assign weights to the control regions using the vector:

$$W = \left(w_2, w_3, \ldots, w_J\right)'$$

ensuring that:

$$w_j \geq 0 \quad \text{and} \quad \sum_{j=2}^{J} w_j = 1$$

The "synthetic Marrakesh" palm area index is constructed as:

$$P_{Mt}^{S} = \sum_{j=2}^{J} w_j P_{jt}$$

This synthetic region was designed to replicate as closely as possible the trend in Marrakesh's palm area before the social governance activities began (t<T0t<T0). The difference after the intervention captures the net effect of OPM's social governance in the M region.

$$\delta_{Mt} = P_{Mt} - P_{Mt}^{S} \quad \text{for } t \geq T_0$$

To construct an accurate synthetic control, we also employed a nested optimization algorithm with Stata MP 16 that minimizes the Root Mean Squared Prediction Error (RMSPE) between the treated unit and its synthetic counterpart in the pre-treatment period. This involves selecting an optimal weight matrix (V) for predictor variables and computing a convex combination of control units (W) accordingly.

As shown in Table 2, in the Mediterranean region, we selected 20 palm forest areas with similar climate, soil, and socioeconomic characteristics as potential control units to construct the synthetic control group. By weighting key variables such as forest cover change, population density, nighttime light intensity, annual precipitation, and average annual temperature in these regions, we ensured that the synthetic control group could closely replicate the forest cover change trajectory of the treatment group during the pre-intervention period (2000-2010).

Table 2. Selected palm groves in the Mediterranean region

ID	Palm Grove	Description
1	Marrakesh Palm Grove	Morocco
2	Zagora Palm Grove	Morocco
3	Skoura Palm Grove	Morocco
4	Tafilalt Palm Grove	Morocco
5	Figuig Palm Grove	Morocco
6	Ouargla Palm Grove	Algeria
7	Timimoun Palm Grove	Algeria
8	Biskra Palm Grove	Algeria
9	Taghit Palm Grove	Algeria
10	Ghardaia Palm Grove	Algeria
11	Tozeur Palm Grove	Tunisia
12	Nefzaouia Palm Grove	Tunisia
13	Kebili Palm Grove	Tunisia
14	Kharga Oasis Egypt	Egypt
15	Siwa Palm Grove	Egypt
16	Farafra Oasis	Egypt
17	Bahariya Oasis	Egypt
18	Dakhla Palm Grove	Egypt

19	Ubari Lakes	Libya
20	Palms of the Jericho area	Palestine
21	Elche Palm Grove	Spain

This weighting combination was determined by minimizing the sum of squared weighted residuals in the pre-intervention period, following the algorithm of the SCM. Our core idea is to create a synthetic control group that can realistically simulate the development trajectory of the treatment group in the absence of conservation intervention.

2.3. Interview

We conducted interviews with 24 individuals representing diverse social and professional backgrounds relevant to the governance and transformation of MPG. This included 6 participants from the OPM/ENNAKHIL District—agencies directly involved in the management of the MPG—and 9 individuals from planning entities such as the Municipality and the Urban Agency of Marrakech, which are responsible for broader urban development and thus play a role in the area's expansion. The remaining 9 participants were local residents of the MPG, 4 of whom are actively engaged in its rehabilitation.

The selection of interview participants was informed by a thorough understanding of the hierarchical structure of relevant administrative institutions. We primarily engaged with department heads responsible for urban planning and green infrastructure within the municipal government. Participants were identified either by directly inquiring about the individuals responsible for specific interventions in the study area or through referrals from initial contacts, who directed the research team to individuals more closely involved with the subject matter.

Key interviewees included the Director of the MPG Observatory and his secretary, the Head of the Green Spaces Department at the Urban Agency, the Head of the Green Spaces Department in the Ennakhil District along with three employees from the same sector, the Head of the Urban Studies Division in the Urban Agency, four architects from the Municipality of Marrakech, an architect affiliated with the National School of Architecture of Marrakech, and a private architect specializing in projects within the MPG.

Tailored interview questions were designed for three distinct groups—governmental actors, planning department professionals, and local residents. For governmental actors, the focus was on institutional roles, governance challenges, and the balance between restoration and ecotourism. Planning professionals were asked about administrative duties, inter-agency coordination, policy frameworks, and development trajectories. Residents were engaged on topics such as personal connections to MPG, perceptions of interventions, ecological knowledge, and suggestions for improved restoration practices.

2.4. Survey and Participatory Mapping

In addition to the in-depth insights gained from interviews, a participatory mapping exercise was implemented to explore local perceptions of the spatial extent and boundaries of MPG. A targeted yet randomly distributed online survey was disseminated via social media platforms, incorporating a MyMaps link that enabled respondents to delineate their perceived boundaries of the MPG. This approach yielded 15 valid responses from individuals with varying degrees of familiarity with the area.

3. Results

3.1. Deforestation Slowing Down

Preliminary land change analysis showed the declined forest and increased urban area in MPG [Figure 2]. Between 2000 and 2020, forest area decreased by 220.3 hectares, representing a 55.64% reduction. Correspondingly, the urban area increased by 240 hectares, a 9.27% rise.

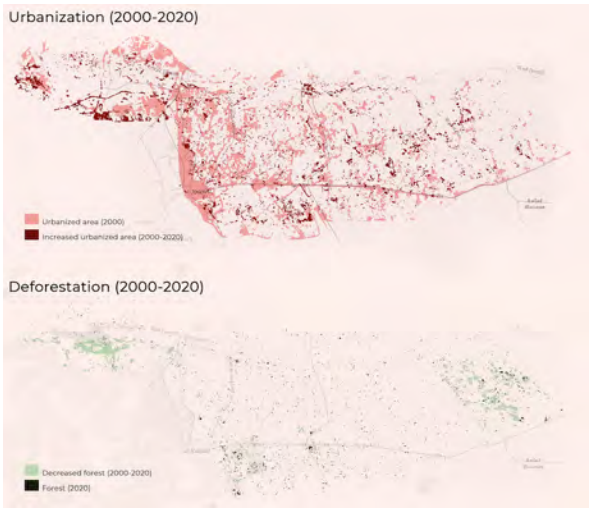


Figure 2. Urbanization and Deforestation of MPG

However, SCM results showed a recent slowdown in deforestation in MPG in

comparison to the other Mediterranean palm groves, driven by the conservation efforts from OPM. Figure 1 illustrates the changes in forest cover area for both Marrakesh and its synthetic control from 2010 to 2020. Prior to the intervention, the forest cover trends of the actual and synthetic MPG closely overlapped, suggesting a good pre-treatment fit. Following the implementation of OPM social governance measures in 2010, actual forest cover in Marrakesh consistently exceeded that of the synthetic control, indicating a positive policy effect.

Table 3. The Treatment Effect

Year	Actual Outcome	Synthetic Outcome	Treatment Effect
2010	2051.90	1903.47	148.43
2011	2029.63	1820.81	208.82
2012	1962.09	1647.14	314.95
2013	2001.09	1611.49	389.59
2014	2066.98	1725.54	341.44
2015	2233.92	1771.17	462.75
2016	2057.16	1687.31	369.85
2017	1605.50	1658.69	-53.20
2018	1606.14	1518.01	88.13
2019	2202.25	1450.16	752.10
2020	1952.43	1279.44	672.99

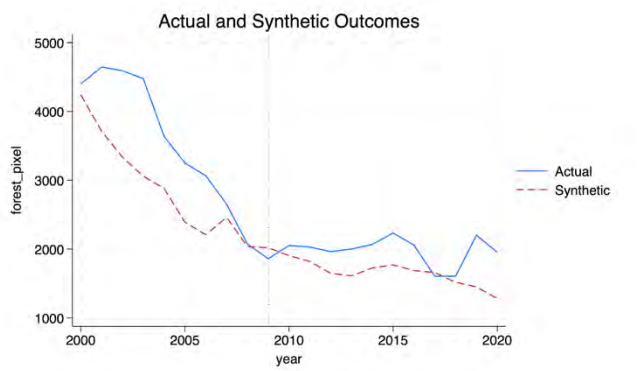


Figure 3. Actual MPG vs Synthetic MPG

Between 2010 and 2020, the average annual forest cover in Marrakesh was 1,979.01 units, while the synthetic control averaged 1,643.02 units, yielding an average treatment effect of 335.99 units. In several post-treatment years—such as 2013, 2015, and 2019—the intervention effect was particularly pronounced, with positive gaps of 389.59, 462.75, and 752.10 units, respectively. Although a minor negative effect of −53.20 units was observed in 2017, the overall trend points to a substantial net increase in forest cover, demonstrating the effectiveness of the social governance intervention in curbing forest degradation.

The permutation test [Figure 4] shows that MPG's gap sharply diverges from the placebo trends after 2010 and remains consistently positive. In contrast, the placebo units exhibit flat or negative trajectories. The solid black line represents the treatment effect (i.e., the gap between actual and synthetic forest cover) for Marrakesh, which was designated as a pilot region for social governance intervention in 2010. Dashed and dotted lines represent placebo gaps from Units 4 and 21, which were not exposed to the intervention. The red vertical line indicates the timing of policy implementation. This visual separation suggests that the treatment effect in Marrakesh is not due to random fluctuation, but rather a result of the policy intervention. The gap plot provides compelling graphical evidence that the policy led to a meaningful improvement in forest cover.

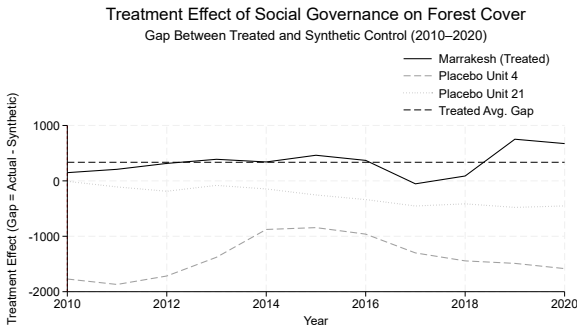


Figure 4. The Treatment Effect of Social Governance on Forest Cover

3.2. Diverging Perceptions: Experts, Residents, and the Value of the Palm Grove (combine qualitative data and interpretation of quantitative patterns)

Findings also reveal a sharp contrast in perspectives: while experts perceive MPG as a fragile and deteriorating ecosystem, driven by pollution, desertification, and the pressures of real estate and tourism expansion, residents exhibit a more ambivalent stance, acknowledging both the economic benefits of tourism and the loss of ecological integrity.

Survey data highlight discrepancies between institutional restoration efforts and community engagement, with many residents unaware of or uninvolved in conservation initiatives.

3.3. Governance Gaps and Community Disconnect (relate interview findings to OPM's effectiveness and data gaps in participation)

The resulting map revealed significant discrepancies between the administratively defined boundaries and those perceived by participants. This divergence underscores a critical spatial disconnect, suggesting that formal planning processes may inadequately account for community-defined understandings of the landscape. These findings highlight a fundamental gap in spatial recognition, emphasizing the need for more inclusive planning approaches that integrate local ecological and cultural valuations.

4. Discussion

These insights align with prior scholarship on the tensions between heritage tourism, conservation, and community participation (Graham, Ashworth, & Tunbridge, 2000; Taylor, 2009).
This study reveals a complex picture of conservation in the Marrakesh Palm Grove (MPG), where formal governance has yielded measurable ecological benefits but remains poorly aligned with community engagement. The application of the Synthetic Control Method shows that interventions by the Observatoire de la Palmeraie de Marrakech (OPM) significantly slowed deforestation post-2010, confirming the effectiveness of institutional conservation efforts.

However, qualitative findings highlight critical gaps. Many residents are unaware of or disconnected from these initiatives, despite their direct proximity to and dependence on the palm grove. Perceptions of MPG's value, boundaries, and identity vary sharply between experts and locals, reflecting deeper tensions between top-down planning and community knowledge. This disconnect is further illustrated by mapping exercises, which revealed spatial mismatches between official and community-defined boundaries.

These results point to the limits of conventional preservation strategies. They support calls for more inclusive governance models that recognize landscapes as co-produced entities shaped by both institutional frameworks and lived experiences. Digital tools—such as PPGIS, social media analysis, and immersive technologies—offer promising means to document diverse perspectives, support local participation, and enhance transparency in landscape planning.

5. Conclusion

While formal conservation measures in MPG have slowed ecological degradation, their long-term success depends on stronger integration with community values and knowledge. A shift toward adaptive, participatory heritage management is essential. By embedding digital tools and collaborative planning into conservation efforts, MPG can evolve as a resilient cultural landscape—one that sustains ecological function while honoring its social and historical significance.

References

The accuracy of the references in the paper is under the full responsibility of the Author/Authors of the paper. All publications cited in the text should be referred to by a number in square brackets, [1,2,3].

The full reference **(maximum 10 references)** should be given in a list at the end of the paper according in the following format / ISO690 / International standart for bibliographic elements:

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RESILIENT REGENERATION OF RURAL MINING PIT HERITAGE LANDSCAPES UNDER SOCIO-ECONOMIC CHANGES: THREE LANDSCAPES IN SUBURBAN AREA OF NANJING, JIANGSU, CHINA

TOPIC: Guiding territories with legislative and social advances in planning: Evolution of heritage landscapes

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Keywords: rural industrial remnants, mining pit heritage, cultural landscape, value, resilient regeneration

Abstract

In rapid urbanization and industrial restructuring, many industrial remnants have appeared in rural areas. As one of the types, the remnants of mining pits are the results of the interaction between industrial civilization and nature. Also, these remnants can be considered typical cultural landscapes to record the traces of artificial activities in nature. However, in the contemporary changing socio-economic relations, for these rural industrial remnants, the transformation of their identities, the challenges of reconstruction of heritage values and identification of local communities are arising. On the other hand, the mission of cultural landscapes has to be emphasized to continue to interact with people in the present and even in the future. In this study, we take three rural mining pit landscapes of different scales and types in the suburbs of Nanjing as research objects, and focus on the historical process of their transformation from " productive industrial spaces " to " heritage landscape landmarks" and the evolution of their forms, functions, and meanings. Through the multi-dimensional mapping method, the data from remote sensing images, mining archives and field surveys are integrated and analyzed. It aims at revealing the resilience mechanism of the evolution of the mining pit heritage landscape in the socio-economic changes and exploring the adaptive practice strategies. Based on the comparison of the three cases, it's found that the three-layered nested value system, including ontological layer (material remnants of mining facilities, geological profiles, and habitat systems), elemental layer (social composition of population mobility and natural & artificial environment under heritage values), and relational layer (regional synergies of pit-countryside-ecological base), is an important element of the resilience mechanism of the rural pit heritage landscapes, and a key part of guiding the regeneration of heritage landscapes. Finally, the study concludes by advocating "heritage + landscape-ing" as a dynamic approach that not only creates the possibility of reconstructing the value of heritage landscapes in response to ongoing urban and rural socio-economic changes, but also guides the practice of regeneration of rural heritage landscapes.

Introduction

China's urbanization has experienced significant growth over the past half-century. In the rapidly changing socio-economic relations between urban and rural areas, rural industry has undergone several transformations, from crude extractive development dependent on natural

resources, to large-scale development by village and town collectives, to friendly development that prohibits damage to the environment. This process has resulted in a large amount of industrial heritage in rural areas, and mining pits are a typical category[1]. As a result of local people's production activities attached to the nature based on specific geographic features, rural heritage sites not only leave an irreversible mark on the rural fields, but also reflect people's past ways of living. Karl Sauer pointed out that the cultural landscape is the result of the interaction between man and nature, in which culture is the main body and the natural area is the medium[2]. Undoubtedly, the rural mining pits are typical cultural landscapes. Nowadays, these heritages are being intervened in different ways to give them a new look and identity in the contemporary process of sustainable urban and rural socio-economic development.

Research and practice on the regeneration of industrial heritage landscapes have focused on the museumization, ecological restoration, renewal and reuse, and heritage tourism[3]. When resilience is used as the thinking of industrial heritage landscape regeneration, both the protection of established elements and the implementation of new design elements emphasize the importance of the process, transforming the heritage regeneration from being regarded as a functional product production-style approach to an open design that is inclusive of future uncertainties[4]. Under the current closely interrelated urban and rural development, seeking a resilience mechanism that integrates the regeneration of heritage landscapes as a medium for the socio-economic relationship between cities and villages has become a necessary path for sustainable development. This paper takes three mining pit heritage landscapes in suburban villages of Nanjing as examples, and aims to explain the historical process of their transformation from "productive industrial spaces" to "heritage landscape landmarks" and the evolution of their forms, functions, and meanings, and discusses a resilience framework from the heritage ontology to the construction of a network of relationships, to the synergy of urban and rural systems.

Methodology and materials

Since 2005, when the Chinese leadership forwarded the ecological concept of protecting green mountains and clear water, the Nanjing Municipal Government has been closing more than a hundred open-pit quarries of different sizes since 2006. The geology of the Qinglong Mountain Range, located on the outskirts of the main city of Nanjing, is rich in limestone and is a major source of raw materials for lime and cement production. Lime mines and lime kiln firing industries have existed here since ancient times, and were at the peak of mining from the 1980s to the beginning of this century, producing a large number of pits. In this paper, three mine pit heritage landscapes of comparable size, but with completely different regeneration pathways, located in the Qinglong Mountains, were selected for study (Figure 1). Based on fieldwork data, archival materials and drawings, we analyze the differences and similarities by comparing the different regeneration methods, processes and outcomes of the three cases, to summarize the intrinsic resilience mechanisms towards sustainable development.

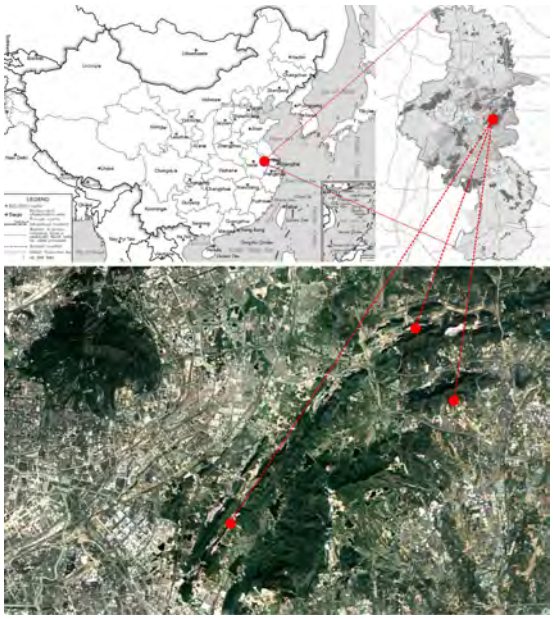


Figure 1. The location of three cases.

1. Case 1: Jiangsu Garden Expo Park Mining Pit Landscape

In 2018, the People's Government of Jiangsu Province, in order to practice the

development concept of urban ecological restoration, chose two mining areas in the hinterland of Qinglongshan Mountain to launch the construction project of Jiangsu Garden Expo Park. The construction will be fully commenced in 2019, and will be completed for public business in 2021[5]. The mining pit Landscape is located on the east side of the Garden, which was once one of Nanjing's large-scale quarry pits, 1,100 meters long, more than 100 meters wide, and ranging from 10 meters to 22 meters deep. The mountain on one side of the pit was mined to form a cliff. The bottom of the pit is almost entirely bare limestone, with large and small puddles. The overall planning of the Park follows the principle of multi-functional integration, with the objectives of ecological restoration, recreational tourism, and heritage education to shape a suburban destination with lasting commercial appeal and tourist attraction. In the plan, a high-end hotel, an outdoor theater, a botanical garden, a restaurant, a café, and other complex functions themed on quarrying culture are to be built at the mining pit. The hotel and the botanical garden are the two core components.

The Mining Pit Hotel makes full use of the cliff landscape and lays out the building along the mountain. The interior of the mine pit is deconstructed and reorganized with elements of the landscape such as stones, cliffs, sunlight, and rainwater. The sinuous shape of the building is consistent with the original pit form, and the large glass windows introduce the pit landscape elements into the interior, so that even part of the cliff wall naturally becomes the wall of the building. The main body of the building is intentionally disconnected from the cliff face and the bottom of the pit, in order to reflect the relationship between the man-made structure and the natural pit, and to emphasize the dominance of the original state of the pit[6]. Lots of pine trees were planted at the bottom of the pit, which, along with climbing vines in the building's corridors, gave green life to the otherwise barren pit. Over time, the plants filled the space between the pit and the building, making the building one with the pit as if it had grown out of it. In this way, the man-made structures were brought back to nature, and the mining pit was revitalized (Figure. 2).



Figure 2. The hotel in mining pit.

The botanical gardens are completely man-made and ecologically restored, with more than 800 species of plants selected for 12 themed areas. In order to create a more modern and interesting place, the roof of the arboretum was designed as a huge transparent pool supported by 42 tall, rooted tree-like structures, through which the sunlight shines vibrantly in the arboretum at the bottom of the pit. The Arboretum uses biodiversity restoration to reshape the negatively inhospitable pit into a vibrant place where the public is happy to interact with nature (Figure 3).



Figure 3. The botanical garden in mining pit.

2. Case 2: Jiangning Tang Mountain Mining Pit Landscape

In 2017, in order to solve the ecological environment problems of abandoned mines and expand the city's outdoor recreational space, Nanjing Tang Mountain Construction and Investment Development Co. initiated the construction of Tang Mountain Mining Pit Park. Here, since 1972, six township enterprises have continued to mine limestone in the open air, which has caused more than 600 acres of environmental damage to mountains, vegetation, and water bodies before production was banned in 2002. The pit side skins in the mining area are subject to serious safety risks such as collapses and landslides. The regeneration of the Tang Mountain mining pit heritage adheres to the principles of ecological restoration, risk abatement followed by treatment, and combines planning, architecture, and landscape design to create a suburban recreational public space with the mining pit as a characteristic landscape.

The restoration and regeneration of the heritage landscape of the mine pit has taken a light intervention approach. In addition to removing the slope spoils and backfilling with high-quality soil for re-greening, the exposed cliffs destroyed by quarrying have been preserved in their entirety. These cliffs are used as the backdrop for the four functions of the hot spring hotel, the waterfall of the pit, the air corridor, and the campsite, depending on the shape and scale of the pit (Figure. 4). The architect uses paving, tunnels, steel ramps and other elements to organize a path that connects the four functional areas, so that visitors can experience the destroyed natural environment up close and cause them to think about the environment and ecology[7]. As the core part of Tang Mountain Mining Pit Park, the pit landscape has attracted a large number of tourists by virtue of its landscape potential of being preserved as a huge cliff face, so much so that it has driven other aspects of economic income such as lodging, food and beverage, and recreation throughout the park. At the same time, the development of these features has provided employment for residents of the surrounding countryside. The regeneration of the Tang Mountain Mining Pit landscape has contributed to the socio-economic development of the entire pit park area.

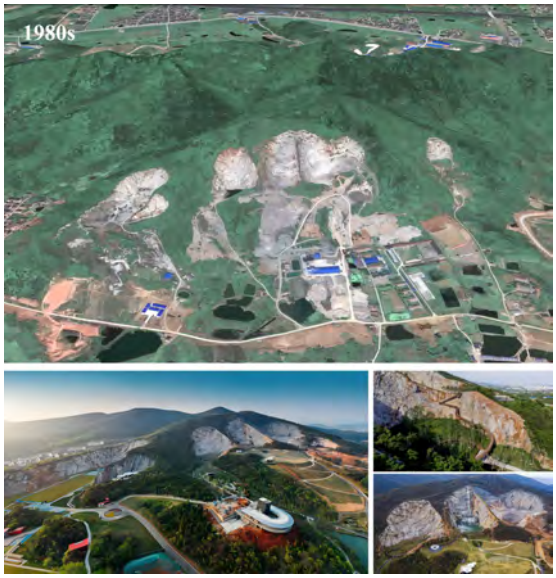


Figure 4. The mining pits as the background of an urban country yard.

3. Case 3: She Village Ten Mile Valley Mining Pit Landscape

According to geological archaeology, the She Village Ten Mile Valley was formed about 2 million years ago by the Quaternary glacial movement, and after a long period of geological evolution, it has formed the 3.2-kilometer-long canyon landscape nowadays. Since the 1990s, this area has been a major lime mining area for the villagers of She Village because of its rich lime content, and in 2007, the Nanjing government banned the mining and shut down the neighboring lime kilns in order to protect the environment. As a result, a long strip of mine pits along the canyon has become a permanent feature of the mountain, recording the history of the local people who once survived by mining and calcining lime.

Unlike the previous two cases where artificial participation in the regeneration of the mining pit was involved, the regeneration of the She Village mining pit took place in a completely natural restoration process. After the mining was banned, there was no additional construction activity in the entire pit area except for regular artificial irrigation, which maintained the self-healing of the vegetation, soil, and microorganisms in the pit area. Habitat and rewilding have become the

keywords for the regeneration of the She Village mining pit. After more than a decade of natural restoration, today, it has been largely re-greened and has become a habitat for more than 200 species of plants and 18 species of wildlife. More interestingly, along with the habitat restoration, it has also become a popular spot for the public to go hiking and climbing on weekends. Without human intervention, the mining pit is in a continuous process of self-healing. And visitors without social differences in status, income, age, occupation, etc., become a part of nature when they arrive here. The mining pit heritage landscape has been an ecological container (Figure 5).



Figure 4. The self-repairing mining pit heritage landscape.

Results and discussion

Obviously, in terms of the regeneration process and results, the three cases are characterized by different regeneration practices under the common premise of highlighting the contribution of the mining pit heritage to the memory of place and aiming at ecological restoration. Case 1 is characterized by a government-led, artificial and complete intervention in the regeneration of the mining pit heritage landscape with a large-scale public cultural event as an opportunity, pursuing high investment and high return; Case 2 is characterized by a corporate-led, semi-artificial intervention in the regeneration of the mining pit heritage landscape to supplement the city's recreational function, emphasizing the influence of the mining pit heritage landscape as the core on the vitality of the whole city's country parks; and Case 3 is characterized by without any dominant player, highlighting the self-healing process of the mining pit habitat, and returning the mining pit landscape to nature utilizing rewilding.

Nonetheless, a common structure of sustainable regeneration lurks in all three cases. The regeneration of these rural mining pit heritage landscapes cannot be separated from the socio-economic pull of the city, where groups from the city (both citizens and tourists) are the subject of the perception and experience of mining pit heritage values compared to local villagers. The past geological conditions or the restored habitat systems that have been preserved in the mining pit heritage itself are the objects that are perceived and experienced. A structural and dynamic element-relationship is needed to bridge between urban and rural heritage. The elemental layer consists of transient and mobile social spaces facilitated by population movements and adaptive functional attachments, and physical spaces that allow the natural environment to interact freely with human behavior. The relational layer consists of the rural mining pit heritage being given an explicit landscape function to harmonize and complement urban functions. Whether for commercial consumption, park recreation, or wilderness hiking, the landscape attributes of the mining pit heritage are used to harmonize the everyday lifestyles of urban citizens. Within such a structural framework (Figure 6), the regeneration of rural mining pit heritage landscapes is closely linked to urban territories, heritage entities, heritage values, socio-economic development, and urban-rural functions, conferring resilience to the regeneration process and outcomes.

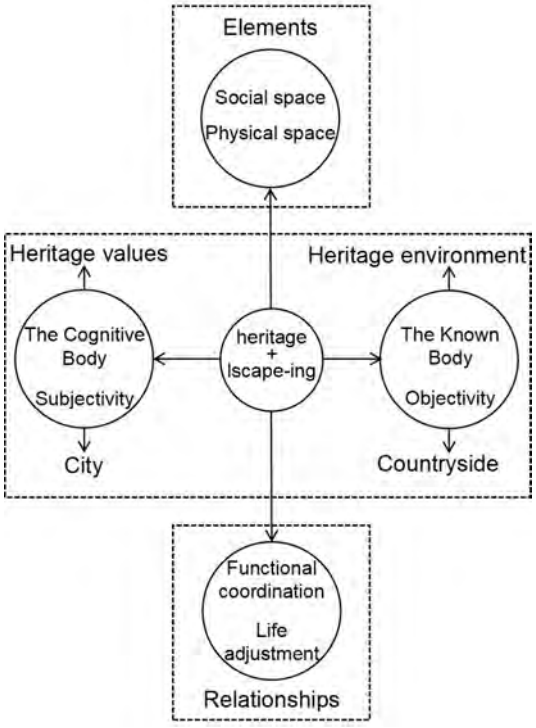


Figure 6. The sustainable regeneration structure is constructed by ontology, elements and relationships.

While the regeneration of the three mining pit heritage landscapes so far has shown good results in restoring natural habitat systems, it is important not to lose sight of the continued growth of plants within the habitat systems, the migration of animal types, and the behavioral and psychological changes of the people experiencing them. Indeed, the life and mission of a heritage landscape should never be considered to be over once a practical regeneration project has been completed. On the contrary, the regeneration of heritage landscapes should be processual, with man-made and natural elements as a continuous interaction. We need to look at interventions in heritage landscapes with a work-in-progress attitude, and this is precisely what it means to guide or remodel territories by heritage landscapes.

Conclusion

This paper takes the regeneration practices of three mining pit heritage landscapes in the suburbs of Nanjing as an example, and by comparing three different regeneration practices in terms of methods, processes and results, it is argued that under the premise of realizing ecological restoration as a common goal, a common regeneration structure lurks in the three cases. In the process of urban and rural socio-economic changes, this structure is centered on the layers of heritage ontology, cognitive relationship, and spatial elements, which construct a framework of resilience mechanisms for the regeneration of heritage landscapes. This framework allows for the dynamic evolution of heritage landscapes over time and facilitates a renewed understanding and examination of the dynamics that guide or reshape territories in the process of heritage landscape regeneration. Finally, we also advocate the use of "heritage+landscape-ing" as a dynamic approach to create the possibility of reconfiguring the value of heritage landscapes in response to ongoing urban and rural socio-economic change, and to strengthen the effectiveness of guiding sustainable regeneration of rural heritage landscapes.

Acknowledgments

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HERITAGE VALUE INTERPRETATION AND ADAPTIVE UTILIZATION OF THE ZHUOZHANG RIVER BASIN CULTURAL LANDSCAPE BASED ON DIGITAL HUMANITIES METHODS

TOPIC: Guiding territories with legislative and social advances in planning: Evolution of heritage landscapes

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Keywords: cultural landscape, digital humanities, heritage preservation, value assessment, text mining

Abstract

The Zhuozhang River is home to long-established villages along its banks, which, combined with the surrounding natural environment and local culture, form a linear cultural landscape of significant heritage value. However, current conservation efforts focus largely on isolated cultural relics and structures, lacking a comprehensive approach that considers the interconnectedness of the region's natural and cultural elements. In response, the research team uses digital humanities methods to provide a foundation and strategic framework for the recognition and interpretation of the Zhuozhang River's linear cultural landscape, focusing on its natural and cultural linkages at the regional scale.

Drawing on the cultural display and utilization experience of the Loire River Basin, this research integrates Shanxi's local cultural characteristics. Using cultural landscape as the methodology, the study establishes an analytical framework for the cultural and natural interconnections within landscapes. The framework is based on "one culture, four voices, five themes, and six aspects." First, the study uses the cultural landscape of the Zhuozhang River Basin as the spatial framework, with water culture as the entry point. Employing digital humanities methods, the research combines text data mining, field surveys, and GIS technology to systematically explore the region's historical context and cultural value elements. This is achieved by extracting six tangible carriers of landscape depiction from the concept of "*landscape culture* " — place names, literature, painting, garden landscapes, architectural planning, and cultural writings. The study further integrates text and network data analysis, expert interviews, and field surveys to evaluate heritage value indicators related to five themes of Zhuozhang River water culture: agriculture, folklore, economy, military, and nature. By mapping cultural values to space using geographic information of heritage sites, the abstract cultural values are quantified to generate a spatial layout of heritage values. The research visually maps the spatial correlation of heritage values, creating a network of cultural connections between different heritage sites and regions. These connections form linear or regional cultural linkages, connecting various heritage types and levels within the basin. The study also demonstrates that digital humanities technologies can effectively quantify the cultural heritage elements of the Zhuozhang River Basin and spatially correlate them using GIS technology.

This research elaborates on the multiple values of the Zhuozhang River's linear cultural landscape within the context of five cultural themes, considering aspects such as the natural environment, cultural heritage,

and historical context. The study proposes strategic recommendations for the interpretation of cultural landscape values from three scales—large (municipal), medium (cultural tourism routes), and small (historical scenes). These strategies aim to enhance the systemic and continuous nature of regional cultural heritage, while promoting adaptive protection and revitalization of cultural landscapes in response to climate change. By integrating digital humanities methods, the study bridges cultural heritage protection theory and practice, offering a systematic framework for heritage preservation and display. Ultimately, the utilization of these heritage landscapes helps preserve the continuity and diversity of Central Plains civilization, addressing global challenges in cultural heritage preservation.

The Zhuozhang River Valley contains diverse heritage resources spanning natural landscapes, folk traditions, agriculture, economy, and military culture [1]. Its geomorphological features—such as mountains, springs, and gorges—and rich cultural sites illustrate the relationship between environment and human settlement [2], as well as mechanisms of cultural transmission through mythology, ritual, and performance. Handicrafts and military relics further reflect the region's economic and spatial-cultural diversity. Amid the rise of digital humanities, a key challenge lies in how to digitally interpret and revitalize this heritage to support regional development. Existing studies often focus on individual sites, lacking integrated approaches that emphasize continuity and interdisciplinary digital methods [3].

To address this gap, the World Heritage Loire Valley—celebrated for its castles, historic towns, and agro-viticultural landscapes—offers a relevant analogue: it shares a linear morphology and dispersed heritage pattern with the Zhuozhang River Valley [4,5]. Since its 2000 inscription, a dedicated heritage office has coordinated integrated interpretation, cross-regional tourism routes, and synergistic linkages among agriculture, wine production, and modernised transport, thereby aligning cultural heritage with local economic growth and tourism diversification. These outcomes provide a transferable model for digitally presenting and integrating heritage and industry [6].

Building on the Loire Valley precedent, the present study investigates the Zhuozhang River Basin—where mountains, farmlands, and craft heritage converge—by applying text mining, GIS spatial analysis, and multisource data integration under a landscape-perception framework derived from *Landscape Culture*. By systematically collecting and evaluating local heritage elements recorded in place names, literature, painting, garden design, architecture, and scholarly texts, the research proposes a regionally adapted model for conservation and display, aiming to bridge disciplinary boundaries and embed digital-humanities methods in cultural-heritage practice.

1. Research Foundation and Methodology

1.1Study Area

This study focuses on the Zhuozhang River Basin, with a primary emphasis on the Changzhi region of Shanxi Province—an area historically known as Shangdang, rich in cultural heritage and mythological narratives. The research scope extends from the city-wide cultural analysis of Changzhi to a detailed case study in Pingshun County, culminating in small-scale historical scene reconstructions using AI-generated imagery (Figure 1).



Figure 1. Study Area.

1.2Theoretical Foundation

This study builds upon the six landscape entities outlined in *Landscape Culture* that represent cultural associations: place names reflecting local landscapes and cultural characteristics; literature describing regional scenery; paintings depicting local landscapes; gardens designed for recreation that embody regional identity; architectural planning with local landscape value; and scholarly works that synthesize regional landscape knowledge [7]. These entities reflect an integrated perception of local landscape features, combining both natural and cultural attributes [8]. As such, they serve as the critical basis for constructing a comprehensive, representative system for interpreting the heritage value of the entire river basin. This system provides

strategic support for the continuity and coherence of cultural heritage conservation, display, and adaptive reuse at multiple spatial scales.

1.3Data Sources

The data for this research are derived from six main sources:
1.Historical texts documenting regional evolution, such as the Annals of *Pingshun County, Changzhi Gazetteer of Place Names, and Compendium of Stone Inscriptions of Sanjin*.
2.The local art collection *Zhanghe Shui*, which features regionally distinctive paintings.
3.Sina Weibo data containing online public reviews and commentary.
4.Spatial point-of-interest (POI) data, including natural place names, tourist attractions, and scenic spots with geographic information.
5.Scholarly articles related to the Zhuozhang River, obtained from the China National Knowledge Infrastructure (CNKI) database.
6.Interview records and oral histories collected during field investigations.

1.4 Research Methods

1.CiteSpace and Weibo Data Crawling
This study applies CiteSpace to conduct keyword co-occurrence and clustering analysis based on CNKI literature, identifying high-frequency academic themes. In parallel, a custom web crawler collects relevant text data from Sina Weibo, where word frequency and cloud analysis help extract public attention hotspots. Together, this dual-source method captures both scholarly and societal thematic focuses.

2.Text Mining and Semantic Analysis
Text mining is a core technique within digital humanities, enabling the extraction of semantic patterns from large-scale textual corpora. This supports multidimensional analyses of concepts such as "sense of place" and "authenticity" within heritage contexts across different time scales [9]. By employing tools such as Word2Vec and Gephi, this research conducts semantic analysis on historical texts and digital media data, extracting key themes and associated terms. Furthermore, text mining techniques are used to quantify the relevance of keywords within digital historical sources, enabling the measurement of each keyword's thematic significance.

3.Expert Interviews and Field Surveys
Domain experts score the correlation between keywords and heritage value dimensions, which are then compared with the results from computational models for the first round of calibration. Then, oral testimonies collected during fieldwork are systematically categorized and incorporated into the value assessment framework, providing a second layer of adjustment that enhances the local relevance and explanatory power of the evaluation.

4. GIS Spatial Analysis
Based on POI data and field surveys, spatial models are developed to map the relationship between heritage sites and their geographic contexts. A minimum spanning tree algorithm is then applied to analyze connectivity based on cultural value indicators, producing spatial distribution maps that inform route planning and regional display strategies.

2.Construction of the Heritage Cultural Value System and Spatial Analysis in the Zhuozhang River Basin

2.1Construction of the Cultural Value System

This study proposes a value assessment framework characterized by "one theme, four voices, five objectives, and six aspects" (Figure 2).



Figure 2. Framework for the Cultural Value Assessment of the Zhuozhang River Basin.

Anchored in a single theme—water culture—this framework integrates four complementary voices (local residents, historical records, academic experts, and online media) to capture diverse cultural perspectives. Heritage value is quantified across five aspects—agriculture, folklore, economy, military affairs, and nature—while cultural elements are interpreted through six interconnected landscape dimensions: toponyms, literature, painting, gardens, architectural planning, and scholarly writings. Together, these layers provide a systematic, multi-actor reading of the Zhuozhang River Basin's water-centred cultural landscape.Spatial Exploration of Cultural Values

2.2Space Exploration of Cultural Value

2.2.1 Extraction and Analysis of Thematic Terms from CNKI

Using CiteSpace to cluster CNKI literature on water culture in the Zhuozhang River Basin, this study identifies five principal research fronts (Figure 3). Current scholarship centres on (1) traditional villages, emphasising cultural connotations, settlement morphology, and vernacular architecture in relation to heritage revitalisation; (2) cultural-heritage conservation, focusing on historic relics, temple spaces, and natural settings that underpin regional tourism and exhibit pronounced spatial clustering of nationally significant monuments; (3) folk-belief systems, particularly the cults of King Zhaoze and Yu the Great, which illuminate the nexus between water-dependent settlement patterns and collective cultural psychology; (4) the Lushang mercantile economy, analysing how salt, iron, coal, silk, and Codonopsis pilosula shaped ancient villages and trade routes; and (5) natural-resource utilisation, highlighting the basin's environmental assets. Together, these themes delineate the field's current scope and emergent research priorities.



Figure 3. Clustering Analysis of Water Culture Research Themes in the Zhuozhang River Basin.

2.2.2 Extraction and Analysis of Thematic Terms from Online Media

User-generated data from Sina Weibo were crawled and tokenised in Python, with posts stratified into high-, medium-, and low-like groups for keyword comparison (Figure 4). High-like posts cluster around "Culture," "Dan River," "Hongqi Canal," and "Timber structure," indicating strong public interest in the valley's cultural and architectural heritage; ancillary terms such as "Teeth," "Cliff," "Rope," and "Fallen Rocks" recall the dramatic canal-cutting episode of Ren Yangcheng, underscoring water–livelihood linkages. Medium-like posts foreground natural landscapes and local products through keywords like "water shortage," "river," "Dangshen," and "Taihang Mountains." As like counts decline, temple-architecture terms and peripheral toponyms become more prevalent, suggesting regional connectivity but also revealing a mismatch between public attention and the heritage significance identified in academic research—evidence of insufficient interpretation and display of the Zhuozhang River Valley's cultural landscape. Notably, some temple spaces historically served as hidden military strongholds, revealing an underlying layer of military relevance embedded within the spatial heritage of the basin.



Figure 4. Word cloud results of Sina Weibo posts, categorized by the number of likes: left—high; middle—medium; right—low.

2.2.3 Calculation of Cultural Correlation Weights

By aligning academic research priorities with public interest, this study distills the cultural heritage values of the Zhuozhang River Basin into five key dimensions: natural geography, agriculture, folk customs, military history, and economic activity. Using text mining, expert evaluation, and field surveys, it identifies secondary thematic keywords under each category to construct a structured framework for cultural value interpretation. To evaluate the relative importance of heritage sites, the study introduces the indicator of "cultural correlation," which assumes that the more strongly a site is associated with others, the greater its contribution to the overall cultural landscape. As the influence of secondary keywords on their primary dimensions—and that of the primary dimensions on the overarching theme of "water culture"—varies, it is necessary to assign appropriate weights when calculating the cultural significance of each site.

First, the *Annals of Pingshun County* is used as a regional data source. Text mining methods are employed to calculate the correlation between thematic terms and keywords in historical texts. A higher co-occurrence frequency of a keyword with the thematic term suggests greater importance, thus assigning a higher cultural correlation weight; in this context, the correlation between word vectors serves as the baseline weight.

Second, these baseline weights are further refined and validated through expert evaluations from multiple disciplines. Given the cross-disciplinary nature of cultural landscape heritage values, a questionnaire survey is used to solicit opinions from experts in various fields. The Analytic Hierarchy Process (AHP) is then applied to statistically integrate the expert scoring results, thereby enhancing the scientific rigor and accuracy of the weight assignments.

Table 1. List of Experts.

Type of Expert	Name	Brief Introduction
Architecture	Wang Zongli	Taiyuan University of Technology; Research focus: Architectural heritage conservation and utilization
Design Institute	Zhang Feng	President, Shanxi No. 2 Construction Group Co., Ltd. Design Institute
History	Duan Jianhua	Changzhi Academy; Research focus: Ancient Chinese history, Chinese social history
	Zhao Qianyun	Changzhi Academy; Research focus: History of the Anti-Japanese Base Area, local culture history
Museum	Yang Qiaoling	Director, Changzhi Museum Research Office
Writer	Ma Yulong	Member, China Writers Association; Vice President, Shanxi Writers Association; Vice President, Shanxi Local Chronicles Society
Intangible Cultural Heritage	Li Changrong	Director, Changzhi Intangible Cultural Heritage Museum
Local Administration	Jiang Meiyuan	Director, Cultural and Tourism Bureau, Tunliu District, Changzhi
	Luo Xiaobo	Huangtuling Township, Luzhou District, Changzhi
	Wei Gang	Shanxi Provincial Forestry Bureau
	Ren Jianmin	Party Secretary, Gaozhuang Village, Pingshun County, Changzhi

Third, oral history materials collected through field surveys are systematically organized, incorporating local residents' perceptions of the cultural correlations among heritage elements as a secondary calibration step in the value assessment process. As direct experiencers and inheritors of heritage culture, residents' lived memories and historical understandings are essential for evaluating the value of water culture. Emphasizing the perspective of residents ensures that strategies for heritage conservation and utilization are more sustainable and inclusive. Consequently, value identification and interpretation should ultimately be grounded in local residents' perceptions. Through in-depth fieldwork, the study uncovers the historical narratives and cultural backgrounds of heritage sites, enabling the collection of more detailed and nuanced information.

Overall, residents exhibit heightened attention to aquatic landscapes such as springs, reservoirs, and gorges. These water features are not only integrated into daily life but also bear profound cultural memory and regional identity. Notably, perceptions of water culture vary significantly among populations living near water: those residing close to water sources emphasize memories tied to everyday experiences, while others focus more on the symbolic meanings of water—such as historical anecdotes, geographic landmarks (e.g., "Eight Scenic Spots"), and notable historical figures. Moreover, the decline of agrarian civilization resulting from "village hollowing" and the development of an outward-looking regional culture shaped by war, opera, and commerce together form the complex historical and cultural background summarized in the saying, "Shangdang has always been the backbone of the world."

Ultimately, the cultural value assessment system for water culture is derived by taking the weighted average of the value weights obtained from historical text mining and expert scoring, with further adjustments based on information from field surveys for certain indicators. The results of the water culture value assessment system for the Zhuozhang River Basin in Changzhi, Shanxi, are shown in Table 2.

Table 2. Interpretation System of Water Culture Values for the Zhuozhang River Basin.

Theme	Primary Keyword	Primary Weight	Secondary Keyword	Secondary Weight
Water Culture	Agricultural Production (A)	6.79	Production (A1)	6.68
			Daily Activities (A2)	7.20
			Major Events/Figures (A3)	6.80
	Folk Customs (B)	6.26	Architectural Structures (B1)	6.41
			Places (B2)	6.85
			Images (B3)	5.75
			Beliefs (B4)	6.70
			Related Folk Customs (B5)	5.90
	Economic Activities (C)	5.79	Transportation (C1)	6.25
			Villages (C2)	6.09
			Production Tools (C3)	5.40
			Commodities (C4)	5.89
			Beliefs (C5)	5.45
			Activities (C6)	6.10
			Techniques (C7)	5.60
			Concepts (C8)	5.55
	Military Activities (D)	6.19	Regions (D1)	6.10
			Places (D2)	6.20
			Figures (D3)	6.30
			Events (D4)	6.40
			Place Names (D5)	6.90
			Strategic Tactics (D6)	5.25
	Natural Geography (E)	6.72	Mountains/Rivers (E1)	6.75
			Landforms (E2)	7.30
			Place Names (E3)	7.50
			Climate (E4)	6.45
			Time/Season (E5)	6.20

In the table, the heritage cultural value of the basin is most prominently reflected in the dimensions of natural geography and agricultural production. Specifically, riverside heritage sites are frequently referenced in inscriptions, couplets, and poetry that evoke water imagery; for example, the couplet at Yuanqi Temple—"Mist shrouds the pagoda's shadow, smoke envelops the temple; by dusk, the bell is heard, by night, the tides"—serves as a typical illustration. The use of river systems for irrigation, hydraulic engineering, and rain-praying rituals also demonstrates the interactive relationship and emotional connection between people and water. In addition, the basin serves as a stage for rituals, war sites, and resource exploitation in the realms of folklore, military, and economic activities, highlighting strong spatial narratives and historical records.

2.2.4 Analysis of Cultural Correlations in the Zhuozhang River Basin

Building on the established interpretive framework, this study quantifies the cultural correlation of each heritage site to guide their strategic clustering and differentiated presentation. Machine-learning algorithms are applied to the historical-text database to uncover latent knowledge and spatiotemporal linkages, thereby determining both intrinsic site value and inter-site correlations. Initially, POI data are employed to identify sites along the Zhuozhang River Basin in Changzhi and to geolocate them within a GIS environment. Text-mining techniques are then used to calculate the semantic association between each site and thematic keywords in historical documents; by integrating keyword weights, the analysis produces quantitative correlation scores across the five value dimensions—agriculture, folklore, economy, military affairs, and natural geography—thus generating a network-node landscape model. Aggregating these dimension-specific results according to primary weights (Figure 5) delineates four core zones, six secondary zones, two principal axes, and two subsidiary axes for heritage display and utilisation. At the zonal scale, the method enables flexible integration of spatially proximate, value-related sites to build systematic routes and refined activity programmes; at the linkage scale, it transcends administrative boundaries, reinforces cultural connectivity within the municipal territory, and supports the development of multi-themed, interconnected tourism itineraries.

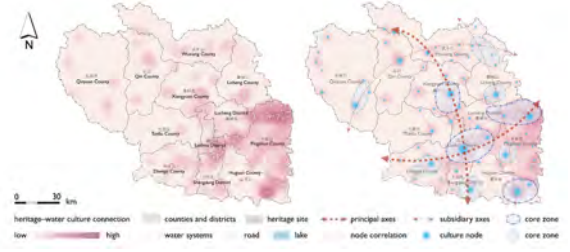


Figure 5 Zoning and linkage strategy for heritage site conservation and utilization.

3.Multiscale Strategies for the Revitalization and Utilization of Heritage Cultural Values

At present, both domestic and international best practices offer a wealth of experience in the promotion and utilization of heritage culture. For example, renowned cultural heritage sites such as the Forbidden City and Summer Palace in China, the Loire Valley and the Louvre Museum in France, and the Statue of Liberty in New York have all developed mature strategies for heritage display. These include the use of digital technologies such as virtual reality (VR), three-dimensional modeling (3D), and augmented reality (AR) to achieve multidimensional, immersive presentations that enhance visitors' perception of cultural and historical value; the production of documentaries and film media to vividly communicate heritage narratives; and the integration of intangible cultural heritage performances, folk activities, special lectures, and exhibitions to boost public engagement and cultural identity. Additionally, effective heritage conservation and utilization increasingly rely on coordinated efforts among government agencies, enterprises, and civil society organizations.

In this study, strategies for the utilization of heritage values in the Zhuozhang River Valley are proposed across three spatial scales. At the macro scale, thematic tourism routes are designed based on the network-node landscape system at the municipal level. At the meso scale, tourism maps are developed to vividly illustrate the heritage values of the Zhuozhang River segment in Pingshun County. At the micro scale, AI-based image generation techniques are used to digitally reconstruct selected historical scenes relevant to key themes.

3.1Macro Scale—Within Changzhi City

Based on the results of cultural correlation analysis at the municipal scale, heritage-themed tourism routes are planned to span multiple counties within Changzhi. This approach supports the synergistic development of cultural heritage with tourism, education, and local communities. Tourism routes can be designed according to different value dimensions, allowing for the construction of diversified thematic paths. Figure 6 presents a schematic example of a principal axis constructed around the value of agricultural production.



Figure 6. Schematic diagram of the conservation and utilization strategy based on agricultural production-themed linkage in the Zhuozhang River Basin.

3.2Meso Scale—Pingshun County

After thematic differentiation at the municipal scale, Pingshun County—distinguished by its rich and diverse cultural resources—is selected as a representative example. Here, a tourism map approach is adopted to provide a detailed interpretation of the county's cultural assets, highlighting local distinctiveness and historical continuity, and enabling the interactive presentation of heritage landscapes and cultural narratives.

The map visualizes mountainous landforms and river courses, revealing the close coupling between upland and river basin cultures. Through resident interviews and field surveys, the map further details the influence of agricultural practices on river basin culture—such as water-carrying in Aozhi Village, the formation of the Chibi Waterfall Scenic Area, and adaptive dry well cultivation. Additionally, the map marks religious buildings, temple fair sites, and nodes of folk activities, illustrating the spatiotemporal distribution of vernacular religious, market, and opera culture.

Commercial routes along both banks of the Zhuozhang River link together industrial heritage sites—such as those of Lutie (ironmaking), Luma (hemp), and Lujiu (liquor)—as well as intangible cultural heritage practices including pile-embroidery, the "Iron Flower" fireworks, and clay sculpture. These connections reflect the co-evolutionary dynamics between the Lushang mercantile economy and river basin culture. This multilayered map thus provides an intuitive and multidimensional tool for interpreting the cultural

value of the basin, while offering a practical spatial framework and display pathway for subsequent heritage conservation, cultural tourism, and community participation.



Figure 7. Tourism map and cultural display strategy for Pingshun County.

3.3Micro Scale—Core Cultural Heritage Sites

This study introduces AI-based image generation techniques, specifically deep generative models such as Stable Diffusion 3, to enable historical reconstruction and contextual storytelling through a bidirectional "text-to-image" workflow. During AI image generation training, the ink structure and color palette from the Zhanghe Shui painting collection are used as visual style references. Fieldwork photographs, combined with oral history scripts, are transformed into multimodal prompts at key narrative nodes—such as villagers carrying water, farming in the fields, and soldiers hiding in temples. These prompts are then used to drive the diffusion model, generating high-resolution historical scene images.

This workflow provides heritage sites with immersive, emotionally engaging visual storytelling tools, significantly enhancing the communication of water culture heritage in the Zhuozhang River Basin and increasing public participation.

Table 3 Visualization of Heritage Value Based on Oral Histories and AI Image Generation

Value Dimension	Oral History Script	Field Photograph / Historical Scene Reconstruction
Natural Geography	When groundwater was abundant, numerous springs were distributed along the Zhuozhang River. Children were often fascinated by bubbles occasionally emerging from the spring eyes, and distinct ripples could be seen when they stepped in the water or threw stones, though such scenes are now rare. One of these springs was named "Xiangquan" (Echoing Spring) by the residents.	 
Folk Customs	In ancient times, people lived by the water. Children often played at the water's edge, women washed clothes by the river, and farmers came to fetch water.	 
Economic Activities	Along the river basin, courier routes were established; Lushang merchants frequently transported polished Lu iron products southward using oxen and horses, and Lu silk was shipped to the capital, while tea merchants traveled north from the south.	 
Military Activities	The river valley became a strategic location for military deployment during wartime, and some temple spaces were often used to hide troops.	 
Agricultural Production	As the terrain rises, the connection between dwellings and the river becomes more distant. Farmlands are mostly located on higher ground, resulting in limited water access. Agriculture thus shifted to primarily maize and wheat, with small areas of rice cultivation near water.	 

4Conclusion and Discussion

Grounded in digital humanities methodologies and the theoretical lens of *Landscape Culture*, this study establishes a systematic framework for interpreting the cultural heritage values of the Zhuozhang River Basin and proposes multiscale revitalization strategies. Through the methodology of "one theme, four voices, five objectives, and six aspects," the study achieves the quantification and spatial visualization of heritage values across individual elements and broader landscape structures. By integrating text mining and GIS spatial analysis, it explores five key cultural dimensions—agriculture, folklore, economy, military history, and natural geography—and proposes value-based connectivity strategies that inform regional cultural planning and heritage conservation. Furthermore, the study advances practical strategies for heritage display and reuse at macro, meso, and micro scales, offering theoretical guidance aligned with evolving regional planning and policy systems.

Although this research primarily focuses on the theme of "water culture" due to temporal and data limitations, it presents a methodological model for broader cross-regional interpretation of river basin heritage. Future research should deepen the exploration of multiscale cultural correlations, refine route planning and spatial narratives, and enhance heritage communication through more immersive and narrative-rich experiences. Supported by big data and AI, the proposed framework transcends traditional abstraction, enabling practical and engaging representation of landscape values. The six culturally associative landscape entities outlined in *Landscape Culture* can be further integrated with digital display technologies to strengthen interpretive coherence between heritage sites and surrounding cultural landscapes, thereby maximizing the social, cultural, and economic benefits of heritage in the context of urban and regional development.

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RECONSTRUCTION OF NARRATIVE SITUATION OF WESTERN HAN DYNASTY IMPERIAL MAUSOLEUM SITE LANDSCAPE

TOPIC: Guiding territories with legislative and social advances in planning: Evolution of heritage landscapes

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Keywords: Situational Reconstruction，Cultural Memory，Spatiotemporal Continuity，Western Han Dynasty Imperial Mausoleum

Abstract

The interpretation of ancient urban sites with earthen architectural heritage in East Asia has long been constrained by the authenticity dilemma between "intentional reconstruction" and "authentic preservation of archaeological remains". This contradiction becomes particularly acute in superimposed capital city ruins like those in Xi'an, where defining the cultural role of large-scale "void areas" surrounded by modern urbanization poses significant challenges. Taking the Western Han imperial mausoleums north of ancient Chang'an as a case study, their pyramidal rammed-earth structures have served as enduring cultural landmarks for two millennia. However, the vanished timber architectures and evolving states of archaeological preservation necessitate mechanisms for memory continuity beyond physical forms.

The study proposes a " situational chain" mechanism connecting urban narratives with landscape interventions through a tripartite spatial reference system: At the macro scale, it establishes spatiotemporal correlations between mausoleum clusters and geographical networks, enhancing the perception of historical urban-territorial evolution through a system of spatial reference identifiers. The meso scale addresses fragmented archaeological data within individual mausoleum precincts by integrating newly discovered spatial patterns to construct transitional interfaces between ancient and modern urban fabrics. At the micro scale, fragmentary exhibitions in underground museums activate spatial imagination between surface landscape voids and subterranean artifact clusters through minimal physical interventions. This multi-scalar approach successfully transforms passively conserved ruins into active cultural media, weaving subterranean remains, surface markers, and collective memory into a semantic network of "interpretive fields" while preserving archaeological authenticity.

The study demonstrates that situational reconstruction weaves subterranean archaeological layers, surface markers, and collective memory through semantically precise spatial languages, forming a sustainable "interpretive field". Within the situation of counter-urbanization landscapes, this approach not only enhances public engagement but also coordinates long-term archaeological pressures with urban development needs via a "situation-production" mechanism. It provides a replicable collaborative model for large-scale site conservation in East Asian historic cities, addressing three critical dimensions: 1) Spatiotemporal continuity of geo-cultural landscapes through reference systems; 2) Dynamic supplementation of archaeological knowledge layers; 3) Transformation of passive preservation into active spatial storytelling. The findings emphasize emotional resonance and imagination stimulation as vital bridges between past material forms and present urban realities, offering new operational logic for heritage interpretation in rapidly transforming metropolitan regions.

Text

1. Background: Advantages and Disadvantages of Two Urban Heritage Landscape Strategies in Xi'an

The landscape interpretation strategies for ancient urban sites in East Asia—characterized by earthen and timber structures—have long oscillated between two conflicting approaches surrounding the issue of authenticity in site presentation. This dilemma revolves around how to reinstate the historical "legibility" of archaeological remains while simultaneously embedding them within contemporary urban functions. Two prevalent landscape strategies embody this debate.

The first relies on visually intuitive, intention-driven reconstructions that offer a secondary interpretation of archaeological information. While such direct and result-oriented representations enrich the site's role as a symbolic landmark within urban parks, they also risk transmitting controversial imagery to visitors as definitive one-to-one replicas. This approach seemingly fills in the gaps left by lost materiality, but in doing so, it blurs the boundary between authentic archaeological data and subsequent speculative overlays.

The second strategy avoids overt reconstruction and instead opts for in-situ presentation, exposing foundational archaeological remains in outdoor settings. In this model, the site participates in urban life through its open-air presence. It resembles Rome ' s practice of layering historical and contemporary landscapes, yet China's predominantly earthen ruins—unlike Roman stone-built relics—struggle to generate comparable cultural value as public urban landscapes due to their lower visual readability. As a result, they often remain marginalized and poorly understood by the public.

Despite the Nara Document on Authenticity lending support to some non-material interpretations and partial reconstructions, these methods fall short when applied to the large-scale and largely irrecoverable archaeological grounds typical of cities like Xi'an. As urban expansion continues to expose vast protected zones surrounding major ancient capital sites, the question of these areas' future roles remains unresolved. The ongoing trend in Xi'an reflects a growing hybridity, combining both strategies to varying degrees.

When applied to the interpretation of large-scale urban ruins, these two methods present sharply divergent cultural implications over short and long-term horizons. The first emphasizes immediate readability and visual enrichment of the urban cultural landscape. The second leans on a slower cultivation of public understanding and coexistence with archaeological authenticity. Both paradigms are rooted in Western archaeological methodologies that privilege scientific materiality, yet they lack a unified framework that accommodates integration.

This context calls for a renewed understanding of large-scale indigenous ruins as agents of historical urban narrative, and for rethinking modes of coexistence between cities and their embedded archaeological legacies.

2. The Ruinous Scene of Historical Reverence as a Driver of Extended Urban Memory

Urban construction in China—especially imperial capitals—has long exhibited a distinct continuity of typology and spatial order. For over two millennia, the coexistence of cities and ruins has been a normative condition in Chinese urbanism (Figure 1). The acts of pilgrimage, sightseeing, and historical reflection at ancient sites were once collective practices among the literati, giving rise to a literary and artistic tradition centered on "nostalgic contemplation of antiquity" (Figure 2). This sensibility has remained deeply embedded in the Chinese cultural consciousness into modern times. In ancient Chinese writing, the term for "ruin" was rendered as the character "墟" (xū), a word imbued with an evocative imagery of temporal and spatial collapse. As ruins gradually merged with the natural countryside and shifted from being destinations of solemn visitation to more recreational grounds, they were referred to as "former gardens" (guyuan)—literally "gardens of remembrance." These terms underscore how the significance of ruins was not simply defined by their materiality, but by the changing relationship between human perception and the environment over time. What emerged was a form of scenographic interaction—what might be called a "ruinous situation"—where history and the present moment converged.

A compelling example of this can be seen in the restoration of the façade at the Mogao Caves in Dunhuang. Here, newly constructed cave walls were added not to recreate the original wooden temple structures that may once have projected from the cliff face (which remain historically unverifiable), but rather to simulate the image of caves long exposed in a state of decay. This visual impression of weathered hollowness aligns more closely with the collective memory of visitors, even

though such raw archaeological states cannot be preserved in situ. The act of reconstructing this impression of ruination is, therefore, a response to an understanding of "historical situations" as dynamic states of erosion and change rather than fixed moments in time (Figure 3).

The imperial tombs and associated settlements of the Western Han Dynasty around Xi'an, long arranged in a satellite configuration around the ancient capital of Chang'an, have for centuries served as pilgrimage sites for those reflecting on the grandeur of the former empire. Especially after the Han and Tang periods, these tombs attracted successive generations of nostalgic visitors well into the modern era. Now gradually enveloped by the expanding urban edge of contemporary Xi'an, these monumental earthen pyramids—rising prominently on the plateau north of the city—have endured as the human-made skyline of Chang'an for over two thousand years. Though the wooden architecture that once crowned these structures has long vanished beyond the reach of historical reconstruction, the ruinous landscape itself preserves a longer and more enduring memory.

3. Reconstructing Situations Instead of Reconstructing Voids

If the ancient mode of coexistence between people and ruins—defined by emotional resonance and spatial memory—can be adapted to the present, it may offer a new integrative approach to the two prevailing strategies of site design. Rather than treating archaeological zones as isolated design problems, this approach proposes situational reconstruction as a systematic narrative framework that operates across both the urban and landscape scales. Its aim is to reinvest these sites with historical depth and establish a new balance: to amplify collective memory and embodied perception of the ruins, while maintaining respect for archaeological authenticity and revealing their significance in a piecemeal but intelligible manner through human interaction.

A key question emerges: how can we, amid the ongoing processes of urbanization and archaeological excavation, continue to sustain the memory of these ruins, uncover more of their buried past, and redefine them within the contemporary urban condition—especially when large-scale interventions are restricted by the "void" left by absent structures? One promising strategy lies in developing methods that translate archaeological content into cultural legibility without overwhelming physical reconstruction.

The Hanyangling Archaeological Site Park, one of the most representative and successful transformations among the Western Han imperial mausoleums, exemplifies this approach. Through minimal intervention, it addresses a series of critical challenges: how to extend historical spatial situations, how to supplement fragmented information, and how to reconfigure the site's cultural role within the evolving city. The concept of situational reconstruction is thus positioned as a method that bridges urban-scale storytelling with landscape-scale intervention.

4. Spatial Memory and Configurational Structure of the Hanyangling Site Situation

By analyzing the spatial evolution and enduring landscape structure of the Hanyangling Mausoleum as a carrier of urban memory, this section seeks to reposition the site within a contemporary cultural framework.

Ancient imperial mausoleum sites such as Hanyangling often originated from geographic conditions—hills, rivers, and other large-scale natural features were deliberately integrated into the spatial order of tomb construction. Natural topography functioned not merely as backdrop but as an active generator of the mausoleum's spatial logic. Each successive imperial burial added new layers to this geography, forming a cumulative spatial order that organized territory around the tomb as a referential point.

Over a long period of spatial transformation, Hanyangling has persisted as a constant presence in the urban environment, though its functional roles and urban identity have shifted. Initially, the mausoleum complex was clearly demarcated as a royal funerary zone with accompanying guardian settlements. Like other mausoleums of the same era, it followed siting principles that emphasized visual relationships with mountains and rivers—either confronting, occupying, or symbolically marking the landscape—and was positioned on the northern side of the Wei River, facing the city on the southern bank.

After the fall of the Han dynasty and through nearly two millennia, the above-ground wooden structures of these mausoleums were dismantled or destroyed. Yet the massive rammed-earth pyramids endured and continued to define the northern skyline of Chang'an, becoming fixed points in the collective memory of its people. As ruinous earthen mounds, these mausoleums coexisted with the city, serving as evocative sites where literati across dynasties engaged in acts of historical reflection—"nostalgia for antiquity," "lament for the passing of time," and so forth—giving symbolic meaning to these funerary landscapes at the rural-urban fringe.

Since the early 2000s, as Xi'an's urbanization extended beyond the Wei River into the area surrounding the mausoleums, the Hanyangling precinct has become embedded in the city map as a clearly bounded urban "block." The seemingly "empty" surface condition of these sites, along with the addition of green spaces, made their transformation into modern urban parks relatively easy. However, this shift from a "rural ruinous site" to a "heritage park at the urban periphery" signals a major change in cultural framing that requires the site to be redefined.

Meanwhile, recent archaeological work has revealed the clarity of the site's internal spatial logic.

– On a macro scale, the enduring presence of the earthen pyramids has preserved the visibility of the site's geographic and symbolic structure in the urban outskirts, until recent urban expansion began to interrupt and fragment this spatial coherence.

– On a meso scale, the orderly configuration of the mausoleum—including the pyramid itself, enclosure walls, gate structures, and processional roads—remains legible, though many features other than the pyramids had long been buried or erased. These spatial traces are crucial for reading the site and recovering its historical spatial situation.

– On a micro scale, the layout of tombs and auxiliary structures exhibits small yet meaningful variations. These architectural and burial details provide micro-historical insights that, when aggregated, enable the interpretation of broader systemic patterns.

5. Situational Reconstruction as a Reconfiguration of the Interpretive Field

Unlike traditional methods that attempt to restore lost architectural forms, situational reconstruction avoids fabricating archaeological material by reconfiguring the interpretive environment. At Hanyangling, this method unfolds across three interrelated dimensions, constructing a thematic interpretive field that weaves together subterranean archaeology, surface markers, and collective memory through a semantically precise spatial language:

(1) Macro-scale: Anchoring Perception through Dynamic and Stable Referents—Geographic Situational Factors

At the macro level, the organization of situational elements begins from the urban-historical scale, linking individual tombs into a coherent system and preserving the connective tissue of their geographical setting. These spatial referents help render the mausoleum cluster legible as a consistent feature in the evolving landscape of Chang'an—from imperial burial grounds, to "earthen pyramids in the countryside," to archaeological sites, and now "peri-urban heritage parks." Such cultural stratification requires systemic inquiry into how these sites assume new roles and situations in urban life.

First, although modern development has disrupted the original relationship between the mausoleums and the historical geography, landscape design within the site park should still embody and reveal the original landscape logic—one shaped by geographic reasoning and environmental alignment.

Second, the formal boundaries of these sites, often framed as urban green spaces, require a form of spatial compromise: absolute physical demarcation must be exchanged for the relative continuity of spatial experience and perceptual legibility. The form of the site may evolve within defined limits, while the encroaching urban environment necessitates a redefinition of the site's function and identity. The boundary between city and site must therefore be rearticulated in both physical and conceptual terms.

(2) Meso-scale: Projecting Elements Toward Systems—Capturing Clues of Configurational Perception

At the meso level, where isolated tombs may provide limited data, recent archaeological discoveries offer valuable situational cues for interpreting the internal configuration of the mausoleum precinct. These cues contribute to the broader macro-narrative, while also serving as transitional devices that connect ancient landscape logic to the demands of future urban environments.

Given that most above-ground wooden structures of the mausoleums have disappeared, what remains are earthworks—pyramidal mounds, foundational traces, column bases. Archaeological evidence regarding the site's gates, roads, and wall alignments, uncovered through excavation, provides a crucial substrate for landscape design. These elements are interpreted along visitor pathways that trace routes of historical reflection. Key geographical markers are highlighted to guide both cognitive and embodied engagement, enabling visitors to sketch an overall understanding of the site's spatial logic through movement.

The landscape strategy at this scale emphasizes how each archaeological element, within a secondarily collapsed natural environment, can project its meaning onto the larger systemic context. This projection depends on maintaining the ruinous condition while designing filtered views, movement sequences, and environmental framing that allow visitors to perceive a coherent spatial narrative. Design interventions—such as understated stone

markers evoking ancient monuments, interpretive paving, or minimal constructed elements among reforested areas—serve to express the site's "nostalgic aura" without resorting to imitation. Like ancient stele inscriptions, these features reveal and extend the logic of the site without compromising archaeological integrity.

Seemingly empty and shapeless, these sites come alive through scattered points of historical evocation. These fragmentary spaces enable broader spatial voids to become intelligible. The absence of authentic imagery is no longer a limitation; rather, as the saying goes, "a glance across millennia, a panorama of shifting atmospheres."

(3) Micro-scale: Part-to-Whole Correlation—Sampling Archaeological Situational Fragments

At the micro level, situational reference systems culminate in human-scaled, immersive museum environments embedded within the archaeological site. These minimally intrusive structures selectively exhibit underground tomb objects in direct relation to the architectural layout of the mausoleum. By granting spatial legibility to the larger, visually "blank" surface area, these interventions anchor perception in tangible artifacts. Such interior environments preserve the experiential value of macro- and meso-scale landscape voids. Visitors approach with the curiosity of an archaeologist, the imagination of a historical builder, or even the thrill of a tomb raider—each emotional posture contributing to a multidimensional dialogue between past and present. The absence of visual structures on the surface provokes questions, which are then resolved within museum spaces designed to simulate ongoing excavation. This behavioral inversion enhances sensitivity and appreciation toward limited, fragile archaeological phenomena.

Unlike conventional encyclopedic museums that prioritize comprehensive display, these micro-environments promote situational storytelling. The richness of underground finds juxtaposed with the surface's emptiness results in a productive dialectic. As visitors shift perspectives—linking micro artifacts to macro landscapes—they develop a deeper understanding of the site's spatial and temporal dimensions. In doing so, they not only protect untouched archaeological deposits but also discover rare, contemplative landscapes within the urbanized frontier (Figure 4).

6.Conclusion:

From Passive Ruin to Situational Narrative—Repositioning Urban Heritage through a Cohesive Chain of Situations

By establishing a cohesive chain of situations, the Hanyangling site demonstrates how passive and marginalized heritage ruins can be transformed into active and participatory cultural mediums. This approach preserves historical authenticity while engaging contemporary audiences through a narrative-driven design framework. The case of the Hanyangling Archaeological Site Park illustrates how situational design, grounded in spatial storytelling, can enhance public involvement within the context of counter-urbanized landscapes. It also suggests a compelling alternative to image-based, formal reconstructions by instead fostering interpretive experiences rooted in context, memory, and movement.

Through the translation of archaeological data and heritage information across multiple scales into referential, legible spatial environments—both large and small—this method enriches the cultural depth of large-scale heritage landscapes. More importantly, it signals a paradigmatic shift from defensive preservation toward proactive situation production.

This research thus advocates for heritage landscapes that evoke emotional resonance and stimulate imagination, positioning them as dynamic links between past and present material conditions. In doing so, it offers a replicable model for historically layered cities in East Asia undergoing rapid transformation—where the pressures of archaeological conservation and urban development must be delicately balanced.

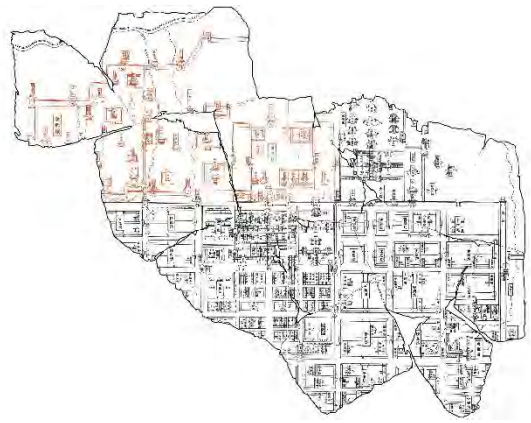


Figure 1. The Han Dynasty city ruins in the Chang'an Map as part of the Tang Dynasty imperial gardens



Figure 2. a monumental reading.





Figure 3. The Mogao Caves murals restored according to the language of ruins protection

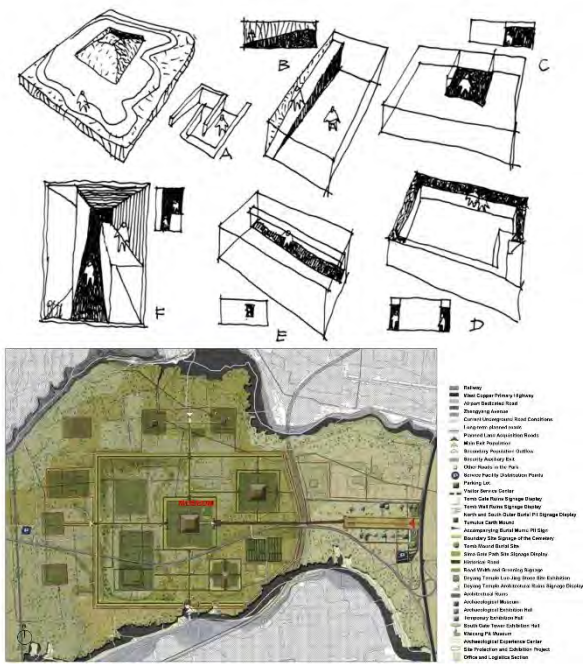


Figure 4. The architect's sensitive handling of the museum's sightlines benefits from the achievements of ground environment narrative.

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SAN LUCAS ISLAND NATIONAL PARK AND LAS CRUCES BIOLOGICAL STATION: EVOLVING HERITAGE LANDSCAPES OF PUNTARENAS, COSTA RICA

TOPIC: Guiding territories with legislative and social advances in planning: Evolution of heritage landscapes

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Keywords: Heritage landscapes, Heritage value, Conservation, Tropical landscape, Cultural landscape

Abstract
Puntarenas is one of the seven provinces of Costa Rica (CR) that extends along the Pacific coast of the country. Despite being a vulnerable area, it has enormous scenic potential and important protected areas such as San Lucas Island National Park and Las Cruces Research Station (CRS), both of which are heritage sites due to their cultural and natural value. The Island was declared a national heritage site in 2002 and the Station is part of the "Talamanca Range-La Amistad Reserves / La Amistad National Park", a World Heritage Site since 1983.

The objective of this paper is to analyze two CR sites with heritage value, as well as their evolution both spatially and in terms of valuation, seeking alternatives for their conservation. Some of the methods used are field work, surveys, botanical inventories and interviews.

The collective imagination associated with these landscapes has changed drastically, going from spaces considered of little aesthetic value to highly valued spaces. San Lucas Island (472 ha) was populated between 1000 and 1500 by native peoples. From 1873 to 1990 it was transformed into a penitentiary center where a series of buildings were constructed to preserve its history. Climate change has caused droughts, floods and loss of coastal areas. The island underwent an important change of valuation being declared a National Wildlife Refuge in 1991 and a National Park in 2020. As a conservation proposal, an Infrastructure and Landscaping Master Plan was designed based on sustainable development. It promotes planning based on green and blue infrastructure, generating a non-anthropocentric response. Additionally, a proposal for Landscape Units was made and imaginaries were formulated to represent the design strategies.

In San Vito, where Las Cruces Station is located, there was an abrupt transformation from tropical rainforest to coffee plantations in 1950 (Quesada & Díaz, 2019), and deforestation continued unchecked until 1965. In 1990, national policies began to control this forest loss by creating the Amistosa Biological Corridor. The CRS, formed by the Wilson Botanical Garden and a 365 hectares of forest, has undergone major changes that have been little studied. In 1962, Robert and Catherine Wilson decided to settle on this site to develop a tropical garden of relevant importance. Shimizu (2015) confirms the important influence that Burle Marx had on the design. In the 1970s, the OTS acquired this property and began to describe this garden as a paradise.

In conclusion, these sites represent unique examples of valorization of the tropical landscape with a patrimonial importance that has varied over time, being this evolution part of its relevance. Las Cruces protects a portion of tropical wet premontane forest and the legacy of the Wilsons; while the island protects a remnant of tropical dry forest, in danger of extinction, as well as archaeological and architectural landmarks. The regulatory protection documents have supported the improvement of the conditions for biodiversity conservation, however, it is necessary to continue with the transdisciplinary work of landscape architects to understand the different layers that make up the essence of these sites.

1. Introduction

Puntarenas is one of the seven provinces of Costa Rica, extending longitudinally along the country's Pacific coast. Despite being one of the most vulnerable areas of the national territory, it holds a vast landscape potential. Covering an area of 11,265 km², it features a remarkable diversity of landscapes and landforms, including valleys, islands, beaches, and mountains, as well as a significant socio-ecological history. It is home to important protected and conservation areas of great environmental and cultural value, such as Isla San Lucas National Park, located in the Gulf of Nicoya within the Central Municipality of Puntarenas, and Las Cruces Research Station and Wilson Botanical Garden, located in the southern Pacific highlands of the Coto Brus Municipality, near the border with Panama. Both spaces have been recognized as heritage sites due to their undeniable cultural and natural value. Isla San Lucas was declared a National Heritage Site in 2002, while Las Cruces Station is part of the "Talamanca Range–La Amistad Reserves / La Amistad National Park", designated as a UNESCO World Heritage Site in 1983. This article aims to analyze two heritage-valued contexts in Costa Rica, along with their spatial and perceptual evolution over time, identifying alternative strategies for their conservation.

2. Materials and methods

Some of the methods used included collection techniques and analysis of historical data. Fieldwork was also carried out, along with the systematization of information by transdisciplinary teams. These efforts included surveys, spatial analyses, botanical inventories, studies of local flora and fauna, analysis of the issues identified across the study areas, interviews, and photographic documentation. Likewise, through transdisciplinary collaboration, diagnoses and proposals were developed to enhance the landscape potential and sustainable use of the sites.

3. Results

3.1 San Lucas Island National Park

The collective imagination associated with these landscapes has changed drastically, shifting from spaces once considered to have little aesthetic value, where the importance of tropical nature was minimized, to highly valued spaces. San Lucas Island, with an area of 472 hectares, has undergone a significant transformation process. It was inhabited from the year 1000 to 1500 by indigenous peoples. At least eight archaeological sites have been identified, with residential, domestic, and funerary characteristics. From 1873 to 1990, the island was transformed into a penitentiary center, where a series of buildings that today hold heritage value were constructed. Its walls not only tell the story of architecturally significant structures but also of injustices and desolation experienced during that time. The island's native flora was heavily altered as a result of human activities, such as forest thinning and small-scale livestock farming to meet the food needs of the prison population [1]. Climate change has manifested in the area mainly through extreme temperature events, rainfall, and tides, resulting in prolonged droughts, more frequent flooding, and loss of coastal areas due to rising sea levels. In 1991, the penitentiary was closed due to the island's ecological importance. In 2001, through Decree 29277-MINAE, San Lucas Island was declared a National Wildlife Refuge, becoming part of the Central Pacific Conservation Area. On September 21, 2020, San Lucas Island National Park was established by Law 9892, published in La Gaceta No. 233, which, in addition to its designation as a Protected Wildlife Area, defines it as a historical-architectural heritage site and a zone for sustainable tourism use, within the specific areas determined by the law [1].

As part of the island's conservation efforts, the "Master Plan for Infrastructure and Landscape Design" was developed under the leadership of First Lady Claudia Dobles, during the 2018–2022 administration, with the goal of promoting tourism

and heritage values. The plan was coordinated in collaboration with the multidisciplinary consulting team from Nagel S.A. It was based on a vision of sustainable development that positioned the island as a hub for ecological, cultural, and beach tourism, grounded in five key dimensions: archaeology, historical and cultural heritage, underwater heritage, natural heritage, and biological diversity. From an environmental and landscape perspective, it was considered essential to responsibly and equitably manage the island's natural and historical resources, since it shelters a remnant of tropical dry forest—one of the world's most endangered and scarce ecosystems—as well as archaeological landmarks and the infrastructure of the former San Lucas Penitentiary. The planning process emphasized the integration of green and blue infrastructure as a core component. It also promoted low-impact sustainable tourism and the protection of the region's limited water resources, guided by the principles of biophilic design. Furthermore, the plan proposed a non-anthropocentric approach, one that includes consideration for animals and the island's floristic diversity.

A detailed analysis was conducted to support the decisions of the master plan. A diagnosis of the current conditions was carried out, which included mapping the entire island to identify ecological habitats, highlighting sightings of fish, mollusks, amphibians, reptiles, bats, birds, and mammals. Likewise, as shown in Figure 1, an analysis was developed using an overlay of slopes, elevations, contour lines, and, in the bottom layer, a 3D massing model of the island. Isla San Lucas has an elevation ranging from 0 to 220 meters above sea level (masl) [2]. In the first layer, areas with the steepest slopes (greater than 40%) are represented in red; slopes ranging from 20 to 40 masl are shown in orange; slopes between 10 and 20 masl appear in yellow, and slopes from 0 to 10 masl are in white. Regarding the tidal analysis, a model was created using three different climate change scenarios based on Balog, Chaves, and the U.S. Global Change Research Program, showing the possible tide increases by the year 2100 depending on future actions taken. The rise in tide levels, from 60 cm (best-case scenario) to 2.43 m (worst-case scenario), would cause degradation of the island's coastal edge, loss of the beach, ecosystem transformation, and erosion of the land where the first line of vegetation is located. To counteract these future effects and mitigate the impact of tides during climatic events, the use of mitigation structures was proposed by utilizing the existing stone on the island to build protective dikes that take advantage of the landscape's qualities and generate multifunctional docks for gatherings, observation zones, or recreational areas.

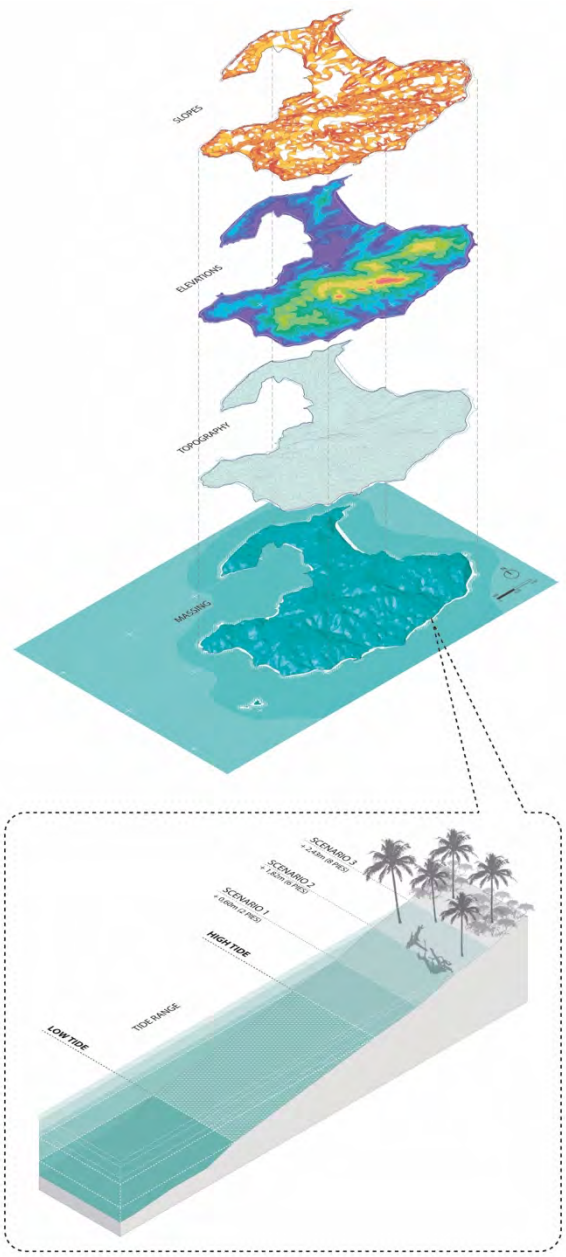


Figure 1. Topographic maps and sea level projection diagram. Source: own elaboration based on Chaverri, Nagel et al., "*Master Plan for Infrastructure and Landscaping of San Lucas Island*" (2020), Balog, J. (2018), Chaves, F. (2018), and U.S. Global Change Research Program (2014).

A synthesis map of landscape components was developed, incorporating elevations, slopes, faunal diversity, management zones, land cover, capacity, and land use classification. The mapping of wildlife sightings helped identify relationships between fauna, flora, and the site sectors. Notable examples

include cliffside areas with *Plumeria* sp. trees used by birds for roosting, mangrove zones inhabited by diversity of mollusks, and evergreen forest patches frequently visited by howler monkeys. These conditions support the identification of key areas of interest for visitors to experience the island's biodiversity. Subsequently, the analyzed layers were integrated to identify potential zones sharing similar characteristics, allowing for the identification of landscape units and a deeper understanding of the island's spatial configuration.

Landscape units were firstly determined by the particular conditions of each sector, such as mangroves, beaches, cliffsides, forest patches, or a series of buildings and then defined according to broader features, including elevation changes and the dispersed distribution of floristic cover across the island. As a result, twelve landscape units were identified, each encompassing an area that maintains a certain degree of homogeneity. The analyzed units were named according to their most prominent feature and are listed as follows:

1. Heritage Complex Unit
2. Mangrove Unit
3. Beach Unit
4. Cliffside Unit
5. Pasture with Trees Unit
6. Evergreen Forest Unit
7. Low Deciduous Forest Successional Mosaic Unit
8. High Deciduous Forest Successional Mosaic Unit
9. Low Mature Deciduous Forest Unit
10. High Mature Deciduous Forest Unit
11. Adjacent Islands Unit
12. Maritime Zone Unit

To define these units, several aspects were analyzed, such as the types of forest present in the different areas (deciduous or evergreen), their maturity, floristic composition, slope type, elevation, their relationship to the sea and associated fauna, all of which served as distinguishing elements. From a cultural perspective, the presence of indigenous archaeological sites or built heritage from the penitentiary era were also important factors in the landscape analysis (Figure 2).

Finally, the Master Plan for Infrastructure and Landscaping was developed, focusing on the intervention of five defined sectors on the island: Heritage Complex, El Coco Beach, El Inglés Beach, Tumba Bote Beach, and Hacienda Vieja Beach. Figure 2 shows the proposed projects for each sector, grouped into twelve categories.

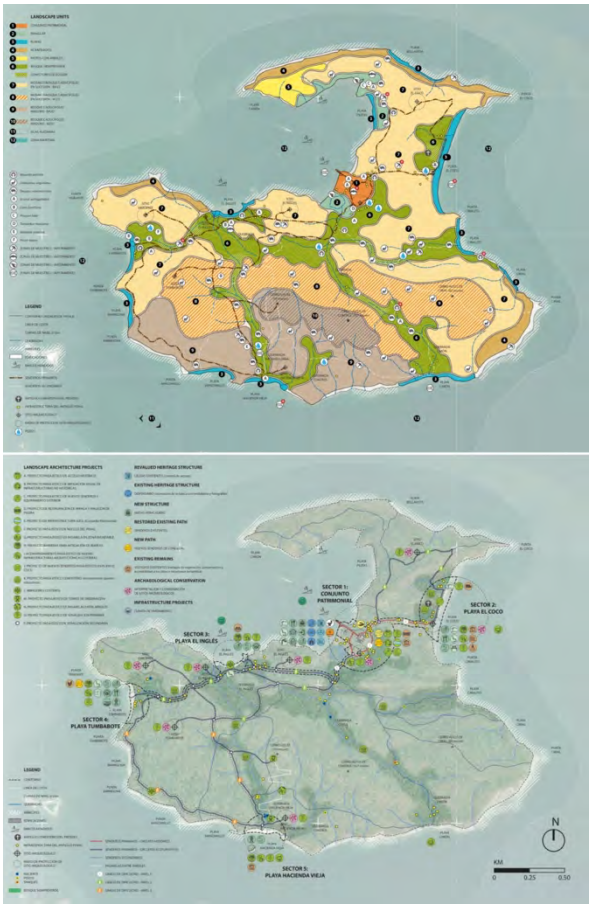


Figure 2. Map of Landscape Units and Master Plan Proposal, Interventions by Sector. Own elaboration based on Chaverri, Nagel et al., "*Master Plan for Infrastructure and Landscaping of San Lucas Island*" (2020).

Specific design strategies and imaginaries were also developed for the island, supported by photomontage technology using original materials to represent the proposal and its design strategies. The landscaping project "Historic Access: Calle de la Amargura and Universal Trail with Associated Gardens and Restoration of Historic stormwater channels" (Figure 3) involved the landscape intervention of the main access paths within the Heritage Ensemble, emphasizing the site's historical memory. As a result, guidelines were generated, such as accentuating the access rhythm with vertically growing species, selecting species of historical importance as *Cocos nucifera*, promoting three vegetation layers (low as shrubs, medium as small trees, high as palms), placing vegetation alternately in

the plan, and including xerophytic gardens with low-maintenance plants suited to infrastructure requirements. Likewise, it was proposed to maintain native vegetation along the edges of the new universal trail, using evergreen trees to create rhythm and climatic protection, incorporating native species notable for their flowering, trunk, or foliage as focal points, and including tactile elements as well as sensory gardens along the universal access trail featuring aromatic species that are pleasant to the touch. Finally, the combination of different ground textures, the conservation of historical elements (such as an old telephone booth), the preservation of original material and dimensions, and the restoration of damaged sections of the historic roadway were proposed.

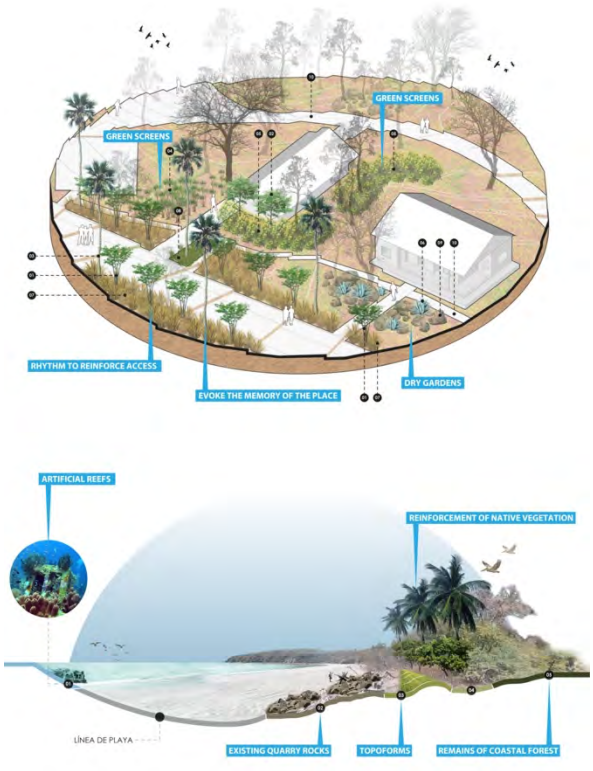


Figure 3. Guidelines for the "Historic Access Landscaping" and "Tide Mitigation Barriers" projects. Own elaboration, based on Chaverri, Nagel et al., "*Master Plan for Infrastructure and Landscaping of San Lucas Island*" (2020).

For the "Tide Mitigation Barriers" project (Figure 3), a series of buffer elements were proposed, which can be used in combination depending on the characteristics of each beach. As previously noted, beach areas represent the most vulnerable zones in the face of projected sea level rise in the coming years. For this reason, it is essential to develop natural mechanisms that can buffer tidal surges and coastal erosion in ways that are resilient to climate change. The proposed guidelines include five buffering barriers: a first line of protection consisting of artificial reefs; a second composed of rocks extracted from existing quarries on the island; followed by a third layer of protection shaped by landforms; a fourth barrier involving the reinforcement of typical beach vegetation, such as coconut palms; and a final buffer made up of the remnants of the coastal forest. Additionally, the project aims to enhance areas that show ideal conditions for the formation and restoration of mangroves, which refer to zones that present a connection between river and sea water, moderate wave action, and the presence of mangrove species. Mangroves provide vital ecosystem services such as erosion control, sediment trapping, protection of coral reefs, carbon sequestration and storage, and improved water quality. Therefore, the protection of native mangrove species on the island, such as *Rhizophora mangle* and *Avicennia germinans*, is considered essential.

3.2 Las Cruces Biological Station

The area of San Vito where the second site is located had maintained its forest cover until approximately 1940. However, by the late 1940s, with the arrival of new settlers, both national and Italian, the landscape underwent a rapid transformation, converting tropical rainforest into pastures and coffee plantations in just a decade [3]. From 1965 to 1990, agricultural activities continued with widespread deforestation, driven by livestock farming and urbanization processes. Over approximately 40 years, the area experienced a 70.3% loss in forest cover [3]. In the 1990s, the zone underwent agricultural diversification, which brought new patterns of forest fragmentation and increased habitat loss [3]. However, during this same period, national policies aimed at controlling deforestation began to take effect. Later, in 2010, the Amistosa Biological Corridor was established with the goal of restoring connectivity and strengthening linkages between forest areas and reserves, with Las Cruces located at its midpoint [4]. Thus, Amistosa was created as a biological corridor that seeks to connect the mountains of La Amistad International Park (PILA) —passing through indigenous territories as well as Piedras Blancas National Park, the Térraba-Sierpe Wetland, and the Golfo Dulce Forest Reserve— with Corcovado National Park on the Osa Peninsula [5].

As shown in Figure 4, Las Cruces Research Station lies within the corridor, as well as the regional high water abundance. The influence of nearby Protected Wildlife Areas is significant, as within a 5 km radius there are two key sites: the San Vito Wetland Protected Area of 45 hectares and the Palustrine Wetland Laguna del Paraguas with 49.5 hectares. Both areas declared under the Wetland Management category in 1994, protect primary and secondary forests, water resources, and ecosystems of high value for both migratory and resident bird species.

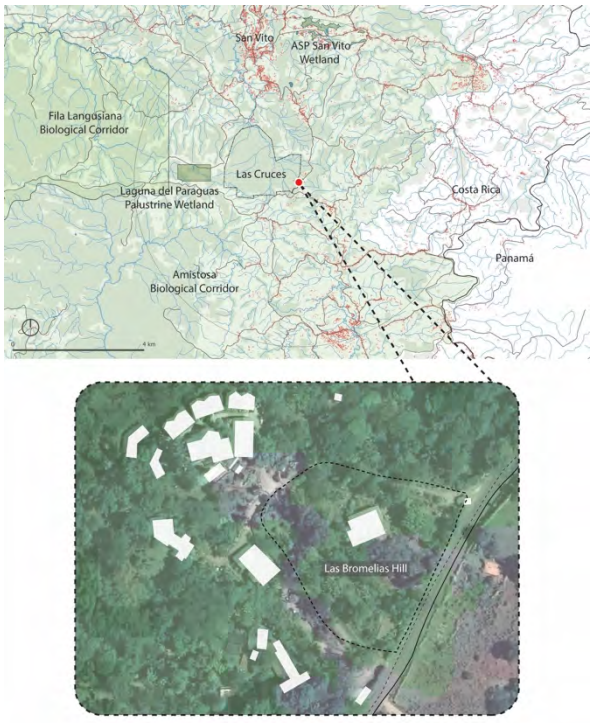


Figure 4. Location of Las Cruces Research Station and biological corridors. Own elaboration based on SNIT cartography. Image montage by Luis Solano.

Las Cruces Research Station, which includes the Wilson Botanical Garden with an area of 10 hectares and an additional 365 hectares of forest, is located within the influence range of the Premontane Very Humid Forest life zone (according to Holdridge's classification). This area has also undergone significant transformations. In 1962, American horticulturists Robert and Catherine Wilson decided to establish their estate in Las Cruces de San Vito to fulfill their dream of developing a tropical garden that could help preserve desirable horticultural plants for the American tropics [6]. Holly Shimizu (2015) confirms the significant influence that Burle Marx, one of the most prominent landscape architects of the 20th century, had on the design of the Wilson Botanical Garden and the Bromeliad Hill during one of his visits to Costa Rica in 1962 [7]. This adds to the cultural relevance of the site, where an intellectual, cultural, and botanical exchange between Brazil and Costa Rica began, generating discourse that emphasized the value of tropical vegetation.

There is no doubt that both Robert and Catherine Wilson were among the main promoters for the use and appreciation of bromeliads in Costa Rica, native species of the tropical Americas that were, at the time, rarely used in ornamental gardens. After conceiving The Bromelliad Hill as a site for experimentation, they published the book "Bromeliads in Cultivation" in 1963, a study designed to serve as a practical tool for people with little botanical knowledge to learn about and appreciate bromeliads. Through its illustrations and identification guide, the book enables readers to successfully recognize and cultivate these types of plants. It is especially important to highlight the following acknowledgment from the book: "The buildup of enthusiasm for the subject is much more involved. The opportunity of visiting Roberto Burle Marx, the Brazilian landscape architect, in his country and seeing so many bromeliads growing in nature was inspiring" [8], demonstrating the friendship and exchange that existed between the Wilsons and Burle Marx. Moreover, the couple contributed significantly to the conservation and research of native species. For instance, the tree *Blakea wilsoniorum*, discovered in the region, was named in their honor.

In 1973, the Organization for Tropical Studies (OTS) acquired this property along with other adjacent natural areas, which were incorporated into the land to form what is now known as Las Cruces Research Station. Today, the station functions as a center for research, education, and visitation, contributing to conservation efforts as one of the largest remaining forest fragments in the region. Restoration and reforestation projects have been carried out in collaboration with the local community, focusing on the production and planting of native species and the recovery of degraded areas. These efforts have contributed to increased forest cover and the restoration of regional ecosystems.

From an aesthetic and symbolic perspective, Victoria Padilla described the Wilson Botanical Garden as a paradise, "the Mecca" for plant enthusiasts, in "The Bromeliad Society Bulletin" [9]. This garden has one of the most important tropical

plant collections in Central America [10]. In this sense, the landscape is understood as a social construct that involves the perception and interpretation of a territory, where the tropical world is valued, in contrast to early 20th-century narratives previously mentioned. It is also worth noting that in 1983, UNESCO declared the garden a World Heritage Site, as part of the Talamanca Range-La Amistad Reserves / La Amistad National Park, highlighting the importance of its plant and animal collections, reinforcing the institutional recognition of the tropical garden's value.

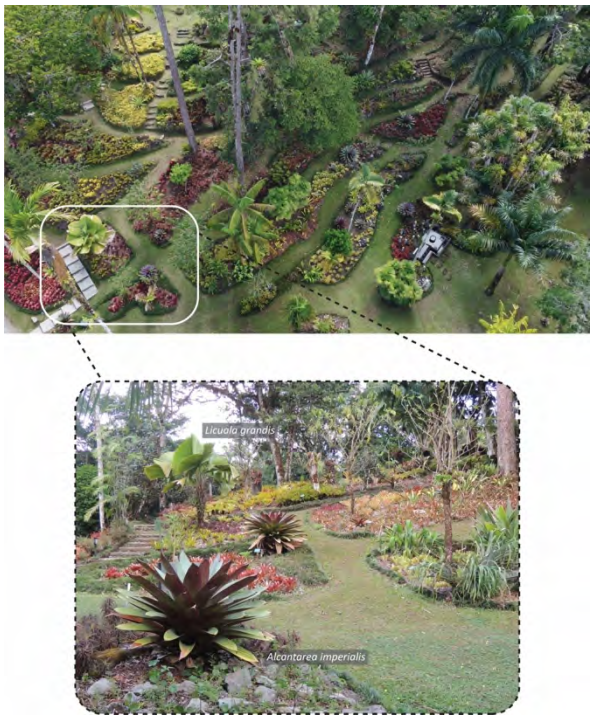


Figure 5. Aerial and detailed photograph from the north-west sector of the Bromeliads Hill. Source: Luis Solano (2022) and Laura Chaverri (2019).

Figure 5 shows a current image of the Bromeliad Hill Garden. It is presumed that many of the species still present are part of the original design, which features a series of elongated islands with various ground covers combined with palms such as *Prestoea acuminata*, *Rhapis humilis*, and *Chamaedorea costaricana*. The hill includes a set of stairways and ramps covered by grass that lead to the highest point, where the original Wilson house still stands, now functioning as part of the OTS facilities. In the photograph, two of Burle Marx's signature plants can be seen: the ruffled fan palm (*Licuala grandis*) and the imperial bromeliad (*Alcantarea imperialis*, formerly known as *Vriesea imperialis*) [7], which is native to Brazil. Additionally, the composition includes a wide variety of bromeliads, both from Brazil, such as *Nidularium innocentii*, and native to Costa Rica, such as *Aechmea magdalenae*.

4. Discussion and conclusion

In conclusion, these sites represent unique landscapes of heritage, ecological, and touristic importance, which have changed over time. Las Cruces Research Station protects one of the largest remaining fragments of tropical wet premontane forest in the country [10], along with its socio-economic history. Meanwhile, the island safeguards a remnant of tropical dry forest –a rare and endangered ecosystem worldwide– as well as archaeological landmarks and the infrastructure of the old prison. The evolution of these spaces is thus part of their relevance. A paradigm shift toward the appreciation of tropical landscapes is evident in both cases, however, they remain vulnerable to deforestation and the effects of climate change in surrounding contexts. Regulatory protection documents have supported the enhancement of conservation conditions for both ecological and cultural diversity. However, transdisciplinary work must continue, in collaboration with landscape architects, to understand the multiple layers that form the essence of these sites.

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HOW DOES THE PUBLIC DEVELOP AN AESTHETIC EXPERIENCE TOWARDS INDUSTRIAL HERITAGE LANDSCAPES? ——A DISCOURSE ANALYSIS BASED ON SOCIAL MEDIA DATA

TOPIC: Guiding territories with legislative and social advances in planning: Evolution of heritage landscapes

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Keywords: Industrial heritage landscapes, Social media data, Discourse analysis, Urban regeneration, Natural language processing

Abstract

Industrial heritage bears unique memories of industrial civilization's evolution, possessing profound historical, cultural, aesthetic, and multi-dimensional values. In recent years, with the advent of the stock conservation era, China has increasingly prioritized the preservation and adaptive reuse of industrial heritage. The shaping of industrial heritage landscapes has assumed greater significance in urban regeneration, while scholarly research in this domain has witnessed substantial growth. Although exceptional industrial heritage landscapes are recognized for delivering unforgettable aesthetic experiences to the public, quantitative investigations into public perception and aesthetic experience generation mechanisms remain conspicuously scarce. This study examines Beijing's 789 Art District - a regenerated industrial heritage site in China - as a case study, analyzing 219 online notes, containing a total of more than 64,000 Chinese characters, from rednote, China's prominent social media platform. Through natural language processing (NLP) and coding techniques, we systematically extract aesthetic elements of industrial heritage landscapes. Employing Fairclough's three-dimensional discourse analysis framework, we interpret social media commentary to investigate how industrial heritage landscapes facilitate public aesthetic experiences and manifest through digital discourse. By integrating big data analytics with discourse analysis methodologies, this research establishes a novel paradigm for industrial heritage studies while providing theoretical underpinnings and practical scientific guidance for landscape revitalization within urban regeneration contexts.

1. Introduction

Industrial heritage comprises remnants of industrial culture with historical, technological, social, architectural, or scientific significance, including production facilities, infrastructure, energy systems, and associated social spaces like worker housing and community institutions[1]. Emerging as a preservation focus in mid-20th century post-industrial societies[2], its adaptive reuse now drives global urban renewal and economic revitalization efforts[3].

Industrial heritage landscapes represent the value of industrial heritage, embodying high heritage authenticity and multiple values, and are gradually becoming a key element of urban landscapes. Landscape has long been a significant aesthetic

subject. Essentially, a landscape is an aesthetic system formed by an external environment with aesthetic value, and the process of appreciating it is a process of conveying aesthetic experience.

Given the essential role of aesthetic experience in understanding beauty and art, research in this area has generated growing interest across multiple disciplines recently. Slobodan Markovic[4] identifies three key characteristics of aesthetic experience´: fascination with the aesthetic object, evaluation of the symbolic reality of the object, and a strong sense of unity with both the aesthetic fascination and the object of aesthetic evaluation. Industrial heritage landscapes particularly enable complex aesthetic experiences through their integration of regional characteristics, historical narratives, and cultural symbols. However, empirical studies remain limited due to methodological challenges in capturing subjective evaluations and scaling qualitative analyses. Traditional methods like interviews often yield small-sample data with constrained generalizability.

Rapid mobile and social media development has led to extensive sharing of real-time urban landscape experiences online. Comments on industrial heritage landscapes contain valuable data, revealing, through substantial text reflecting aesthetic unconsciousness, tourists' underlying cognitive structures of aesthetic experience. Compared to traditional methods like interviews, big data analysis of social media comments enhances sample size and authenticity. This established approach in tourism research provides a robust tool for investigating aesthetic experience pathways (Figure 1)..

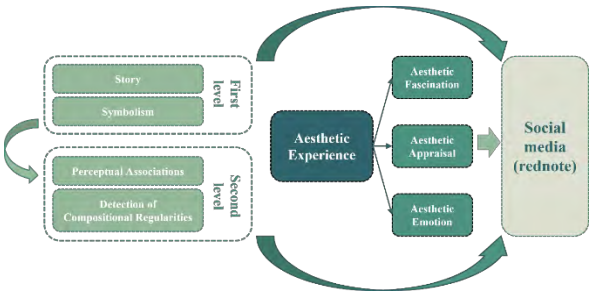


Figure 1. The mapping relationship of aesthetic experience on social media

2. Methodology

In terms of analytical methods, this study adopts Fairclough's three-dimensional discourse analysis framework[5], combined with corpus linguistics, and selects the 798 Art District in Beijing, China—an area redeveloped from industrial heritage—as the research subject. On the rednote platform, 229 posts were collected using the keyword: 798艺术区(798 Art District); after manual filtering, 219 posts were retained to form a corpus. The corpus was segmented and annotated using the CorpusWordParser software, and following the classification proposed by Mengyuan Xu et al., the vocabulary was categorized into aesthetic object (AO), aesthetic perception (AP), aesthetic association (AA), and spiritual state (SM)[6]. Frequency and part-of-speech analyses were conducted for each category, followed by discourse and practice analysis, which provided a basis for further discussion on social practices (Figure 2).

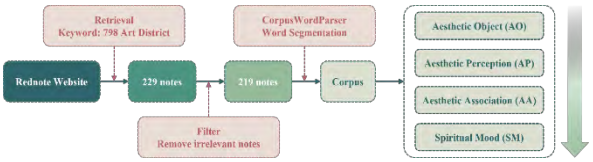


Figure 2. Framework of Data Processing and Analysis Method

Fairclough's three-dimensional discourse analysis aims to uncover the ideologies embedded in language use and the power relations they reflect. In his critical discourse analysis theory, Fairclough critically adopted and integrated various linguistic and sociological theories, while simultaneously transcending and modifying Foucault's ideas. Specifically, he drew upon Halliday's systemic functional linguistics and incorporated sociological theories such as Foucault's discourse theory and Bakhtin's dialogism. On this basis, he developed an analytical framework encompassing three dimensions: text, discourse practice, and social practice[7](Figure 3).

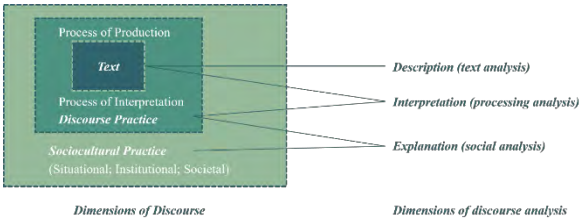


Figure 3. Fairclough's three-dimensional discourse analysis framework

Within this theoretical system, the textual dimension involves linguistic analysis of surface meanings, covering vocabulary, grammar, coherence, and textual structure. Discourse

practice refers to the production, distribution, and consumption of texts, serving as a crucial link between textual analysis and social practice, with an emphasis on who produces discourse, what is produced, and how it is produced. The social practice dimension analyzes the power relations underlying discourse, examining the interactions between discourse and society, and between discourse and ideology. In this framework, texts are the product of discourse practices and are simultaneously shaped by and constitutive of specific social conditions. This study applies the discourse analysis framework to explore the pathways of aesthetic experience, incorporating elements of Jacques Rancière's theory. It not only interprets the fundamental components of aesthetic experience in industrial heritage landscapes, but also reveals the relationship between aesthetic experience and external social systems, along with the ideological forces behind them. This, in turn, assists landscape designers in understanding the generation pathways and discursive expressions of aesthetic experience in industrial heritage landscapes, allowing them to connect with visitors (aesthetic subjects) on a conceptual level, and thereby more effectively engage in the protection and construction of urban industrial heritage landscapes.

3. Text Analysis Result

3.1 Text feature analysis

Using the Weiciyun platform for text analysis, word frequency statistics from the 219 manually screened posts show that "art" appeared 523 times, ranking as the most frequent lexical item aside from functional words like prepositions and articles. Other high-frequency terms included "exhibition" (308 occurrences), "798 Art District" (201), "taking photos" (177), and "visiting exhibitions" (168). Completing the top ten were words like "space," "center," "check-in," "free," and "artist". These high-frequency terms suggest that the 798 Art District, transformed from industrial heritage, mainly serves as a host for art exhibitions. The dominant visitor activities involve attending exhibitions, taking pictures, and participating in "check-in" rituals. It is noteworthy that the word "space" appeared frequently, indirectly reflecting the spatial qualities that characterize the art district. This could be a crucial element in understanding how the public constructs aesthetic experiences of industrial heritage landscapes. The prominence of the word "center" reveals its notable attraction in particular functional or thematic contexts. The high frequency of "free" underscores the economic appeal the art district holds for the general public. A high-frequency word cloud was created for the top 100 terms (Figure 4), and relational networks among selected terms were examined (Figure 5). The relational map demonstrates that "art," "exhibition," and "photography" are closely connected with a wide array of other vocabulary items.



Figure 4. Word Cloud

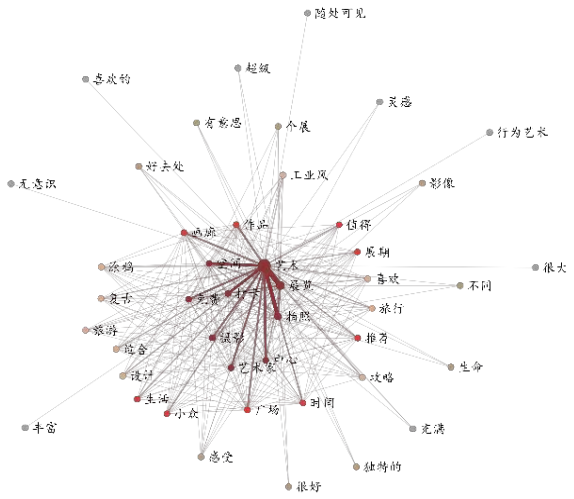


Figure 5. High frequency word network diagram

This reveals the centrality of these three words in the discourse surrounding the 798 Art District on social media. It further highlights the identity and significance of the 798 Art District as an ensemble of industrial heritage landscapes.

Social media corpus data is marked by several notable textual characteristics. Firstly, the text style is predominantly conversational, reflecting the intimacy between content creators and their

audiences. These texts make extensive use of online slang, emojis, and exclamatory phrases, cultivating a lively and conversational atmosphere that bridges the author–reader gap. Such linguistic choices work to enhance the text's authenticity and trustworthiness. Likewise, highly visual vocabulary like "light and shadow," "graffiti," "industrial vibe," and "cyberpunk" are employed to increase textual reliability. These visual descriptions stimulate the reader's sensory imagination, thereby intensifying their aesthetic engagement. The defining factor that makes social media suitable for aesthetic experience analysis is its rich repository of evaluative discourse. Adjectives such as "shocking," "gorgeous," and "soothing," when paired with adverbs like "instantly," "super," and "incredibly," constitute heightened aesthetic appraisals. This rhetorical strategy aims to foster discourse consumers' identification with the multifaceted value of industrial heritage landscapes.

3.2 Interpretation of Text Content on The Generation Path of Aesthetic Experience

Based on the vocabulary list, the classification of terms into Aesthetic Object (AO), Aesthetic Perception (AP), Aesthetic Association (AA), and Spiritual Mood (SM) (Figure 6) reveals that the "aesthetic object" refers to the specific content perceived by the human senses, marking the starting point of aesthetic experience. As an art district transformed from an industrial area, the aesthetic objects it contains include not only artworks (sculptures, paintings, photographs, ceramics) but also spaces, squares, buildings, graffiti walls, former factory sites, and various shops. Aesthetic perception reflects individuals' direct perception of the aesthetic objects in the art district. Some scholars consider this stage to be the first step in the formation of aesthetic experience. This includes various spontaneous emotions and experiences that the aesthetic subject has toward the aesthetic objects. Terms like "photogenic" reflect the aesthetic subject's view that the aesthetic object is suitable as photographic material, which is a sensory experience. "Rich" reflects the direct cognitive experience gained from the aesthetic object, while "surprising" highlights a strong, intuitive emotion evoked by the aesthetic object, all of which reflect the primitive state of aesthetic experience formation. Subsequently, the aesthetic subject, i.e., the visitor, generates relevant associations based on their aesthetic perception of the aesthetic objects. The generation of aesthetic associations is linked both to the objective physicality of industrial heritage landscapes and to the aesthetic subject's life experience and cultural background. Therefore, it covers a wide range of content and reflects the ideologies of the aesthetic subject in specific cultural contexts and eras. It is also a crucial element for later analysis of discourse practice and social practice. For example, "treasure" as an aesthetic association expresses the aesthetic subject's perception of the object as valuable and rare, while "Bauhaus" as an aesthetic association reflects the presence of modernist ideology in industrial heritage landscapes, indicating that the aesthetic subject can understand it. The realm of "Spiritual mood " refers to a "selfless" cognitive phase, in which individuals focus and release their thoughts, thus engaging intimately with the external world and their own self, reaching a resonant state with the aesthetics of the environment."Intriguing" expresses the visitor's synesthetic association with "interest," followed by an abstracted feeling such as "treasure" gained from the experience. This is the final part of aesthetic experience. Unlike aesthetic perception based on direct sensory stimulation, spiritual mood is formed through abstract thinking. Only then can aesthetic experience be generated.

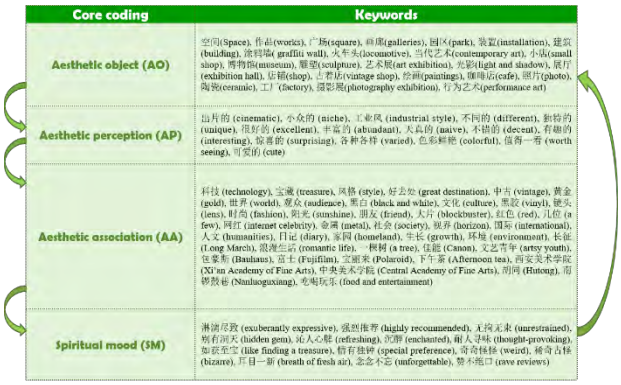


Figure 6. Fairclough's three-dimensional discourse analysis framework

The text analysis reveals that the path of aesthetic experience formation for industrial heritage landscapes is based on the aesthetic subject's (visitor's) direct positive aesthetic perception of three main categories of aesthetic objects: the site carrier, content medium, and commercial services. Based on cultural context, it further generates aesthetic associations related to visual perceptions of industrial objects, cultural symbols & industrial memory, and social behaviors & functional translations, which ultimately abstract into positive.

4. Discourse Practice Analysis Result

In Fairclough's three-dimensional discourse analysis framework, intertextuality[8] is regarded as the key to analyzing discourse practice. The term intertextuality was first introduced by French literary theorist Julia Kristeva in the late 1960s, in her essay *Word, Dialogue, and Novel*. After its proposal, the theory gained widespread academic recognition and was further deepened by scholars including Barthes, Riffaterre, and Foucault. Fairclough strongly affirms Kristeva's theory of intertextuality and further expands the concept by proposing a division between "manifest intertextuality" and "constitutive intertextuality" (or interdiscursivity).

Of the two, manifest intertextuality plays a vital role in conveying aesthetic experience. Accordingly, this study analyzes the discourse practices on social media primarily through the lens of manifest intertextuality. The present study focuses particularly on discourse presupposition as forms of manifest intertextuality.

Discourse presupposition refers to an a priori assumption adopted by the text producer as an established or given proposition. This is typically indicated through a range of conventional surface-level cues that signal implicit textual meanings. As presuppositions are rarely subject to dispute and easily permeate the ideological structures of the subject, they serve as an effective means of influencing discourse consumers. Due to their suggestive nature, discourse presuppositions appear frequently in social media texts. Investigating these presuppositions can reveal how aesthetic experiences originally formed by others are subtly conveyed to discourse consumers. Among discourse presuppositions found in social media texts, two common forms are existential presupposition and evaluative presupposition. Existential presupposition, a crucial category, is often triggered by specific lexical items. For example:

e.g. 798艺术区'必逛'的店铺包括 Tiger Vintage、Underneath Vintage，均价200元就能淘到设计师孤品。("Must-visit" shops in the 798 Art District include Tiger Vintage and Underneath Vintage, where one can find designer one-offs for an average price of 200 yuan.)

This sentence presupposes the definite presence of "designer one-offs" in these shops, and implicitly suggests that "an average price of 200 yuan" is a reasonable valuation. Through the shared assumption that "one-offs possess high value," the text naturalizes shopping as an essential component of artistic consumption. It assumes the reader accepts the logic that "consumption equals aesthetics," thereby conveying an aesthetic experience through the act of consumption via existential presupposition. Similarly:

e.g. 免费展虽少，但'栖息之所'、'折叠节点'等高质量展览仍值得专程打卡。（"Although free exhibitions are few, high-quality ones such as 'A Place of Rest' and 'Folded Nodes' are still worth a dedicated visit."）

In this example, the phrase "though few" presupposes that "free exhibitions are generally scarce," implying that such accessibility is an exception rather than the norm. The term "high-quality" subtly presupposes that "paid exhibitions are usually of superior quality," thus reinforcing the legitimacy of aesthetic expenditure. Moreover, the expression "worth a dedicated visit" presupposes a devoted attitude toward art on the part of discourse consumers—i.e., the readers—conveying a strongly subjective aesthetic experience while legitimizing consumption behavior.

In contrast to existential presuppositions, which primarily serve to legitimize consumption, evaluative presuppositions in social media texts reflect the hegemonic superiority of niche aesthetics in the process of aesthetic transmission. For example:

e.g. 网红店人多俗气，真正会玩的都去"冷门宝藏空间"。（"Popular influencer stores are crowded and tacky; those who truly know how to have fun go to hidden niche spots."）

The phrase "crowded and tacky" presupposes that "mass popularity equals aesthetic inferiority," while "hidden niche spots" presuppose that "niche equals sophistication." Through this binary discursive structure, aesthetic choice is framed as an issue of identity politics. The reader is assumed to reaffirm their cultural superiority by adopting a counter-mainstream stance and aligning with niche aesthetic experiences. Another example of implicit presupposition reinforcing the superiority of niche aesthetics:

In summary, this study reveals that the transmission of aesthetic experience in the context of industrial heritage landscapes—exemplified by the 798 Art District—occurs through a process wherein the aesthetic subject (i.e., the discourse producer) employs visual and textual media to reconstruct

and reframe the aesthetic object via discourse representation. This is combined with discourse presupposition, which triggers similar aesthetic perceptions and associations in the reader (i.e., the discourse consumer), ultimately enabling an understanding of the aesthetic subject's emotional and spiritual states.

5. Social Practice Analysis Discussion

5.1.Commodification of Aesthetic Experience under Consumerism

Within the corpus, aesthetic experience is systematically transformed into quantifiable and tradable symbols of consumption. The core mechanism lies in the deep entanglement between aesthetic engagement and commodity consumption, serving the logic of capitalist reproduction. Physical spaces of industrial heritage landscapes are juxtaposed with commercial brands as "must-visit check-in spots," as in: "The spiral staircase at COMMUNE is a photo magnet — have a beautiful meal for just 80 yuan per person." Such expressions construct an inseparable experiential chain of photography, dining, and shopping, implying that aesthetic experience must be realized through consumption. This type of social media discourse presupposes an ideology in which purchasing power equates to aesthetic legitimacy, thereby leading readers—unconsciously—to reinterpret their appreciation of industrial heritage landscapes as a competition of economic capital, thus granting aesthetic power to commodity symbols. Moreover, although many posts emphasize the term "free exhibition," the logic of recommendation remains dominated by economic rationality, and "free" is interpreted through utilitarian lenses. For instance, one post states: "The Gold Rice exhibition is free to enter, and you can keep the real gold rice you find—but you must purchase a canvas bag for 19 yuan." Here, "free" becomes a clickbait strategy that eventually loops back to a closed cycle of consumption. This reflects the neoliberal ideology in which "everything is a landscape of consumption," aligning with Guy Debord's notion of the "society of the spectacle." The cultural value of industrial heritage is compressed into a tool for generating traffic, while aesthetic experience becomes bait to stimulate spending. Through terms like "limited edition," "one-of-a-kind," and "celebrity-endorsed," the discourse constructs commodity scarcity as aesthetic scarcity. What readers are guided to pursue is not the art itself, but its symbolic connotation—the enactment of a refined identity through the possession of "unique" items. This mechanism strongly resonates with Jean Baudrillard's theory of symbolic consumption, wherein the cultural capital of industrial heritage landscapes is converted into commodity symbols, becoming a perpetual engine of desire production. Although social media has facilitated the generation and dissemination of aesthetic experience, consumerism has appropriated the same platform to commodify it, displacing aesthetic autonomy with disciplinary consumption.

5.2.Standardization and Superficialization of Aesthetic Experience under Traffic Logic

While social media platforms effectively gather public aesthetic evaluations of industrial heritage landscapes, they also pose significant challenges. The narrative logic of these texts is deeply bound to the algorithmic rules of platforms like Xiaohongshu, reducing aesthetic experience to data-driven visual fragments and reflecting technological interference in cultural expression. A key metric of content value is the so-called "photo output rate," which reduces artistic value to "photogenic potential." This mirrors Debord's "society of the spectacle," where authentic artistic experience is replaced by the displayability of images, and aesthetics become mere raw material for visual data production. The frequent use of platform tags is not a neutral classification tool but a ticket to algorithmic visibility. This strategy forces content creators to compress artistic interpretation into tag-friendly keywords, sacrificing depth for algorithmic compatibility. When "Bauhaus" is mentioned merely as a photo backdrop, its critical modernist spirit is completely dissolved. Expressions like "nanny-level guide" or "quick-hit route" reframe the exploration of industrial heritage landscapes as efficiency-driven tasks. This "aesthetic of efficiency" reflects how users are trained as "data laborers," producing maximum content in minimal time. Aesthetic experience production thus degenerates into an assembly line operation driven by KPIs. The reward mechanism of platform algorithms, to some extent, standardizes aesthetic experience into a computable and optimizable data model. Consequently, the discursive authority over industrial heritage interpretation shifts from creators to algorithm engineers, leading to a homogenization of aesthetic experience and a loss of its public dimension.

5.3.Class Stratification and Identity Politics in the Transmission of Aesthetic Experience

Through discursive strategies, social media constructs industrial heritage landscapes as domains of middle-class cultural capital. At the core of this construction is the naturalized link between "refined aesthetics" and "social status," reinforcing class boundaries. Labels such as "niche," "avant-garde," and "design-driven" frequently appear, suggesting these spaces are accessible only to particular social circles. These expressions equate cultural capital directly with social class, enacting what Bourdieu calls the "distinction" strategy—devaluing mass aesthetics as "vulgar" to uphold the cultural rights and aesthetic discourse of the middle class. Emphasis on features like "few people," "quiet atmosphere," and "closed on Mondays" assumes that readers have flexible work schedules and belong to a "leisure class." Such rhetoric frames art consumption as a privilege divorced from productive labor, presupposing a white-collar audience not preoccupied with subsistence. Aesthetic experience thus becomes a symbolic tool to differentiate between "laborers" and the "leisured." The promotion of "child-friendly spaces" further embeds art consumption into familial cultural capital accumulation. This reflects middle-class anxieties over maintaining class status through intergenerational cultural investment, where aesthetic education becomes a tool for class reproduction. It is precisely through such dynamics that the discourse surrounding spaces like the 798 Art District can reframe the transmission of aesthetic experience as a performance of identity.

6. Conclusion

Through the analysis of a large corpus of textual data obtained from social media, it becomes evident that the production and transmission of aesthetic experiences related to industrial heritage landscapes follow discernible patterns. Drawing on Fairclough's three-dimensional framework for discourse analysis, this study outlines the pathways and mechanisms through which the public produces and conveys aesthetic experiences of industrial heritage landscapes, focusing on textual and discursive practices. However, the same social media data also reveal significant issues inherent in the contemporary processes of aesthetic experience production and dissemination. Consumerism and traffic-driven dynamics have exerted substantial influence on how these experiences are generated and shared. In the current socio-historical context, many industrial heritage sites remain in need of adaptive reuse, and the transformation of these sites into meaningful landscapes remains a long-term and complex endeavor. Addressing these challenges requires the active participation of multiple stakeholders across society and the collaborative development of viable solutions. Only then can the essential aesthetic value of industrial heritage landscapes be reclaimed without compromising economic growth.

Acknowledgments
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FROM DONGSHEN WATER SUPPLY CHANNEL TO ECOLOGICAL CORRIDOR: ORGANIC EVOLUTION AND HERITAGE VALUE RECONSTRUCTION OF THE SHIMA RIVER BASIN LANDSCAPE

TOPIC: Guiding territories with legislative and social advances in planning: Evolution of heritage landscapes

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Keywords: Water Conservancy Heritage, Organically Evolved Landscape, DongShen Water Supply Project, Shima River, Integrated River Basin Management

Abstract

During China's socialist construction period, a series of large-scale inter-basin water diversion projects were built, often distributed in linear and nodal patterns. These projects integrate unique cultural resources, forming significant heritage corridors. Unlike static historical buildings or cultural relics, water conservancy heritage is the result of human beings using and transforming nature in different periods, and has dynamic evolution and complexity. Current research focuses more on engineering techniques or historical values, with limited attention to the long-term evolution process of water heritage and its interactions with ecological and social environments. Therefore, it is of great significance to introduce the 'organically evolved landscape' theory to study the dynamic characteristics of water conservancy heritage. In 1963, to address the drinking water crisis of residents caused by severe drought in Hong Kong, the government constructed the Dongjiang–Shenzhen Water Supply Project, with the Shima River serving as its primary water conveyance channel. As urbanization and climate change pose new challenges, the landscape of the Shima River Basin requires continuous integrated management to sustain its heritage value. This paper takes the Shima River as a research case, employing historical document analysis, spatial data interpretation, and field investigation to sort out its evolution from the DongShen water supply channel to a natural ecological corridor. It identifies four key evolutionary stages and analyzes the corresponding ecological and social background, engineering interventions, spatial morphology, water quality changes, and community participation cases. The aim is to refine the evolution path of the Shima River from a single-function waterway to a multi-value symbiotic heritage landscape, providing a paradigm for adaptive management of heritage landscapes in rapidly urbanizing areas and comprehensive water environment governance in high-density urban built-up regions. The study shows that integrated governance and social collaboration can facilitate the reconstruction of water heritage value, allowing it to serve ecological, cultural, and social functions simultaneously.

1. Introduction

In 1992, the World Heritage Convention became the first international legal instrument to

recognize and protect cultural landscapes. The implementation document of the convention, the 'Guidelines for Action', divides cultural landscapes into three types: clearly defined landscape designed and created intentionally by man, organically evolved landscape, and associative cultural landscape. The organically evolved landscape results from an initial social, economic, administrative, and/or religious imperative and has developed its present form by association with and in response to its natural environment. They fall into two sub-categories: one is relic or fossil landscape, whose evolutionary process has ceased, but entities and materials are still retained as important features; the other is continuing landscape, which is closely related to traditional lifestyles and whose evolutionary process is still ongoing. It is necessary to balance protection with adaptation to contemporary society and climate change, and to continue to develop to maintain heritage value.

Water conservancy heritage is usually based on water conservancy projects, gradually expanding to multiple values such as science and technology, social culture, gradually expanding the multiple values of science and technology, social culture, etc., and can even reflect the relationship and laws between water conservancy methods and ecological evolution and cultural changes. The core characteristics are long time and space span, rich heritage types, dynamic evolution, and it is a holistic cultural landscape.

The water conservancy or canal heritage system involves the long-term interaction between human and natural elements, and is highly dynamic and multifunctional, which poses great challenges to its value certification and protection management. Taking the Guangdong-Hong Kong-Macao Greater Bay Area as an example, the river network density in the Pearl River Delta region is 1.03km/km², which is one of the regions with the highest river network density in China, and a large number of urban and rural social and economic activities are concentrated in waterfront areas. The goal of high-quality development of the Guangdong-Hong Kong-Macao Greater Bay Area and Guangdong Province's emphasis on greenways, rivers and lakes provide a historical opportunity for the construction of the Pearl River Basin Water Transport Cultural Heritage Corridor.

However, there is currently a lack of basic survey information, difficulty in coordinating the multiple functions and multiple objectives of rivers, a lack of clear protection tools and efficient collaborative governance among different departments, resulting in the lack of a mature system for value recognition and protection and management methods for water heritage corridors.

2. Continuous evolution of the Shima River Basin landscape

Shima River originates from Da Naoke Mountain in Bao'an District, Shenzhen City, and flows from south to north through seven towns including Fenggang, Tangxia, Qingxi, Zhangmutou, Changping, Xiegang and Qiaotou in Shenzhen City and Dongguan City. Its main tributaries Guanlan River and Yantian River merge into Dongjiang River. The total length of the main trunk of Shima River in Dongguan is about 67.5km, and the average width is 80m. There are many shallows, the flow is fast, the total drop of the riverbed is 70 m, and the average slope is 0.61‰. The slope is larger in the upper reaches and relatively gentle in the lower reaches. The catchment area of the basin is 1,249 km², and 601km² in Dongguan. There are 107 large and small tributaries of various levels. The total area of towns and streets in the basin is 719.8 km², and the permanent population is 1.513 million.

The 'Dongguan-Shenzhen' water supply project was built in the 1960s. It is a cross-basin water diversion and cross-border water supply project built by Guangdong Province under the instruction of the central government. Its main construction goal is to divert the water from Dongjiang River to solve the serious water shortage problem in Hong Kong, while taking into account the water supply and irrigation of towns along the line. The project connects Dongguan and Shenzhen to form a prosperous development corridor, which is of great significance to the water supply stability and industrial take-off of Hong Kong and the cities along the line. It is highly positioned as 'water of life, water of politics, and water of economy' and is a physical witness to the development of cities at the forefront of the Reform and Opening Up.



Figure 1. Dongjiang River Basin

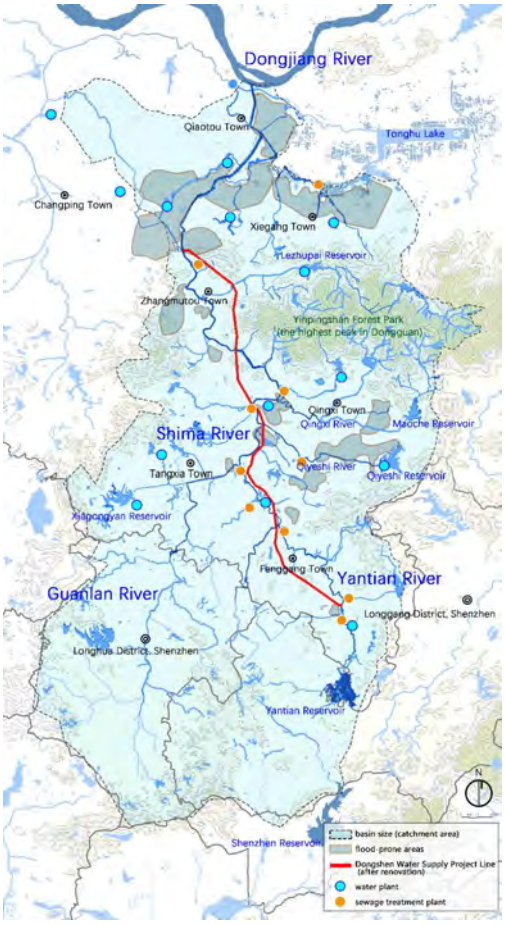


Figure 2. Shima River Basin

The Shima River, the main river in the initial project, has undertaken the special mission of water supply in DongShen in the past, witnessing the rise of the seven towns in the east of Dongguan from former agricultural towns to the ‘ the Top 100 Economic Towns in China’ in China, and connecting the friendship between Guangdong and Hong Kong. After the DongShen Water Supply Renovation Project in 2003, the Shima River ended its water diversion function and resumed its flow. It then focused on pollution control and gradually shifted to comprehensive management of the entire river basin. From ‘water supply channel’ to ‘polluted river’ to ‘clean river’, it is a vivid epitome of the changes in Dongguan's water ecology in the past decade. The Shima River has undergone continuous evolution with the construction and renovation of the DongShen water supply project, transforming from a natural river into the water diversion channel for the water conservancy project, and finally restoring into a multifunctional natural and cultural ecological corridor. Its hydrological environment and heritage value have undergone profound changes, reflecting the typical characteristics of the organically evolved landscape.

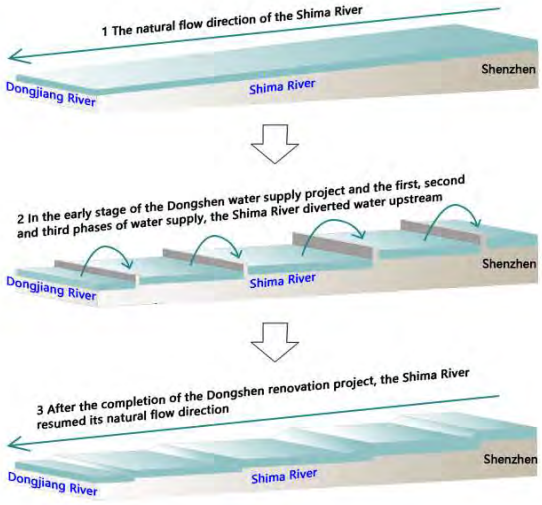


Figure 3. Three stages of hydrological environment changes in Shima River

The continuous evolution of the Shima River Basin landscape and the DongShen water supply project can be divided into the following four periods:

2.1.'Natural river period'—Shima River originated as a seasonal river in the mountainous area

Shima River, a tributary of the left bank of the lower reaches of Dongjiang River in the Pearl River system, is located in the eastern part of Dongguan City. It originates in Shenzhen and was named Jiujiang River in the Qing Dynasty. Shima River is a part of the natural ecosystem of the Dongjiang River. It has the typical characteristics of a mountain river. The water level changes with the seasons and the river will stop flowing during the dry season.

The basin was an agricultural society in the early days. The Hakka people along the coast of Dongguan and Shenzhen have been taking water from Shima River for generations for daily life and agricultural irrigation, giving birth to a unique folk culture tradition. The core contradiction during this period was floods and human settlements. There was a lack of water conservancy facilities in the basin, droughts and floods were frequent, and seasonal floods threatened agricultural production and residents' safety. However, due to the small and scattered population and residential areas during this period, floods mainly submerged farmland, and the impact was relatively small.

2.2. 'Water supply channel period'—DongShen Water Supply Project diverted the water from Dongjiang River through Shima River to Hong Kong

Hong Kong is surrounded by the sea on three sides and has extremely scarce fresh water resources. Severe water shortages have occurred many times in years or seasons with little rainfall. After the end of World War II, with the influx of immigrants from the mainland, Hong Kong's population grew rapidly. In addition, the processing and export trade flourished, and the demand for water was high. In 1959, the Hong Kong authorities and the Guangdong Provincial Government reached a consensus on the construction of the Shenzhen Reservoir to store water for Hong Kong. The Shenzhen Reservoir was completed in 1960. According to the agreement, 22.7 million m^3 of drinking water will be provided to Hong Kong every year. At the end of 1962, Hong Kong experienced the worst drought in history. Although the Shenzhen Reservoir also tried its best to increase the water supply to Hong Kong, it also needed to take into account the water use of local residents. The Hong Kong government adopted a variety of methods such as limiting water supply time, desalination of seawater, digging deep wells, and sending cruise ships to the Pearl River Estuary to draw fresh water, but it was difficult to solve the problem from the root. In 1963, Premier Zhou Enlai personally instructed to use the natural river channel of Shima River to build the DongShen Water Supply Project to divert the water from Dongjiang River to alleviate Hong Kong's water difficulties.



Figure 4. People queuing to fetch water under Hong Kong's water restriction system



Figure 5. Hong Kong sent cruise ships to the Pearl River Estuary to draw fresh water

The initial project of DongShen Water Supply basically follows the natural river course of Shima River and Yantian River. The construction period is only one year. There are many challenges. The most difficult part is to transform the natural water conservancy conditions and let Shima River flow back from north to south. The project is 83 km long, including 6 dams, 8 pumping stations, 2 regulating reservoirs, 17 large gates and a total of 16 kilometers of artificial channels. The water intake point is located in Qiaotou Town. Through an artificial river channel 80m wide and 3km long, Dongjiang water is introduced into Qiaotou Pumping Station, so that the river water is raised and flows back into Shima River. After that, the water level is gradually raised by 46m through multiple dams and electric pumping stations to be injected into Yantian Reservoir, and then connected to Shenzhen Reservoir through artificial channels, and finally imported into Hong Kong through water pipes.

As Hong Kong's population and economy grew rapidly, the authorities negotiated with the mainland government on several occasions to increase the water supply of the project. From 1974 to 2003, the DongShen Water Supply Project was expanded three times.

The core function of Shima River during this period was to serve as a water supply channel for the DongShen Project to ensure water supply for Shenzhen and Hong Kong. Other functions included irrigation, sand and gravel transportation, and flood discharge. The landscape of the watershed is characterized by the straightening or channelization of some river channels, the construction of dams, sluice gates and other structures, and the transformation from a stream-like river channel with a dry season to a cascade water storage section landscape that is full of water all year round. The flood level is generally higher than before. The flow direction changes from unidirectional to bidirectional flow with reversible flow during water supply period The core contradictions during this period focused on water supply and ecology. In the process of the original hydrological process being replaced by engineering intervention, the aquatic environment and flood status changed accordingly, the ecological value weakened, and flooding affected towns. On the other hand, because the protection and confidentiality level of the DongShen Water Supply Project was high, the public was not allowed to enter the relevant areas at will, and could not see the river flowing backwards during the water supply period. The visibility of the landscape and the level of public awareness are not high.

2.3. ‘Pollution worsening period’—DongShen Water Supply Renovation Project to separate the polluted Shima River

Since the Reform and Opening Up, Dongguan has rapidly developed its manufacturing industry and has become the ‘world factory’. A large amount of industrial and domestic sewage is directly discharged into the Shima River, and the water supply is seriously polluted. The Guangdong Provincial Water Resources Department has conducted research and demonstrated that there is an urgent need to carry out systematic transformation of water supply project.

The goal of the DongShen Water Supply Reconstruction Project is to achieve the ‘separation of clean water and pollution’ of water supply and the polluted Shima River, build a dedicated water pipeline, separate it from the Shima River, and appropriately increase the water supply along the line. The waterway is fully enclosed for transportation and management. The route has been significantly straightened, passing through towns via open channels and box culverts, while aqueducts have been constructed to resolve conflicts with rivers, and tunnels have been dug through mountains. The project started in 2000 and was completed and put into use in 2003. The total length is 51.7 km. The starting point is located at Taiyuan Pumping Station, and the end point passes through Yantian Tunnel to Shenzhen Reservoir. Before the implementation of the reconstruction project, there were also some construction projects aimed at solving water quality problems. Due to the recent construction time and the same construction purpose, they were all included in the DongShen Water Supply Reconstruction Project, forming a major building and structure system of ‘4 pumping stations, 3 aqueducts, and 1 biological nitrification station’. Many of the technologies are world-leading and have superb scientific and technological value. The annual water supply after the renovation is more than thirty times

that of the first phase. The annual water supply of the project has increased from 41.05 million m³ in 1965 to 820 million m³ in 2023. Up to now, the cumulative water supply to Hong Kong has reached 30 billion m³, and the water quality of the water supply is ensured to be free from pollution and better than the national surface water Class II water quality standard, meeting about 80% of Hong Kong's fresh water needs, and providing a solid and strong water resource guarantee for Hong Kong's social stability and economic take-off

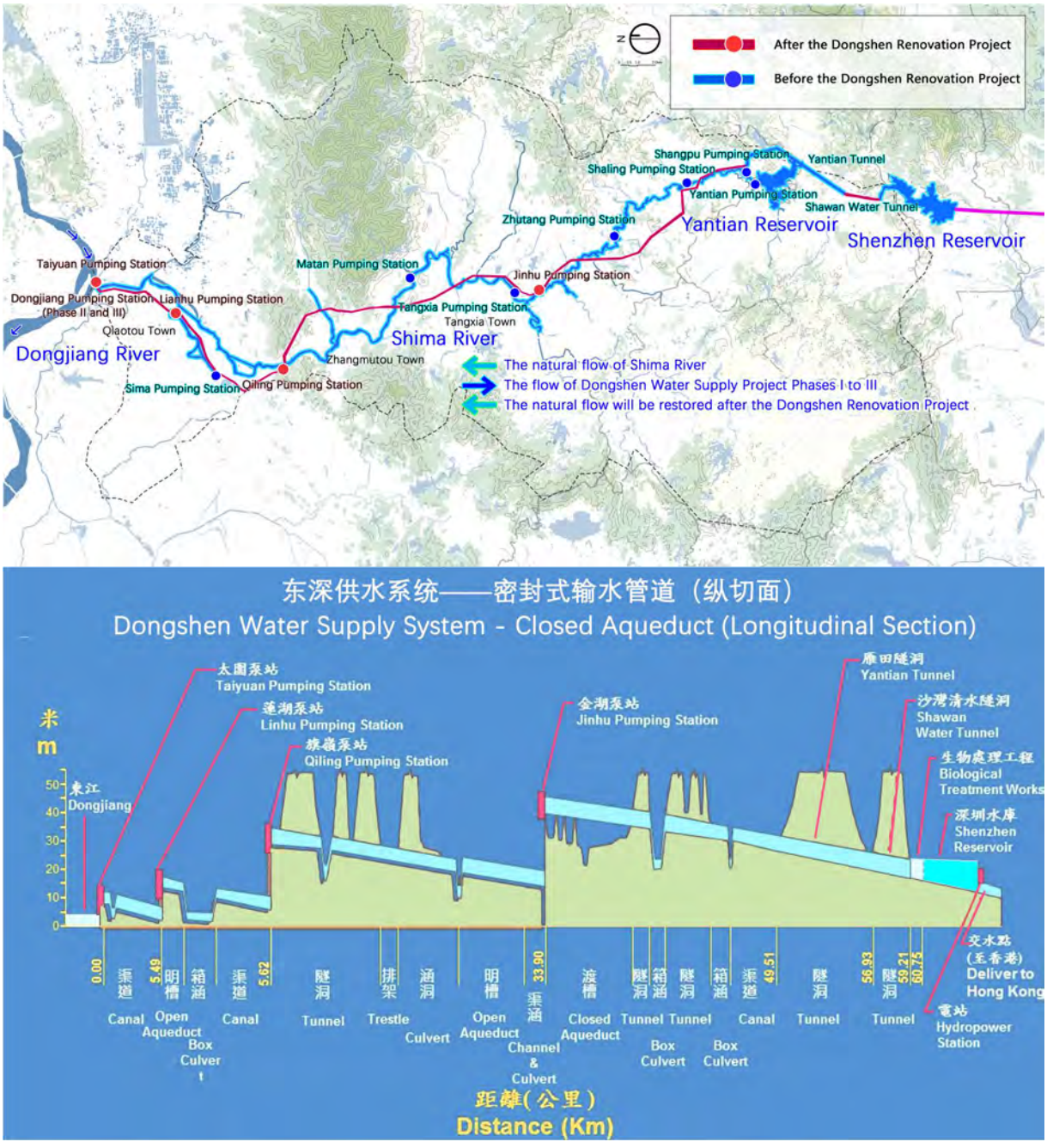


Figure 6. the DongShen Water Supply Reconstruction Project

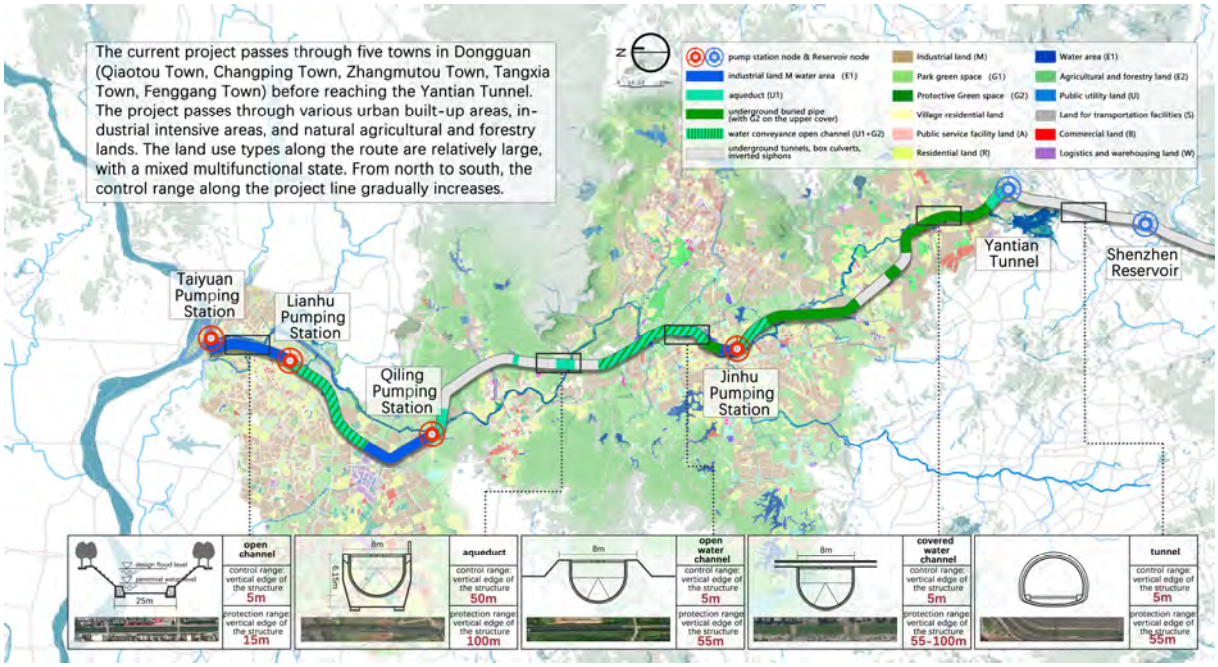


Figure 7. Current facilities of the DongShen Water Supply Project

After withdrawing from the DongShen Water Supply Project, the Shima River resumed its natural flow from south to north, retaining only the flood discharge function. However, pollution in the basin continued to worsen. The water quality monitoring data in 2018 showed that some tributaries of the Shima River were black and smelly and the water quality of the Qiling section was inferior to Class V. The core contradiction in the basin during this period was development and pollution. Pollution control was difficult, and faced pressures such as enterprise relocation and industrial transformation. In 2016, Dongguan has begun comprehensive water pollution control.

The pollution sources of Shima River are diverse and wide-ranging, and the main pollution factors are ammonia nitrogen and total phosphorus. The reasons are analyzed as follows:

a. Incoming rivers cause water pollution.

b. The population and enterprise density in the basin are dense, some domestic sewage is directly discharged into the river, and there is a serious problem of industrial enterprises secretly discharging sewage.

c. An effective rainwater and sewage diversion mechanism has not been established, and the sewage pipe network has not been improved.

d. The discharge standards of sewage treatment facilities are relatively low.

e. Mountain rivers lack natural water resources and their environmental carrying capacity is inherently insufficient.

In addition, the Shima River has problems such as an incomplete flood control and disaster reduction system, a need to strengthen water source protection areas, and disordered shoreline landscape. The Shima River is narrow and seriously silted, with many water-blocking bridges and other bottlenecks. The original infrastructure is backward, the flood width is insufficient, and some sections of the river only meet the flood control standards of once every 5-10 years, resulting in a prominent waterlogging problem.

2.4. 'Multifunctional ecological corridor period'—comprehensive management of Shima River Basin

Since 2019, Dongguan has continued to promote the comprehensive management project of the Shima River Basin, with 'whole-basin system management' as the basic principle, covering five measures: water environment management, water safety, water ecological restoration, water landscape improvement, and digital control of the basin. A natural return plan has been tailored for the Shima River, including the diversion of rainwater and sewage at the source, the improvement of the secondary sewage interception network, the regulation of

sewage outlets, the construction of overflow storage ponds, the comprehensive management of tributaries, sediment treatment and disposal, mainstream flood control, the improvement of the landscape on both sides of the river, and the construction of an integrated basin management and control platform.

In the end of 2024, all 107 rivers and streams in the Shima River Basin completely eliminated black and smelly water, the water quality of the Qiling section reached Class V standards, and the water quality of some tributaries will have been upgraded to Class IV, ensuring that the water quality will continue to meet standards. The water ecosystem has been significantly restored, and the number of fish and aquatic plant species has recovered to more than 30. During the construction of the mainstream flood control project, the supporting waterfront scenic belts and riverside parks on both sides of the river have not only provided citizens with places for leisure and entertainment, significantly improved the living environment, but also attracted a number of ecological industry investment projects to land. It have produced significant social, economic and ecological benefits.







Figure 8. Before and after the renovation of Shima River Greenway

3. Protection and development of the water conservancy heritage corridor of the DongShen Water Supply Project

3.1. Characteristics of the DongShen Water Supply Project remains

The remains of the DongShen Water Supply Project have a short construction period, a late completion time, and a fast iteration speed. The earliest remains are less than 60 years old, showing a ‘younger’ feature in terms of time. In terms of space, they are distributed linearly based on natural rivers and are concentrated around water pumping stations. In the early stage of construction, the site selection relied on hydrology. Later, as productivity improved, it gradually got rid of the constraints of natural conditions and passed through the mountains. The layout is based on the principle of ‘form follows function’. The architectural style shows the characteristics of the times and the characteristics of traditional architectural styles. In addition to bridges and memorial sculptures, the material remains are mainly typical water conservancy facilities such as pumping stations, dams, hydropower stations, biological nitrification stations and aqueducts. For example, the combination of ‘dams + aqueducts + highway bridges’ can fully demonstrate the characteristics of water conservancy industrial landscapes. At present, only the entire line of the renovation project continues to carry out water transmission functions, and the functions of the remaining facilities have declined and are idle or even abandoned. In addition to material relics, there are also intangible relics, including slogans, commemorative images of the project, oral histories, folk stories from Hong Kong's water shortage period, etc., which together

demonstrate historical value, scientific and technological value, artistic value, and important contemporary value and social and cultural value.

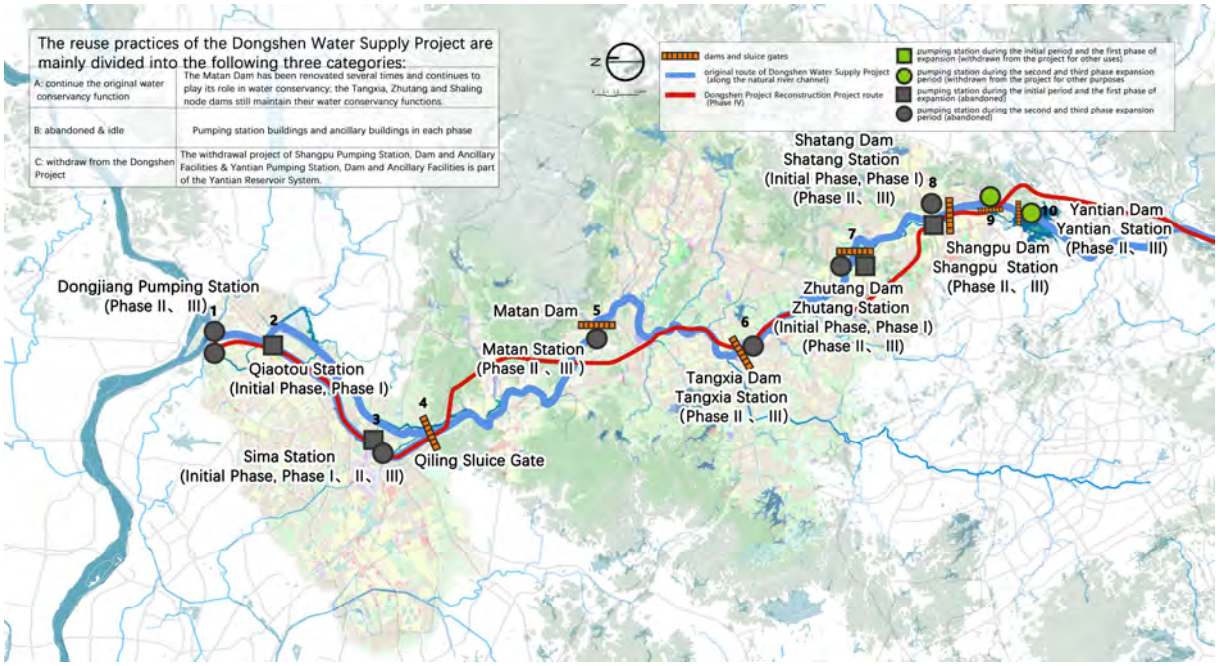


Figure 9. Remains of water conservancy relics in different periods of Dongshen Water Supply Project

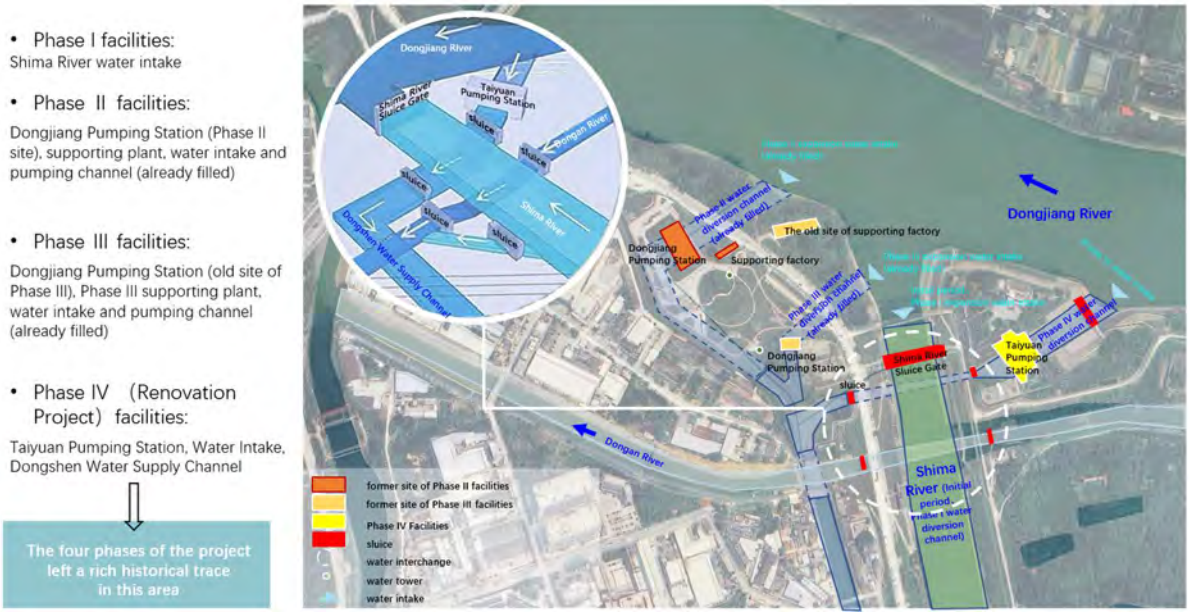


Figure 10. Distribution of remaining facilities at the water intake of the DongShen Water Supply Project, Qiaotou Town①



Figure 11. Distribution of remaining facilities at the water intake of the DongShen Water Supply Project, Qiaotou Town



Figure 12. Memorial sculptures and historical bridge

3.3. Issues and strategies for the protection and development of the DongShen Water Supply Project water heritage corridor

The DongShen Water Supply Project has important value information and contemporary significance. As a lifeline of water supply, it is a physical witness of socialist construction and a material carrier of cooperative development in the Guangdong-Hong Kong-Macao Greater Bay Area. It has built a bridge of friendship between mainland and Hong Kong compatriots and embodies the emotional memory and spiritual connotation of the builders. The remains after the construction and renovation of the project can form a linear cultural landscape with water

conservancy characteristics, showing the achievements of water conservancy and regional development during the socialist construction period.

In recent years, global climate change has led to frequent extreme weather events. With population growth and economic development, the urbanization process has continued to accelerate, urban land has expanded, green space has decreased, and surface hardening has led to a decrease in infiltration and water storage capacity, making floods more likely to occur. Dongguan City is located in the southern subtropics, with frequent heavy rains during the flood season and is susceptible to typhoons. Urban rivers are coupled systems under complex natural conditions and artificial regulation conditions. Artificial control projects such as embankments and sluices have changed the natural state and hydrodynamic conditions of the river. The Shima River has gone through multiple states from natural to artificial and back to natural. In addition to ecological restoration and the survival and utilization of heritage sites, the basin should focus on urban flood control and emergency dispatch, and connect water safety projects with greenway landscapes.

Assess existing problems of Dongshen Water Supply Project and Shima River Basin from the perspective of landscape characteristics. As a large-scale cross-border and cross-basin water supply project in the city, the measures of backflow and water diversion with the help of natural river channels in the early stage can be used as a typical feature to reflect the relationship between man and nature. However, due to the high level of protection and confidentiality of the project in the past, the public was not allowed to enter at will, and could not see the scene of river water backflow during the water supply period, and the visibility and popularity of the landscape were not high. After the renovation project, the DongShen Water Supply Project is still under fully closed management, the characteristics of the Shima River Basin that withdrew from the project are not obvious, the utilization rate and aesthetics of the visible landscape renovation of the pump station are not high, and the expressiveness of the project landscape is getting weaker and weaker, making it difficult to present the history of the heritage landscape from the past to the present in a panoramic manner.

The water conservancy heritage corridor of the DongShen Water Supply Project cannot adopt a frozen cultural relic preservation method, but must fully recognize its ‘living heritage’ characteristics, expand it to the basin scale, think about the overall framework from a holistic perspective, and dynamically protect and utilize it. First of all, a comprehensive assessment of the value and future development direction of the heritage element system of the DongShen Water Supply Project should be carried out, and then appropriate protection management and development and utilization strategies should be formulated by classification. Secondly, water resources allocation and basin management should be optimized, landscape construction and popular science education should be integrated into the management of the Shima River Basin, and the existing cascade water landscape should be linearly connected in combination with the heritage value excavated in the early stage, so as to strengthen the connection between important nodes and urban space. Finally, it will gradually evolve into a composite cultural corridor with ecological aesthetics, social culture and other values , and successfully realize the value reconstruction of ‘engineering-ecology-society’.

4. Conclusion

2025 marks the 60th anniversary of the official operation of the DongShen Water Supply Project. The evolution of the Shima River from a water supply lifeline to an ecological corridor not only reflects the interactive trajectory of water conservancy projects and urban development, but also highlights the adaptation and reconstruction of heritage landscapes in the changing times . Its hydrological environment, engineering facilities and cultural memory are constantly reshaped, and finally achieve functional integration and value symbiosis. Under the dual pressures of climate change and urbanization, the practice of comprehensive governance of the Shima River Basin shows that only by adhering to systematic governance and cross-disciplinary collaboration can the heritage corridor be promoted to achieve coordinated development of ecology, safety and humanities. In the future, the protection and development of the water conservancy heritage corridor of the DongShen Water Supply Project can serve as an experience sample for water environment governance and water conservancy heritage

protection in high-density urban areas, and provide a path reference for the sustainable management of more living heritage landscapes.

Notes

①Dongguan Qiaotou Town, as the first water intake point of the project, gathers the remains of the four phases of 'three expansions and one renovation' of the DongShen Water Supply Project, which can show the history of the project in a panoramic way and has high scientific and historical value. There are currently 3 water intakes, 3 water diversion channels, 3 pumping stations and supporting facilities, 2 drainage channels, and 1 water interchange.

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