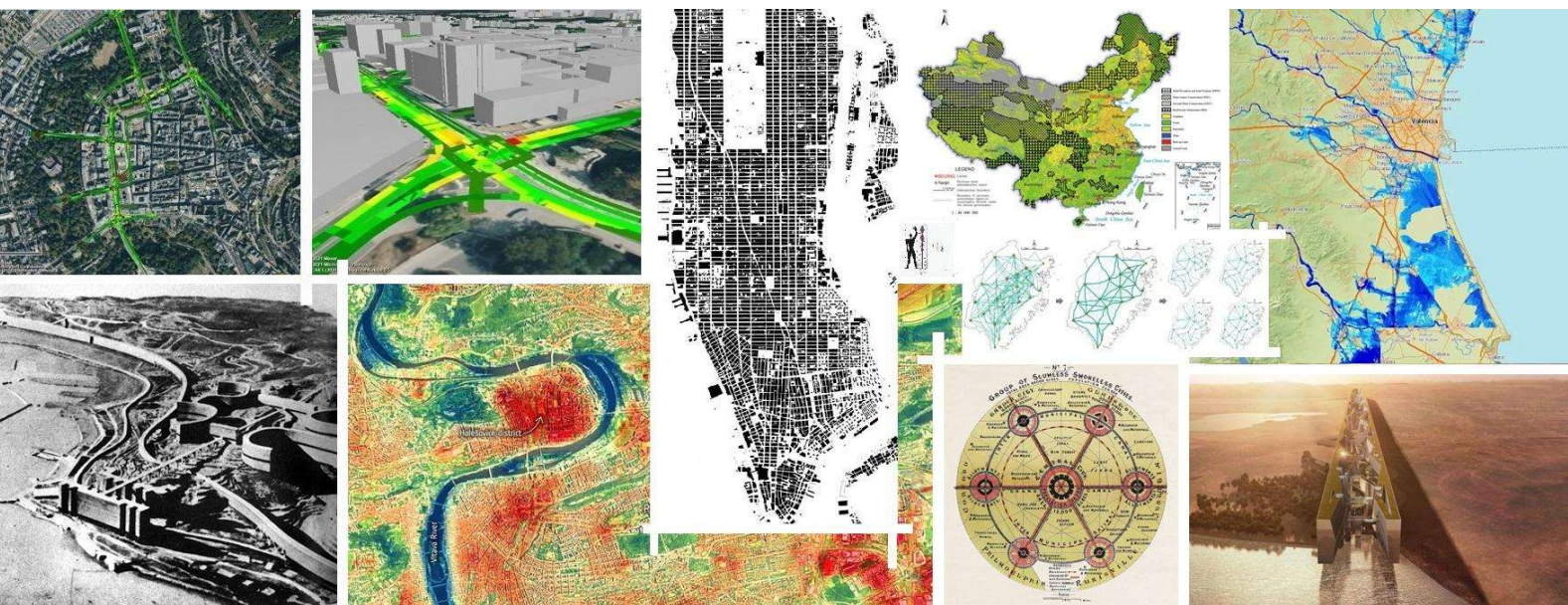




Sustainable Urban Planning & Territorial Management: future challenges in the new era of climate change and artificial intelligence

Proceedings of the SUPTM 2026 conference

**S. García-Ayllón
& J.L. Miralles**
Editors

THIRD INTERNATIONAL CONFERENCE ON FUTURE CHALLENGES IN
SUSTAINABLE URBAN PLANNING & TERRITORIAL MANAGEMENT

SUPTM 2026

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The Technical University of Cartagena is an institution with an unwavering commitment to sustainability, the environment, urban studies and proper land-use planning. Hosting the third international conference on the challenges of the 21st-century in urban planning and land management, SUPTM 2026, is a privilege for us as a scientific and academic institution.

As one of the four technical universities in Spain, our students and researchers are deeply engaged in these disciplines through various academic programmes and research initiatives. City design, urban mobility, environmental and territorial planning, and natural disaster management, such as flood control and preservation of coastal space, are areas where our institution excels nationally and internationally. Every year, we graduate numerous professionals who bring their expertise to diverse fields.

Research in these critical areas is essential for the future of the planet and must be prioritised by society, supported by public administrations, and disseminated to industries through knowledge transfer. I reaffirm our institution's unwavering commitment to participating in international knowledge sharing events, which empower our researchers and facilitate collaboration with peers.

I am confident that this conference marks the beginning of a series of meetings that will drive progress towards our planet's sustainable development goals.

Mathieu Kessler

Rector of the Technical University of Cartagena



It is a pride for the city of Cartagena to host this third international conference on challenges in urban planning and land management SUPTM 2026. The city of Cartagena, as the cradle of a three-thousand-year-old civilization, is a historical reference in terms of architecture and urban planning. However, we are not resigned to living from our past, but rather we are committed to a future in which innovation and research are the spearhead to help move our society forward.

In this sense, our city is a reference in sustainable urban mobility, environmental planning and innovative architecture, incorporating researchers and professionals of the highest prestige into our projects. These projects have placed our city in a vanguard position in many of the topics that will be discussed during these days in this congress. In this sense, I am convinced that the results of this meeting will be very useful and will help our cities and territories to advance along the path of sustainable development.

I am confident that the success of this first call is only the beginning of new meetings in the future that will consolidate our city as a benchmark in terms of research on urban planning and land-use planning. And I am sure that in the near future, the more than 200 researchers from the five continents who will meet electronically these days, will be able to come and see our wonderful city in person at the next edition of the congress, which we will be happy to invite you to.

Noelia Arroyo
Mayor of Cartagena



PREFACE

For many years now, the scientific community has warned of the need to evolve the social and economic activities of our societies around the world towards a situation of ecological balance with the ecosystems that produce the environmental services that these activities consume. And this, in addition, maintaining a fair distribution of wealth so that the evolution towards that ecological balance does not generate greater differences in economic development between the different countries of the planet. This is the great challenge that humanity faces in the coming decades.



Furthermore, every social or economic activity generates its own land demand for associated uses in the city and territory, sometimes competing with ecosystem uses that generate essential environmental services or altering them and modifying the urban and territorial morphology and landscape.



According to the United Nations, the urban population will concentrate up to 70% in urban areas in the coming years, and this means, as many authors highlight, that the economic and social transformation towards a sustainable society, and the achievement the United Nations SDG, it will only be managed if sustainable cities are achieved in ecological balance with the territory that provides essential environmental services.

In this context, the 3rd International Conference on Future Challenges in Sustainable Urban Planning & Territorial Management (SUPTM 2026), whose proceedings are published in this book, wants to be a scientific contribution to the great challenge of sustainability that humanity faces in the coming decades. A space for thought, the exchange of experiences and action.

In the process towards an economic activity based on ecological balance, urban and territorial planning is an essential and irreplaceable instrument since, unlike other areas of the economy in which errors in the production of goods and services can be corrected, in the field of the location of uses and activities in the city and the territory, mistakes in said decisions either cannot be corrected or their correction is very economically expensive and requires a lot of time. Therefore, it is, in any case, better to prevent through urban and territorial planning to guarantee the maintenance of the production of environmental services. The poor planning of activities, such as developing industrial or a tourist areas in zones where essential

environmental services are produced, implies a territorial transformation that is practically unaffordable or even impossible to reverse, and consequently a production loss of environmental services. A sustainable urban and territorial planning is only possible if there is simultaneously an administrative organization able to enforcing it, especially in its environmental dimensions, and particularly the protection of areas with some environmental values, locating urban developments in areas compatible with the maintenance of said ecological assets.

The researchers who deal with urban and territorial sustainability in any of its many facets is very aware of this, as is evident in the high participation that has occurred in this conference as well as in the great variety of topics discussed. It is therefore evident, on a global scale, of the great concern that exists in humanity about these issues and, at the same time, it shows the need to share knowledge, experiences, analysis, proposals... In our scientific field, knowledge is often generated locally as a way to generate universal rules. Local analysis and experiences allow us to learn about similar situations in societies that apparently are very different, and to generate global knowledge.

Urban and territorial sustainability will be global, or it will not be. The major environmental problems that exist on our only planet require, in many cases, comprehensive global solutions. In this framework, research in our field plays a fundamental role. As an example, aspects such as the emission of greenhouse gases, which in a significant part occur in the transportation sector, require a transition towards widespread sustainable mobility. And of course, these transformation processes should not produce an increase in wealth differences between the different countries of the world.

A huge job to do, a huge task ahead, a great challenge that humanity has never faced. Our collective, with the contributions of our research, plays an essential role.

At the same time, many scholars and scientists who share their research in this conference are academics who also fulfill the function of transmitting the acquired knowledge to new generations. Again, in this area we also face a great challenge. It is the challenge of global learning thorough systems such as Collaborative Online International Learning, so that new generations learn to live and share with students from any other university in the world, and to address global challenges collaboratively, thus generating a New Ecological Paradigm global.

We hope that humanity will be able to generate and apply the knowledge that constitutes this New Ecological Paradigme to achieve a balanced world in its economic development that must necessarily be based on a local and global ecological balance.

Salvador García-Ayllón & José Luis Miralles
Chairs of the SUPTM 2026 conference

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Opening Lecture

Urban green infrastructure and its implications for equity and well-being

Urban green infrastructure (UGI) has become a central concern of contemporary urban planning and policy, as cities confront the intertwined challenges of environmental degradation, public health risks, and socio spatial inequality. Rather than treating green spaces as isolated amenities, UGI conceptualizes them as an integral part of the urban systems that support ecological functioning, human well being, and equitable development. This talk synthesizes conceptual and empirical insights on UGI with explicit relevance for urban planning and public policy, focusing on high density contexts. Drawing on recent theoretical frameworks and empirical evidence from Mainland China and Hong Kong, it examines how UGI influences health outcomes, how planning decisions affects equal access to UGI, and how peri urban green spaces can contribute to environmental justice. The talk argues that a policy oriented infrastructural approach to UGI is essential for advancing sustainable and inclusive urban development.



Urban green infrastructure (UGI) reflects a modern planning approach focused on multifunctionality and integration, transitioning from solely recreational spaces to interconnected networks of natural and built systems. International definitions emphasize intentional design, integration with existing infrastructure, and the delivery of multiple public benefits, positioning UGI as a priority in urban governance and investment. Evidence shows that UGI improves physical and mental health by supporting activity, reducing environmental hazards, and enhancing well-being through stress relief and social interaction. However, these benefits depend on careful planning around location, access, design quality, and ongoing maintenance. Currently, research gaps remain: studies often favor parks and street trees, leaving other forms of UGI underexplored, especially regarding indirect health benefits. Additionally, UGI can lead to unequal social impacts, such as gentrification and displacement, challenging planners to balance environmental, health, and equity objectives.

Research on inequalities in access to urban green infrastructure (UGI) shows that green space accessibility often increases housing prices, reinforcing income-based residential sorting. This raises questions about who truly benefits from public investment in green spaces. The research by Shan, Fan, and He (2024) examines the implications of prevalent "club" green spaces in urban China—greenery within gated communities and accessible by residents only, which primarily serve wealthier populations. The widespread club green

space challenges the assumption that expanding green space always means increasing public access. Empirical evidence from Nanjing, China illustrates how public and private green spaces interact within urban systems shaped by planning and market forces. Using multi scalar accessibility analysis and hedonic modelling, research shows that public parks and club green spaces exhibit a supplementary and mutually reinforcing relationship. Club green space can enhance residents' daily contact with greenery, particularly in newly developed areas, while public park provision may incentivize private developers to invest further in green amenities to capture housing premiums. However, the distributional effects vary by urban context and travel mode. In inner city areas, club green space may exacerbate inequalities in walking accessibility, whereas its influence is stronger in suburban sub cities under comprehensive travel modes. These findings highlight the need for planning policies that explicitly regulate and coordinate public and private green space provision.

Another research by Shan and He (2025) examines the role of peri-urban parks in enhancing urban green spaces accessibility from an environmental justice perspective. Country parks, situated on city edges, conserve ecology and provide recreation. Unlike urban parks, they feature larger, semi-natural settings that serve varied needs and offset limited city green space. Their effectiveness depends on accessibility and transport links, making them a crucial element in spatial and infrastructure planning. The case of Hong Kong demonstrates how peri urban parks can reshape urban green space accessibility and environmental justice outcomes. Although the influence of country parks generally declines with increasing travel time, empirical analysis shows that they can mitigate or even reverse disparities between central and peripheral areas across different accessibility thresholds. Importantly, neighborhoods with more disadvantaged populations are often more reliant on peri urban parks to improve overall access to green space, and this reliance has intensified during recent urbanization processes. To inform urban policy making, these findings underscore the importance of coordinating green space planning with transport investment and housing policy to ensure acceptable travel times and equitable access.

Looking forward, an integrated UGI–health nexus provides a policy relevant framework for future urban planning. Such a framework conceptualizes UGI as a system composed of diverse elements, including public parks, club green spaces, green roofs, and peri urban parks, operating across multiple spatial and temporal scales. Health and well being outcomes are similarly multidimensional, ranging from short term psychological effects to long term life course impacts. For policymakers, this suggests the need for longitudinal

evaluation, cross sectoral coordination, and adaptive governance mechanisms capable of responding to changing social and environmental conditions.¹

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¹ **References:**

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Shan, L., & He, S.* (2025). The role of peri-urban parks in enhancing urban green spaces accessibility in high-density contexts: An environmental justice perspective. *Landscape and Urban Planning*, 254, 105244.

Closure Lecture

What does it mean to be “too hot”? A New Paradigm for Extreme Heat Management

It is a pleasure for me to close this conference on challenges for the 21st century in sustainable urban planning and territorial management. [...] Heat is a central concern for cities everywhere. Fundamentally, the term ‘heat’ describes a thermal state determined by multiple climate-related variables including air temperature, radiation, humidity, and air movement that have consequences for the human body and biophysical systems (Oke 1982, Parsons 2002, Kuras et al 2017). Those thermal states are consequential to cities as a set of impacts on people and places. For instance, extreme heat—a thermal state that has negative consequences for human bodies—is one of the deadliest climate change impacts globally and predicted to increase with future urban population growth and an extreme heat event (EHE) frequency and severity (WHO, C40, Madge 2011, Mora 2017, Buchanan 2021, Tuholske et al 2021). Impervious surfaces such as asphalt and other attributes of the built environment contribute to states such as local warming and the regional urban heat island (UHI) in most urbanized regions (Oke 1982, Grimmet al 2008, Imhoff et al 2010, Stewart and Oke 2012, Lazzarini et al 2013, Hardin et al 2018).



The combined effects of global and urban-scale warming are disproportionately felt by marginalized groups due to higher heat exposure and lesser capacity to cope with hot conditions (Harlan et al 2006, Eisenman et al 2016, Hoffman et al 2020, Dialesandro et al 2021). Excess heat can amplify other environmental problems, worsening air and water quality, increasing wildfire risk, and greenhouse gas emissions through higher energy demand for cooling (Santamouris 2020). Heat has consequences for every aspect of urban life: it compromises critical urban infrastructure (Chapman et al 2013), lowers educational outcomes (Park et al 2020), increases pre-term births (Barrecca et al 2018, Barecca and Schaller 2020), and reduces labor productivity (Park 2021). Given that urban heat is a multi-faceted problem, cities will need to pursue a suite of different approaches to effectively govern a hotter future.

Few governing institutions at any jurisdictional scale have historically formally, directly, or comprehensively managed heat (Nordgren et al 2016, De Shazo et al 2021, Gabbe et al 2021, Keith et al 2021, Meerow and Keith 2021). Some of the first efforts to mainstream heat response and management by government and international non-government actors⁸ laid the foundation for a current acceleration in action. The distributed network of response to

heat suggests that nascent urban heat governance systems are emerging. Environmental governance refers to the 'set of regulatory processes, mechanisms and organizations through which political actors influence environmental actions and outcomes' (Lemos and Agrawal 2006). Problem framing is a critical function in environmental governance, because it constrains what solution sets are deemed critical and which institutions take ownership of governance (Adger et al 2011, Whittemore and Ben Dor 2018), with downstream implications for what aspects of a problem are addressed or not. Heat governance framing directs attention to particular consequences of elevated temperature for people and places, with implications for what constitutes a desirable state and if and how to address it.

Municipal plans provide insight into prevailing problem framings through inclusion of particular policies, programs, and initiatives and alignment with a specific high-level 'vision' (e.g. sustainability, resilience, see Berke and Godschalk 2009). Those broad visions are an amalgamation of policy agendas set in consultation with environmental networks and local innovations (Broto and Bulkeley 2013, Nordgren et al 2016). Plans—or networks of plans—do not encompass the full variety of actors, tools, and narratives present in a governance system, but do signal which environmental agendas are included and prioritized in formal in city governance (e.g. Berke et al 2000, Tennoy 2010, Berke et al 2019).¹

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¹ words extracted from the presentation given by Professor Kelly Turner at the closing ceremony of the SUPTM conference held on January 22, 2026



Urban Form, Accessibility, and Cultural Change: Insights from Comparative Spatial Analysis

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Abstract: Urban accessibility profoundly influences cultural and social dynamics. As historic port cities evolve, understanding how spatial form mediates change is essential. This study compares Porto and Cagliari by integrating space syntax to assess accessibility at multiple scales. Porto displays adaptable, polycentric integration aligned with cultural revitalisation, while Cagliari shows a centralised structure with reduced accessibility in its historic core. These spatial differences reveal uneven cultural access. Future research may incorporate demographic and mobility data to deepen insights. The study concludes that spatial configuration is a vital lens for guiding inclusive, culturally responsive urban planning in heritage-rich port cities.

Keywords: Port Cities; Space Syntax; Urban Morphology; Cagliari (Italy); Porto (Portugal)

1. Introduction: The Spatial Mediation of Cultural Change in Port Cities

Historic port cities function as crucibles where heritage preservation collides with contemporary transformation, yet the spatial dimension of cultural change remains critically underexamined. As maritime economies evolve under pressures of deindustrialisation, tourism, and climate adaptation, these cities experience profound cultural shifts—gentrification, demographic turnover, and reconversion of waterfronts—that manifest spatially through changing patterns of accessibility and movement [1]. This study interrogates how urban morphology actively structures these transitions rather than passively containing them, addressing a fundamental gap in understanding the configurational drivers of cultural accessibility within municipal boundaries.

The theoretical framing integrates three domains. Urban morphology reveals how historical port functions, mercantile activities, and topographical constraints produce distinctive spatial structures—linear waterfronts, dense cores, and hierarchical gradients—that persist long after functional obsolescence [2]. Cultural geography, particularly Massey's conception of space as relational and Harvey's analysis of spatial justice, positions accessibility as inherently political: who can reach which cultural assets, through what routes, and at what scales determines whether heritage functions as living urban fabric or as a privatised museumscape [3]. Space syntax theory provides the methodological bridge, positing that street network configuration exerts independent influence on movement, encounter, and socio-economic potential. The integration measure—calculating mean topological depth of street segments at multiple radii—offers a powerful proxy for accessibility that is simultaneously geometric and social [4]. Multi-scalar analysis (global, 3000m, 1000m, 300m radii) becomes essential: cultural economies operate at city-wide (municipal) scales, while everyday cultural participation depends on pedestrian walkability. Port city literature further identifies "cultural mobility mismatches" where waterfront redevelopment and tourism gentrification decouple heritage sites from networks of daily life, producing what Augé termed "non-places"—heritage containers devoid of lived culture [5].

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This research addresses urgent policy challenges: how can historic cities strike a balance between preservation and inclusive cultural access? How does spatial form enable or foreclose cultural reinvention? Through a comparative analysis of Porto (Portugal) and Cagliari (Italy), focusing strictly on their municipal jurisdictions, we employ space syntax to diagnose spatial inequalities and illuminate pathways for culturally responsive planning. Porto's steep river valley topography and Cagliari's fortified hilltop core provide natural experimental conditions for examining how similar external pressures interact with distinct morphological structures to produce divergent cultural and spatial outcomes.

2. Methodological Framework

A comparative case study methodologically leverages the similarities and differences between Porto and Cagliari within their administrative municipal limits. Both developed as primary Atlantic/Mediterranean ports, feature medieval-origin historic cores, and face comparable post-industrial transitions. However, they differ radically in topography, contemporary economic structure, and infrastructural development, creating conditions for controlled comparison of morphological effects at the municipal scale.

Data collection involved acquiring high-resolution street network data from municipal GIS databases, which were then precisely clipped to the municipal boundaries. Depth-MapX software, we computed integration values at four radii: global (radius-n bounded by the municipality), capturing city-scale movement within administrative limits; 3000m, representing municipal pedestrian accessibility (sufficient to traverse most municipal territories); 1000m, approximating district-scale walkability; and 300m, modelling immediate neighbourhood access. Segment analysis was utilised for its superior handling of metric street properties and alignment with actual movement patterns within the municipal fabric.

The analytical framework identified "integration corridors"—continuous sequences of highly integrated street segments forming the configurational backbone of pedestrian and vehicular flow within each municipality. We spatially overlaid these corridors with: (1) institutional cultural assets (museums, theatres, heritage sites) from municipal cultural inventories, and (2) emergent cultural reinvention zones identified through field observation, municipal planning documents, and local media analysis of new venues and events. This overlay assessed alignment between configurational centrality and cultural vitality, revealing whether heritage sites occupy accessible network positions or remain morphologically marginal within the municipal boundary.

3. Case Studies and Findings

3.1. Case Study 1: Porto—Polycentric Adaptation and Cultural Alignment

Porto's municipal morphology reflects its steep Douro River valley topography, producing a "fragmented but adaptable" integration structure within its administrative limits (Fig 1). Global (municipal-bound) analysis reveals no single dominant core but multiple linear corridors along major arterials (Rua de Santa Catarina, Avenida dos Aliados) that parallel the river, creating a polycentric structure across the municipality. At a 1000m radius, integration intensifies along uphill connectors linking the riverfront to the plateau, particularly around the Hospital de Santo António and municipal metro corridors. This multi-scalar differentiation proves crucial for cultural dynamics.

Areas of cultural reinvention—Cedofeita arts district, Bonfim creative quarter, and reactivated warehouses in the eastern waterfront area (within Porto municipality)—position themselves precisely along these medium-radius integration corridors. They occupy "sweet spots" where neighbourhood-scale configurational potential meets affordable space. The Museu de Serralves, situated in the western part of the municipality, offers accessibility via integrated avenue corridors, making it cognitively accessible despite its relative distance.

The UNESCO-listed Ribeira historic core presents a paradox: municipally integrated due to its tourist visibility and riverside location yet showing markedly low integration within a 300 m radius. Its dense medieval fabric creates a locally disconnected environment for residents, while tourists follow canalised routes. This indicates a "tourist trap" morphology—heritage appears accessible at the municipal scale but lacks granular permeability for everyday cultural practices. Nevertheless, Porto's municipal polycentric structure allows alternative cultural spaces to emerge elsewhere without abandoning the historic core, suggesting a resilient distributed model of cultural urbanism within the municipal boundary.

3.2. Case Study 2: Cagliari—Centralised Rigidity and Spatial Decoupling

Cagliari's municipal urban form contrasts sharply with Porto's adaptability. The fortified hilltop Castello district occupies a position that dominated the medieval port but shows surprisingly low integration across the municipal territory (Fig. 1). Global (municipal-bound) integration is concentrated in the modern Marina district and the Poetto beachfront road—areas developed after port expansion bypassed the historic core within municipal limits. At a 1000m radius, Castello's steep street network exhibits severe integration deficits due to cul-de-sacs and level changes. In contrast, the municipal districts of Stampace and Villanova display higher local integration but remain configurationally segregated from Castello.

Cultural mapping reveals structural decoupling within the municipality. Major institutions (National Archaeology Museum, Municipal Art Gallery) remain concentrated in Castello, occupying spatially marginal positions. Meanwhile, emergent cultural activities—such as Loftasai creative cluster near the municipal market and ExManifattura in the industrial zone—are in integrated peripheral zones near redeveloping municipal port areas, creating a "cultural-periphery accessibility core." The municipal Poetto waterfront exemplifies dysfunction: high integration but lacking cultural depth, facilitating movement without encounter—a "transit landscape" where accessibility serves mobility rather than cultural embedding. Cagliari's morphology thus constrains transformation by forcing a choice between heritage authenticity (municipal spatial isolation) and contemporary accessibility (a culturally thin approach).

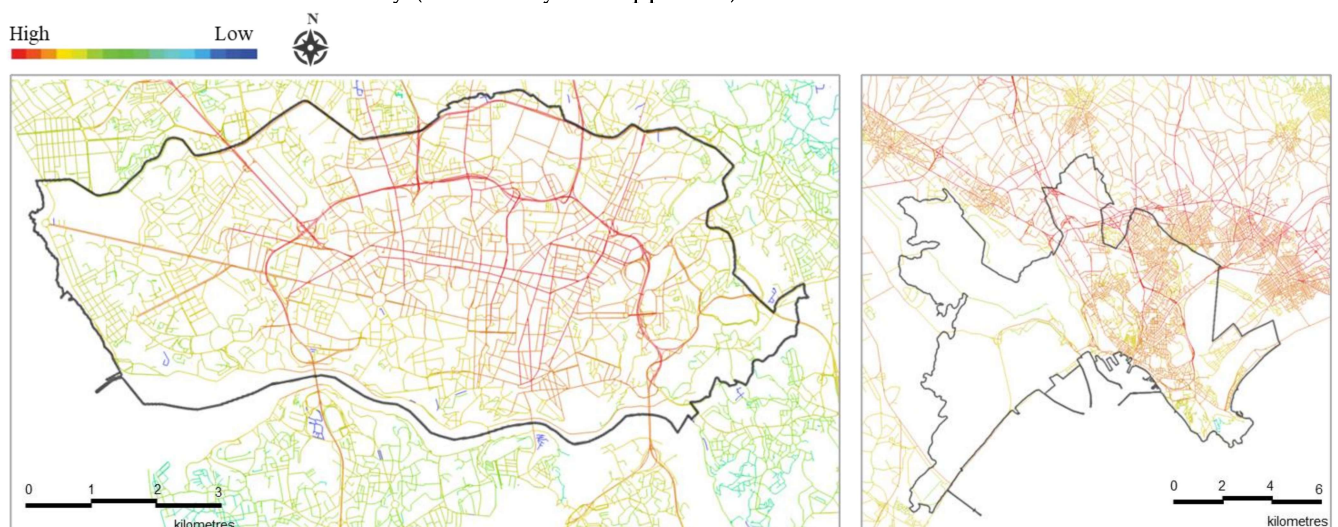


Figure 1. Global integration results of major road networks in Porto (left) and Cagliari (right).

4. Discussion

The comparative analysis reveals divergent models of cultural-spatial dynamics within the municipal scale. Porto exhibits configurational complementarity, where morphological fragmentation enables multiple scale-specific integration patterns across its

municipal jurisdiction, allowing cultural activities to align with strategically designated accessibility corridors [6]. The vertical topography creates discrete municipal layers, each with a distinct configurational logic, allowing for the coexistence of tourist heritage, local commerce, and creative reinvention without direct spatial competition [7].

Cagliari demonstrates configurational contradiction: its centralised historic morphology proves maladapted to contemporary pedestrian accessibility within the municipal boundary. Concentrating heritage in spatially segregated Castello creates a zero-sum dynamic where preservation equals isolation, while accessible peripheral zones lack morphological depth for organic cultural evolution. This generates an "either/or" condition, forcing heritage marginalisation or cultural displacement within the municipality [8].

These findings advance theory by introducing radius-specific cultural accessibility at the municipal scale: different cultural practices require different network properties [9]. Effective municipal planning must align cultural land uses with appropriate configurational scales rather than pursuing undifferentiated accessibility. For Porto-like municipalities, policy should protect medium-radius integration corridors supporting emerging cultural quarters while improving micro-scale permeability in historic cores. For Cagliari-like municipalities, "configurational acupuncture"—targeted municipal interventions creating new through-routes—can bridge heritage and contemporary networks.

5. Conclusion: Toward Culturally-Just Spatial Planning

This research demonstrates that municipal urban form actively mediates cultural change, not as neutral background but as configurational structure enabling or constraining inclusive cultural access. Through comparative space syntax analysis bounded by municipal jurisdictions, Porto's adaptable polycentricism emerges as more conducive to equitable cultural transformation than Cagliari's centralised rigidity, which structurally decouples heritage from everyday life within the city. The study contributes a replicable municipal-scale methodology for diagnosing cultural-spatial inequalities and a theoretical framework emphasising radius-sensitive planning. The research advocates for cultural justice in municipal spatial planning: ensuring that municipal street networks enabling urban life also to weave diverse cultural expressions into everyday experience. As historic port cities navigate tourism, gentrification, and climate adaptation, municipal-level morphological analysis provides essential tools for preserving not just built heritage but the spatial conditions necessary for heritage to remain culturally vital and socially inclusive within local governance boundaries.

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