

Impacting Sustainability Operations.

Integrating Local Knowledge and Nature-
Based Solutions through Theoretical
Frameworks and Innovative Cartography for
Cultural Impact

Antonella CONTIN, Politecnico di Milano, Italy

Abstract

This research explores the integration of local knowledge (CBS) and nature-based solutions (NBS) within metropolitan sustainability frameworks, emphasizing the importance of context-driven approaches in urban planning. Acknowledging the shortcomings of existing policies, particularly in addressing poverty and inequality, the study proposes a transdisciplinary framework that fuses Culture-Based Solutions (CBS) with NBS, creating a unified knowledge ecology termed "Metropolis as Heritage." Utilizing innovative cartographic techniques (Metropolitan Cartography), the research aims to enhance territorial intelligence, enabling policies that reflect local realities and foster inclusive growth. By examining the interplay between human behavior, cultural practices, and ecological systems, the study highlights the potential of metropolitan urban-rural connections (MetroURLs) to serve as sustainability commons. Key findings underscore the need for institutional capacity and community engagement to implement robust policies that promote resilience and social equity. The research advocates for a new antifragile paradigm of metropolitan urbanity, where culture becomes a vital agent of change, facilitating collective agency and a sense of belonging. Ultimately, this work seeks to redefine urban landscapes through a holistic approach, bridging nature and culture to achieve sustainable development aligned with global agendas like the New Urban Agenda and Sustainable Development Goals.

Keywords

Antifragility, Local Knowledge, Metropolis as Heritage

1. Integrating Local Knowledge and Nature-Based Solutions.

1.1. Enhancing Urban Planning and Policy through Territorial Intelligence and Metropolitan Cartography

Current frameworks often overlook ground realities, as evident in SDG 11's insufficient attention to poverty and inequality. To address this, we should integrate local ecological knowledge through Culture-Based Solutions (CBS) and Nature-Based Solutions (NBS); we named this unified *knowledge ecology* (Castells, 1996), Metropolitan Heritage. Using innovative tools like cartography, urban

policies must reflect local contexts, economies, and cultural traditions, combining global insights with local knowledge for impactful outcomes. Developing a *theory of metropolitan culture* and leveraging advanced cartography can enhance urban planning and design.

Effective policies must guide citizens' behaviours towards desired results and challenge norms that neglect the planet's interests. Market-oriented approaches, particularly in tourism, should align with cultural and economic sustainability to promote inclusive growth.

Nevertheless, institutional capacity is vital to implementing robust policies that support urban transformation. However, to face the current climate crisis, integrating *operational culture* with local knowledge is crucial for stimulating *collective intentionality* (Barbera, 2023) to foster coherent urban planning and sustainable development. This approach addresses real-world complexities and benefits all urban residents equitably. This allows for the *symbolic capacity* to construct cultural practices focusing on the *collective agency*.

In Alessandro Balducci's 2023 work, "invisible cities" are the other side of the visible ones and are characterised by inequality, digital influence, and opaque governance that obstructs citizen participation. Balducci recognises urban life's visible and invisible elements, fostering social learning. Additionally, MSLab at Politecnico di Milano emphasises the importance of the physical context in defining sustainable culture. Understanding causal pathways in modern metropolises is essential for exploring how human behaviour impacts urban spaces and contributes to sustainable urban planning. Our research aims to develop and apply innovative local-scale resource management strategies through metropolitan architecture (Contin, 2015) approaches suited for urban areas. The central question focuses on creating a transdisciplinary framework to evaluate policies, management practices, and projects in metropolitan interphase areas by incorporating local ecological knowledge and understanding social mechanisms and practices. The problem addressed is that the physical structure of geographic relationships reflects *territorial intelligence*, encompassing social, economic, ecological, anthropological, and cultural aspects. Territorial intelligence refers to using spatial data and knowledge to improve land management and promote sustainable development, as the 7th Framework Programme for Research and Technological Development (7th FP) outlines. This program, active from 2007 to 2013, supported research and innovation across various fields, including spatial planning and resource management. This intelligence supports inclusion, redistribution, accessibility, and democracy, foundational for resilient urban transformations. According to that approach, subnational governments, with national funding, play a vital role in implementing systemic prevention measures and adapting climate funding to local needs. It could be fundamental, though, to allow the metropolitan governance dimension to have its funds to address modern climate policy better. Moreover, the European Union's emphasis on environmental and social governance (ESG)

highlights the strategic importance of sustainability, aligning with the research's goal of developing resilience frameworks for local and metropolitan governments.

The research employs a transdisciplinary approach focused on anti-fragility (Taleb, 2014) and de-risking, utilising the Metropolitan Cartography (Contin, 2021) tool to represent the metropolitan scale and the dynamic interplay between nature and culture, in line with the New Urban Agenda (NUA) and Sustainable Development Goals (SDGs). Innovative mapping methodologies assist in identifying, understanding, and designing *hybrid metropolitan landscapes*. Metropolitan Connectivity represents the spatial structure's connections, vital for the continuity of green-grey infrastructure. Maps help grasp the morphological structure of Green, Gray, and Blue Infrastructures, transforming urban-rural margins into potential sites for revitalising metropolitan cultural, natural, and anthropic services. This is a key objective of a Metropolis as a Heritage as promoted by the Heritopolis Society initiative.

Data collection methods include:

- Spatial Analysis: Mapping metropolitan landscapes to evaluate connectivity.
- Qualitative Research: Conducting interviews and focus groups with local stakeholders.
- Quantitative Research: Gathering data on energy, material, and land consumption within a metabolic framework.
- Case Studies: Identifying best practices in specific metropolitan areas.

Participatory Workshops: Engaging communities to co-create sustainable development initiatives.

Key findings emphasise integrating nature-based solutions (NBS) to develop culture-based solutions (CBS) that address social needs by merging nature and culture. The hypothesis is that metropolitan urban-rural connections (MetroURLs), incorporating NBS and CBS, can evolve into *new sustainability commons*, addressing various anthropo-ecological challenges.

The MetroURL Framework, designed with NBS and CBS, offers tailored responses to local challenges, leveraging unique local features. It aligns with the One Health strategy, introducing a new paradigm for metropolitan landscapes by emphasising the interconnectedness of human, animal, and ecosystem health.

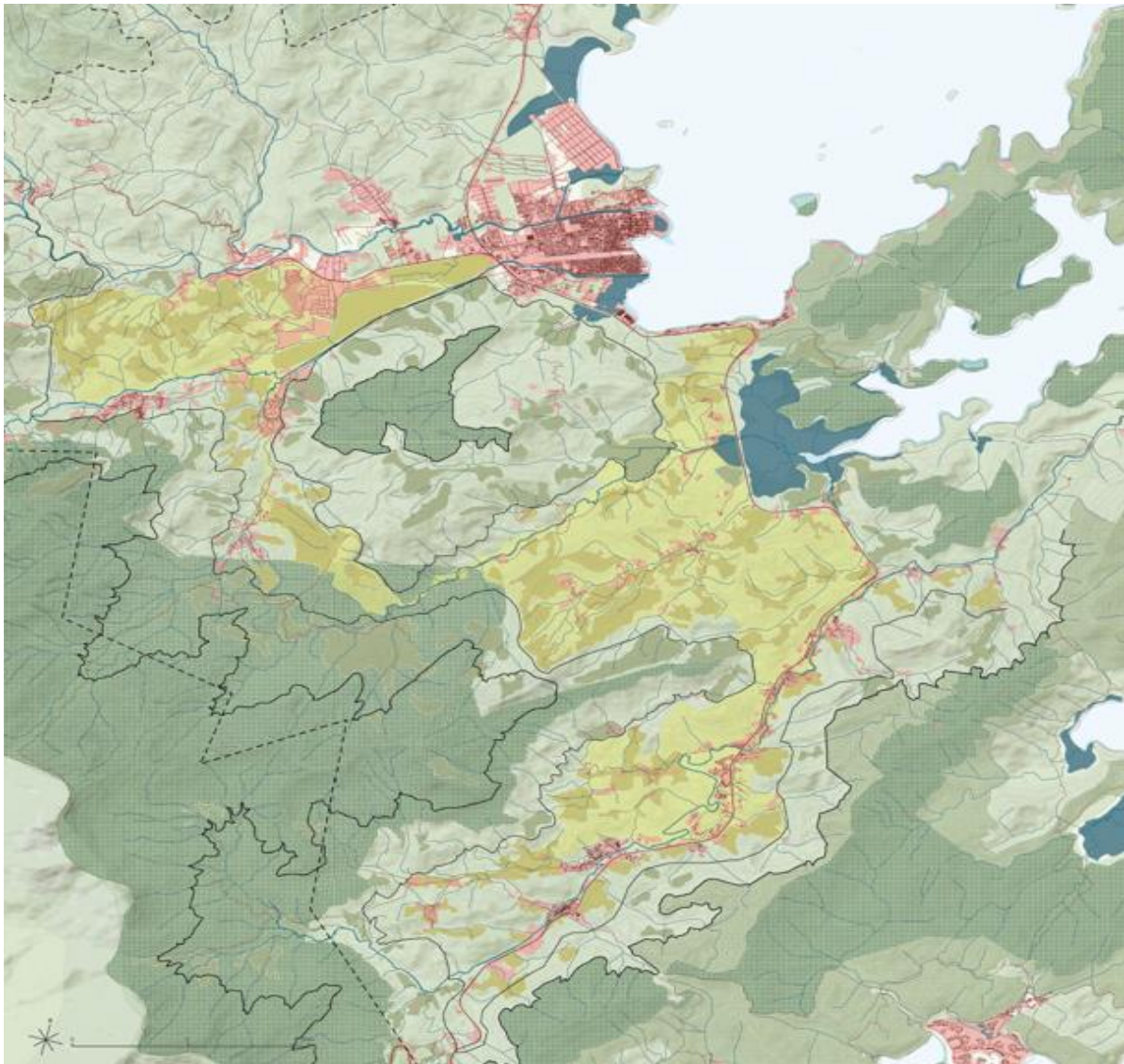


Figure 1: Paraty (Brazil). Definition of the Cairuçu Environmental Protection Area (APA) border following the MC analysis, in Agroforestry as a strategy for biodiversity preservation: directing urban expansion in Paraty's Atlantic Forest. Credit: MSLab, Erika Nataly Amidati, Francesca Cisaria (2024)

2. Metropolis as heritage

2.1 Guidelines for experiencing metropolitan urbanity

We aim to explore whether metropolitan heritage can catalyse the development of an urban culture — envisioned as a “new utopia of reality” (Rogers, 1965) — and formulate a *theory of metropolitan urbanity*. This theory would be supported by a *technological culture* that regulates technological density, enabling contemporary humanity to increase its sustainable care for the world. Achieving this requires a search for meaning, orientation, and direction and a commitment to intentional reading and the art of noticing, as suggested by Anna Tsing (2015).

In an era where relationships—whether among civil and human rights holders or between communities and territories—are often reduced to legal frameworks that bind individuals primarily through force, metropolitan heritage emerges as a source of spiritual meaning (Agamben, 2024). Here, "spiritual" refers to something that transcends individual interests, offering an objective criterion that establishes a canon that regulates ethics, aesthetics, and expressions of human subjectivity. Culture, in this sense, becomes the experience of a spirit not above us but one that envelops us (Tsing, 2015). This culture, understood as "religio" in its etymological sense, binds and connects people to an ideal centre, creating a shared space that transforms a collection of individuals into a society capable of *collective experience*. Our study, therefore, seeks to develop guidelines for experiencing metropolitan urbanity through an integrated, multi-scalar project grounded in an evolving technological culture.

In the Anthropocene, humans often feel alienated and seek environments that allow for experiences of sharing, freedom and quality of life. To achieve this, the antifragile approach (Taleb, 2014) emphasises building on what already exists, reinterpreting and re-imagining it in response to unintended designs marked by unpredictability. This approach is context-based, non-scalable, and results from the interplay between human and non-human life. We must, therefore, consider the unintended consequences of human actions, which create an *ecology of disruption* (Tsing, 2015) and, consequently, foster an art of living on a damaged planet—products of the Anthropocene's disruptive forces. Each force may require its *agent of change* (UN-Habitat, Strategic Plan 2020-23). Our Hypothesis is that culture is that agent. This vision could lead to the formation of a metropolitan civilisation, or metropolitan "Humanitas" (Mancuso, 2024), where human and civil rights coexist, creating a *new collective public space*. In this space, citizens can experience a different kind of space-time: local, intimate, collective, and global. Such a collective public space would be characterised by behaviour oriented toward sustainability.

This spiritual sense still exists in some regions of the Global South, where nature has not been secularised and where the relationship between places and communities is mediated by rituals—practices that structure ways of life. This marks the beginning of a metropolitan anthropology that identifies and explains new behaviours and practices within metropolitan spaces. Culture is not just a product of descriptive language but manifests through practices and behaviours representing experience, exploration, invention, and meaning. This brings to light the importance and utility of metropolitan heritage.

	goal	strategy	action	SDGs
inclusivity	Creating a collective atmosphere and constructive relations among inhabitants, fighting with segregation and discrimination	Finding commonalities between cultures, emphasizing similarities, and ensuring a safe atmosphere where people could create their cultures	Designing common spaces where people spend time together for a higher purpose and eventually interact	5 GENDER EQUALITY 10 REDUCED INEQUALITIES
circularity	Financially support the system and the users with a circular economy strategy and concretize the project	To ensure that the neighborhood become self-sufficient by creating production-consumption cycles	Revitalizing local community gardens , adding cultural value to the products in the workshops , feeding the whole system with market sales	8 DECENT WORK AND ECONOMIC GROWTH 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
sustainability	Designing sustainable and self-sufficient neighborhoods, in terms of food, water, and energy	Getting inspired by the methods of the past, following the heritage with the new technology and innovations	Organizing meetings for products, water, energy and waste management using information and communication technologies	11 SUSTAINABLE CITIES AND COMMUNITIES 12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Figure 2: Strategy Table to foster Collective Public Space, in Collective Landscapes of İstanbul: A Tool for Social Integration. Credits: MSLab, İlayda Cömert, Kübra İlayda Turan (2024)

Strategic decision-making at the metropolitan level requires political intervention capable of reshaping the rules and attitudes of metropolitan agents, particularly in real estate, to promote sustainable planning and design. This would address the structural challenges of metropolises by strengthening existing agents of change and creating new ones.

Can metropolitan heritage be an agent of sustainable transformation? Can it enhance quality of life, raise awareness of territorial fragility, and prevent gentrification? As a social project born of collective intelligence, Metropolitan heritage is deeply connected to knowledge of the territory and its practices. The academy's role is to promote integrated pathways across various disciplines, train metropolitan agents to manage the cycle of technological innovation for all and interpret territorial culture as competence, wealth, and heritage.

Finally, metropolitan heritage can become a tool for social equity in climate change, provided we overcome the dichotomies between nature and culture, urbanity and equity, and establish a system of cross-feedback between these elements.

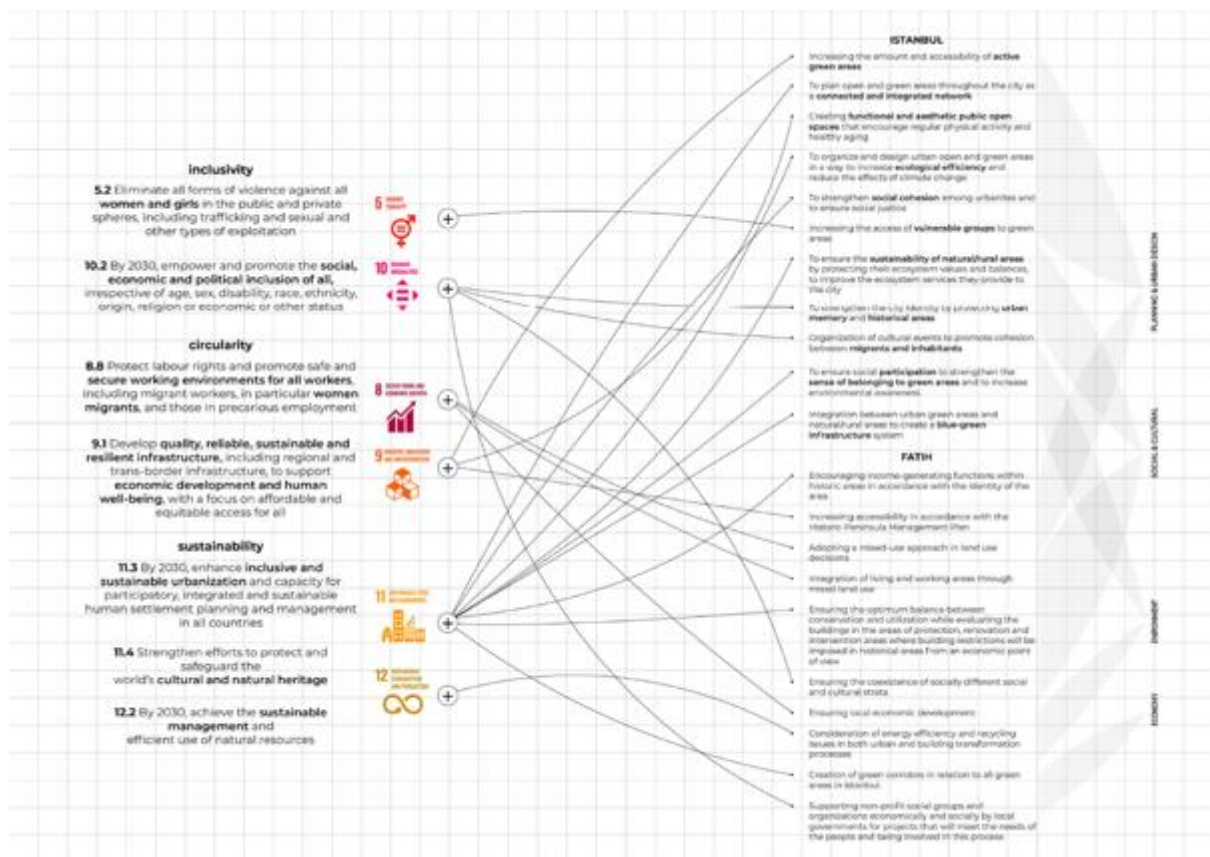


Figure 3: SDGs Targets Map, in Collective Landscapes of İstanbul: A Tool for Social Integration. Credits: MSLab, İlayda Cömert, Kübra İlayda Turan (2024)



Figure 4: Paraty (Brazil). The Agroforest Cultural Practices, in Agroforestry as a strategy for biodiversity preservation: directing urban expansion in Paraty's Atlantic Forest. Credit: MSLab, Erika Nataly Amidati, Francesca Cisaria (2024)

3.Context-Driven Metropolitan Urbanity Sustainability

3.1 The Role of Culture and Cartography

Culture as philosophy or culture impacting sustainability operations? Recognising oneself as a 'seeker' (Mauthner, 2012) means being human. Tracing everything back to past knowledge is to renounce the specificity of humans, as Socrates recalled in his oration to the Athenians (Plato, 2021).

During the 1990s, heritage preservation practices began challenging the dominant Eurocentric approaches, which had previously emphasised universal standards, particularly those derived from the Venice Charter (ICOMOS, 1994). This shift brought attention to previously marginalised aspects of heritage value, recognising that heritage is closely tied to cultural practices and performances rather than solely rooted in material, aesthetic, or historical significance. This change marked an anthropological awakening in heritage studies, acknowledging the legitimacy of different urban and social processes and ritual traditions alongside global and institutional standards (Rico, 2024).

Sustainable culture highlights the critical role of context, where environmental conditions profoundly influence the effectiveness of protection efforts. It aims to close the gap between knowledge and practical application by transforming analysis and interpretation into concrete, impactful actions. Setting clear objectives for sustainable culture is essential, particularly when addressing issues like poverty, inequality, and low productivity in urban settings. Cartography is invaluable in this process, as it can pinpoint areas of survival activities, shed light on local practices, and facilitate targeted interventions.

Policy documents often provide abstract recommendations that need to address specific urban challenges. For example, SDG 11 on urban sustainability overlooks critical issues in metropolises. The term "commitment" in the SDGs lacks a foundation in metropolitan urbanity and its culture theory and omits references to social justice or ethical imperatives. Effective urban planning must relate heritage preservation to its socio-economic context, which varies between regions. Understanding local economies, ecologies, cultural traditions, and institutional hierarchies is essential for a coherent metropolitan culture and space theory. With this understanding, addressing the impacts of human behaviour on urban areas and improving living conditions for most urban residents is possible.

4. Developing a Metropolitan Culture

4.1 Operational Culture for a Metropolitan Urban Space Theory

Developing a *theory for the culture of metropolitan urbanity* and utilising cartography to explore sustainable habitats is crucial. The context in which these theories and tools are applied significantly shapes the choice of

instruments, and these instruments, in turn, redefine the context itself. Historically, urban planning has often neglected areas outside of formal plans, labelling them as illegal and subject to demolition while failing to acknowledge the value of ancestral practices within protected areas. Effective urban policies should, therefore, aim not just at resource allocation but at guiding urban behaviour towards desired outcomes.

Context encompasses spaces, sites, flows, processes, and the interactions among actors that influence supply, demand, and pricing. However, the limited capacity of institutions to effectively implement these policies presents a significant challenge. Market-oriented policies, particularly in tourism, are often designed to influence individual and collective behaviours. This raises important questions about the need for *operational culture* in fostering prosperity and identifying the values generated by the tourism industry.

Experimenting with values and resources linked to operating culture can help combat poverty, inequality, and low productivity, improving quality of life. Cartography can identify these values and convert them into measurable indicators. Metropolitan planning should, therefore, challenge purely anthropocentric approaches and acknowledge the significance of behavioural norms, particularly in the Global South, where local cultures play a pivotal role in shaping urban practices and governance strategies.

5. Metropolitan Landscapes

5.1 Fusing Natural and Human Systems

The metropolis embodies an integral fusion of biosphere, water, and soil, collectively called the critical zone (Latour, 2022), requiring regenerative techniques. Within this framework, the intertwined connection between culture, science, and technology, described as entanglement (Chakrabarty, 2021), reinforces the natural system's anti-fragility (Taleb, 2014). The goal is to diminish the susceptibility of nature, with society taking a central role in preserving and promoting this natural heritage to ensure its sustainable perpetuation. The ambition is a collaborative effort between the metropolitan city and technology to minimise loss or exposure to risk and capitalise on opportunities that may arise from difficult or unforeseen situations. By cultivating the ability to protect, adapt and transform through exposure to risk and uncertainty, and with the help of technology that can adjust to natural processes, we must develop opportunities, fostering potentials and advantages to improve systems, organisations and strategies that thrive under conditions of stress and volatility, rather than survive. Technology in the contemporary metropolitan context is fundamental for studying nature through verification tools. This tool, however, must operate in tune with historical knowledge of past sustainability. Metropolitan landscapes embody a complex interaction between natural and human systems, necessitating innovative tools to analyse and comprehend these dynamics. Research should prioritise integrating local ecological knowledge at the metropolitan scale, focusing on fostering environmental stewardship, democratic engagement, and resilience. The concept of geohistorical DNA, which merges geography with collective memory, offers a

foundation for creative approaches to urban design.

Territorial Intelligence (<https://cordis.europa.eu/article/id/87501-the-smart-approach-to-territorial-intelligence/it>), which addresses social, economic, ecological, and cultural dimensions, is vital for developing inclusive and democratic urban solutions. Engaging subnational metropolitan governments in climate prevention efforts is essential, as they are better positioned to address the specific needs of their communities. The European Union's initiatives in regulating environmental and social governance further underscore the growing importance of sustainability in this context (https://finance.ec.europa.eu/sustainable-finance/tools-and-standards/esg-rating-activities_en).

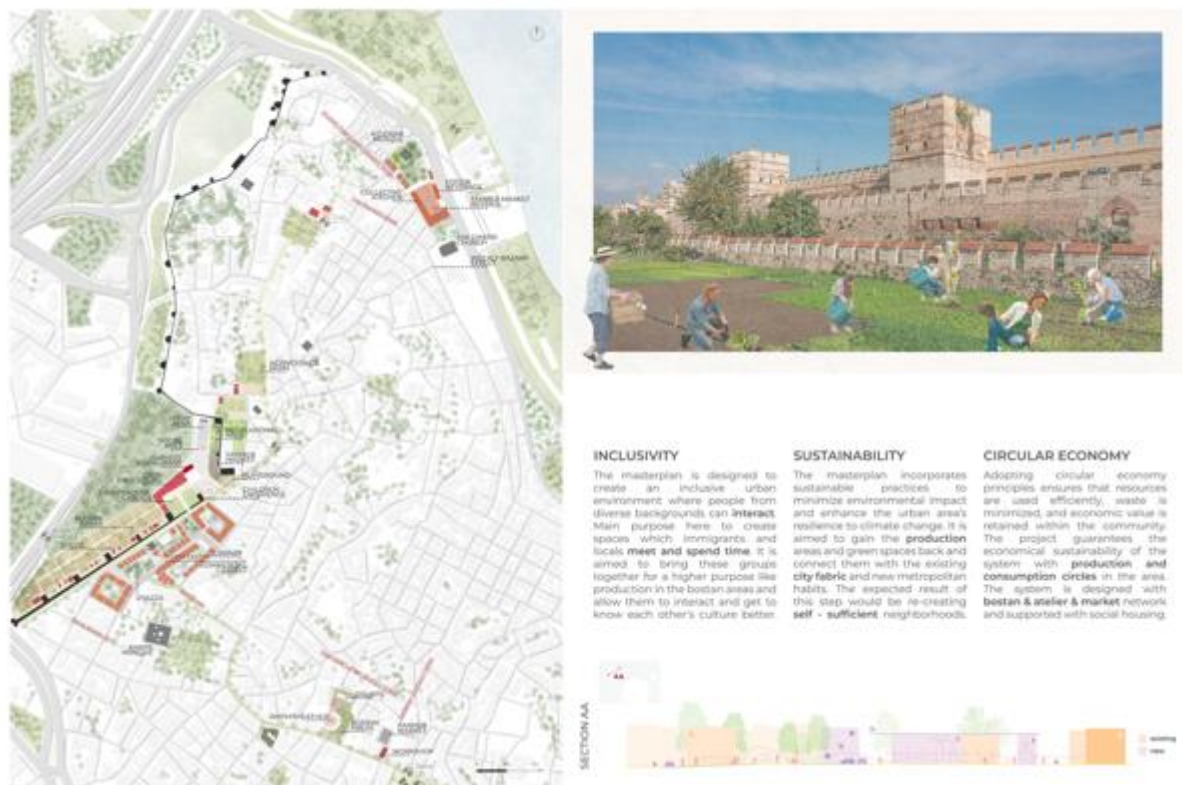


Figure 5: The new Bostan Project, in Collective Landscapes of İstanbul: A Tool for Social Integration. Credits: MSLab, İlayda Cömert, Kübra İlayda Turan (2024)

6. Nature-Based and Culture-Based Solutions for Metropolitan Resilience

6.1 A New Approach to Mapping and Design Hybrid Metropolitan Landscapes

The metropolitan landscapes, particularly through initiatives like the MetroURL project (Contin, 2021), aim to achieve a nonlinear understanding of territorial identity by emphasising antifragility and the integration of multiple disciplines. The One Health approach also highlights the interconnectedness of human, animal, and ecosystem health, reinforcing the need for holistic solutions. Introducing nature-based solutions (NBS) offers tailored responses to local challenges crucial for decarbonisation, hydrogeological balance, and climate adaptation. These solutions can redefine urban-rural connections, creating new metropolitan commons of sustainability that address multiple issues simultaneously. However, to truly preserve the heritage of metropolitan areas, it is essential to implement nature- and culture-based solutions (NBS and CBS), transforming these landscapes into collective sustainability assets. By leveraging natural processes and cultural practices, NBS and CBS provide a comprehensive approach to tackling environmental and social challenges in metropolitan settings.

7. Metropolitan Cartography

7.1 Advancing Cartographic Methods for a Culture of Technology

Constructing cartographies that contribute to a pact between the Culture of Technology and the Theory for the Culture of Metropolitan Urbanity evolves map-making through a significant transition. The approach goes beyond mere interdisciplinarity, moving towards a transversal perspective that embraces the diversity of disciplines and focuses on the interactions inherent in architecture and urban studies using a Glossary (Contin, Giordano, Nacke, 2021) that unifies knowledge and underlines shared cultural values. This shift recognises the dynamism and interconnectedness in knowledge creation, incorporating post-disciplinary perspectives and post-human considerations (Braidotti, 2014). This perspective extends from a predominantly anthropocentric and social constructionist angle to a broad consideration of the agency and vitality of human and non-human entities at the local scale. The culture of technology assumes a central role as a transitional element between nature and culture in this panorama. Understanding the intertwined relationships between materials, spaces and dynamic local forces is emphasised, shaping contemporary planning and architectural experiences.

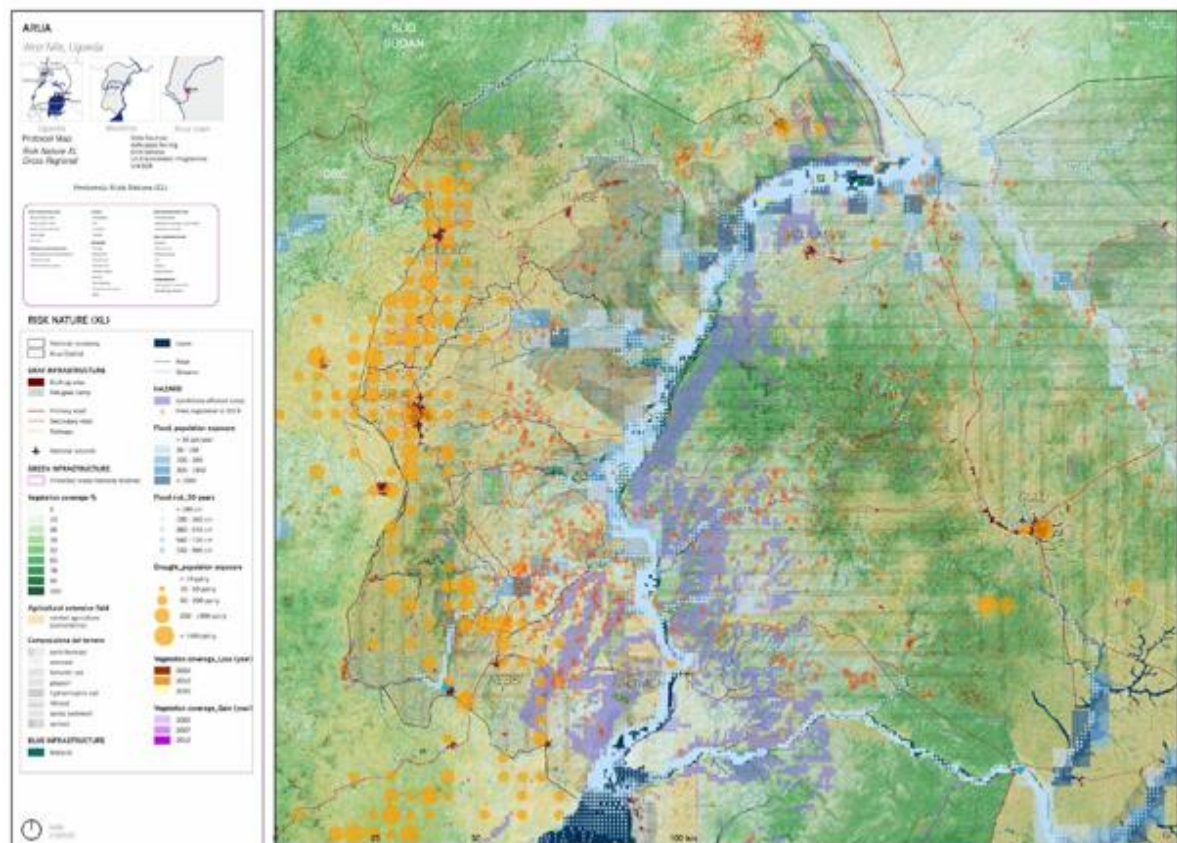


Figure 6: Metropolitan Cartography: Arua (Uganda) Risk Map, in A new periurban centrality for sustainable development in ARUA, Uganda. A multiscale approach for the West Nile region. Credit: MsLab, Bianca Cesarotti

In conclusion, the research provides theoretical insights and practical methods to enhance metropolitan sustainability and resilience. Integrating local knowledge (CBS) and nature-based solutions (NBS) offers transformative strategies for sustainable urban development in alignment with global agendas such as the New Urban Agenda and Sustainable Development Goals. The MetroURL framework illustrates how metropolitan areas can evolve into resilient landscapes that harmonise human activities with ecological systems, fostering inclusive growth and environmental stewardship. Future applications aim to expand these findings across various metropolitan contexts, ensuring that urban planning reflects local realities and promotes equitable and sustainable development. Hybrid metropolitan landscapes are today's main urban arena, requiring new mapping methodologies to understand and design them effectively. Metropolitan Urbanity, described through cartography (Contini, Galiulo, 2021), can convert urban-rural margins into vibrant sites for cultural, natural, and anthropic services, advancing the goals of the Heritopolis Society initiative for a living landscape supported by a cultural vision of territories.

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