

Green infrastructure as a geographical concept: Bridging spatial planning, ecological and social dimensions

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ABSTRACT

The concept of Green Infrastructure (GI) bridges spatial planning, ecology, and social sciences, yet its application in geography is often hindered by conceptual ambiguity and disciplinary fragmentation. This study aims to synthesize these fragmented perspectives into a robust geographical framework. We employed a hybrid review methodology, combining a systematic search with a qualitative thematic synthesis of 106 core studies published between 2000 and 2025. Our analysis categorizes the existing literature into five distinct thematic pillars – ranging from conceptual definitions and ecosystem benefits to critical governance challenges – demonstrating that these domains often operate in isolation. The analysis reveals that contemporary GI research is characterized by a “paradox of sophistication”: while methods for measuring ecosystem services are advanced, they are applied within a narrow geographical scope, overlooking the Global South and failing to integrate critical social dimensions. In response, we introduce the Form-Process-Power framework. This model integrates the physical configuration of green spaces (Form), their dynamic ecological and social functions (Process), and the political economies determining their distribution (Power). By systematically linking these dimensions, the proposed framework provides geographers and planners with a comprehensive tool to address the complexities of urban resilience and environmental justice.

KEYWORDS

green infrastructure; spatial patterns; urban sustainability; geographical theory; conceptual framework

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1. Introduction

Geography, as a discipline that interfaces with the natural, technical, and social sciences, is more than just a bridge between fields; it fundamentally investigates the spatial organization of the world. The discipline has a unique ability to combine physical geography's analysis of biogeographical patterns and climatic processes with human geography's critical study of the governance, social power, and cultural landscapes that shape human-environment interactions. This dual focus makes geography ideally suited to address complex, multifaceted socio-ecological phenomena. While the concept of Green Infrastructure is broad and scaling – encompassing both natural landscapes and urban environments (as defined by the European Commission) – this study intentionally narrows its primary focus to the urban and peri-urban landscape. This delineation is conceptually justified: cities represent the most intensive nodes where ecological processes, dense spatial forms, and complex socio-political power structures collide. It is precisely within the urban landscape that the integration of the spatial, ecological, and social dimensions is most urgently needed and, paradoxically, most challenging to achieve. Therefore, while acknowledging the broader landscape context, isolating the urban dimension allows for a more focused critique of geographical thinking regarding human-nature interactions.

The study of urban “greenery” or “green space” illustrates both this potential and its persistent challenges. As often noted in scholarly debates, selecting precise terminology is difficult; these terms, while widely used, are often conceptually unclear, complicating comparative analysis and policy implementation. The concept of Green Infrastructure (GI) has emerged as a powerful framework to overcome this ambiguity, positioning greenery as a strategically planned network of natural and semi-natural areas designed to deliver a wide range of benefits. However, we argue that this strategic concept, GI, must be recognized as more than just a planning tool or a static environmental variable. It should be studied as a distinct, dynamic research subject that can contribute to the development of new theoretical frameworks in geography (Long 2022). This requires a theoretical reflection that includes not only ecological and social aspects but also a deeper analysis of its importance in shaping urban and landscape spaces (Camacho-Cervantes et al. 2014). Consequently, the result of this approach is a highly fragmented view of greenery (Chatzimentor et al. 2020), with physical geographers focusing on biogeographical patterns and climatic feedbacks, while human geographers examine questions of spatial justice, cultural landscape, and urban governance. The extent to which such studies explicitly conceptualise GI as geography in its own right varies considerably. This variability points to a persistent issue: despite the increasing attention GI

has received across disciplines such as ecology, urban planning, and environmental sciences (Chatzimentor et al. 2020; Ghofrani et al. 2017), its conceptual positioning within geography remains ambiguous. While green spaces (including urban parks, forests, and agricultural landscapes) are frequently analyzed in geographical studies (Jim and Chen 2003; Nicholls 2001; Supuka et al. 2013), they are often treated as peripheral variables within broader research themes (e.g. land use (Wu and Plantinga 2003), urban sustainability, climate adaptation (Matthews et al. 2015; Shukla et al. 2019) rather than as independent geographical topics in their own right. Indeed, a comprehensive understanding of GI emerges at the nexus of Geography, Ecology, and the Social Sciences (Borges et al. 2017) giving rise to critical hybrid fields like landscape ecology and environmental justice. Shifting research paradigms compound this uncertainty. The rise of landscape ecology, the diffusion of nature-based solutions (NBS) (Nesshöver et al. 2017; Escobedo et al. 2019; Eisenberg and Polcher 2019; Fang et al. 2023; Green et al. 2021) and renewed attention to urban heat (Morakinyo and Lam 2016; Lehnert et al. 2021; Sun et al. 2019; Lungman et al. 2023; Lehnert et al. 2024) have accelerated GI research. However, critiques from political ecology (Hurley et al. 2015) and relational geography suggest that GI scholarship within geography still lacks a coherent conceptual core. Indeed, the ambiguous definition of GI and its divergent interpretations are frequently noted as a challenge (Ying et al. 2022; Chatzimentor et al. 2020; Escobedo et al. 2019).

This conceptual ambiguity hinders the development of cumulative knowledge, as disparate studies often speak past one another using different theoretical languages (Chatzimentor et al. 2020; Malecki 2010). Furthermore, it limits geography's ability to offer robust, critical insights that extend beyond technical support for urban policy and planning (Chatzimentor et al. 2020; Dobšínská et al. 2025). In response, this article aims to critically assess the status of GI as a core concept within geographical thought. Specifically, it investigates whether urban nature can and should be treated as a standalone subject of geographical inquiry, rather than merely a secondary component within existing spatial studies. The logical structure of this inquiry is visualized in the conceptual roadmap in Fig. 1, which guides the subsequent sections of this paper.

Ultimately, scholars call for frameworks that integrate spatial form, ecological process, and social power, but a systematic synthesis has not materialised (Chatzimentor et al. 2020; Dobšínská et al. 2025). Against this backdrop, achieving a new synthesis requires a methodology that balances rigor with interpretive depth. Consequently, rather than relying on a purely quantitative meta-analysis or a traditional narrative review, this article employs a hybrid review approach. This choice allows us to combine a

systematic search protocol with a thematic synthesis (Siddaway et al. 2019), ensuring both the replicability of evidence collection and the interpretive flexibility necessary for robust theory-building (Long 2022). An ill-suited method would risk reinforcing the very disciplinary silos this paper seeks to dismantle; therefore, the specific design of this inquiry is carefully detailed in the following section.

2. Materials and methods

To navigate the complexity of Green Infrastructure (GI) research and construct a coherent geographical framework, this study follows a structured conceptual roadmap, visualized in Fig. 1. This roadmap guides our inquiry from the initial recognition of geography's interdisciplinary nature, through the selection of methodological approaches, to the synthesis of a new integrative model.

Synthesizing a diverse and fragmented field such as green infrastructure (GI) is not a matter of applying a one-size-fits-all methodological template (Chatzimentor et al. 2020; Honeck et al. 2020; Knobel et al. 2019; Taha 2023). The choice of a review methodology is, in itself, a critical research decision that fundamentally shapes the scope and nature of the findings (Siddaway et al. 2019). It requires a careful alignment between the research questions and the tools used to answer them (Siddaway et al. 2019). This chapter therefore begins by justifying the selection of our specific methodology before detailing the individual stages of our research process.

A purely quantitative meta-analysis, for instance, would fail to capture the rich conceptual debates and qualitative nuances surrounding issues of governance

and spatial justice (Dobšínská et al. 2025; Sharifi et al. 2021). Such techniques depend on homogenous data and comparable effect sizes, which are rarely available for complex, context-dependent topics like community engagement or policy implementation. Conversely, a traditional narrative review, while flexible, could inadvertently perpetuate the field's fragmentation through selection bias (Nordbø et al. 2018; Siddaway et al. 2019; Shuvo et al. 2020). This bias often occurs unintentionally, as a researcher's disciplinary background can lead them to overemphasize familiar literature while overlooking contradictory findings from other fields (Weerasuriya et al. 2019). To truly integrate the diverse streams of GI research, an approach explicitly designed to bridge these methodological divides is therefore essential (Honeck et al. 2020).

Therefore, this paper employs a comprehensive systematic review framework. We adopted a systematic search protocol to ensure a comprehensive and replicable identification of relevant literature (Shahtahmassebi et al. 2021; Wu et al. 2025), analysing more than one hundred peer-reviewed studies published between 2000 and 2025 (Wu et al. 2025) (detailed in section 2.1). For the subsequent analysis, we applied a qualitative thematic synthesis based on best-practice principles for structuring a coherent narrative. This approach allows us to combine the rigor of a systematic search with the interpretive depth needed to build a new conceptual core (Siddaway et al. 2019).

2.1 Literature search strategy

A comprehensive literature search was conducted to identify peer-reviewed articles. The search timeframe was set for publications between January 2000 and

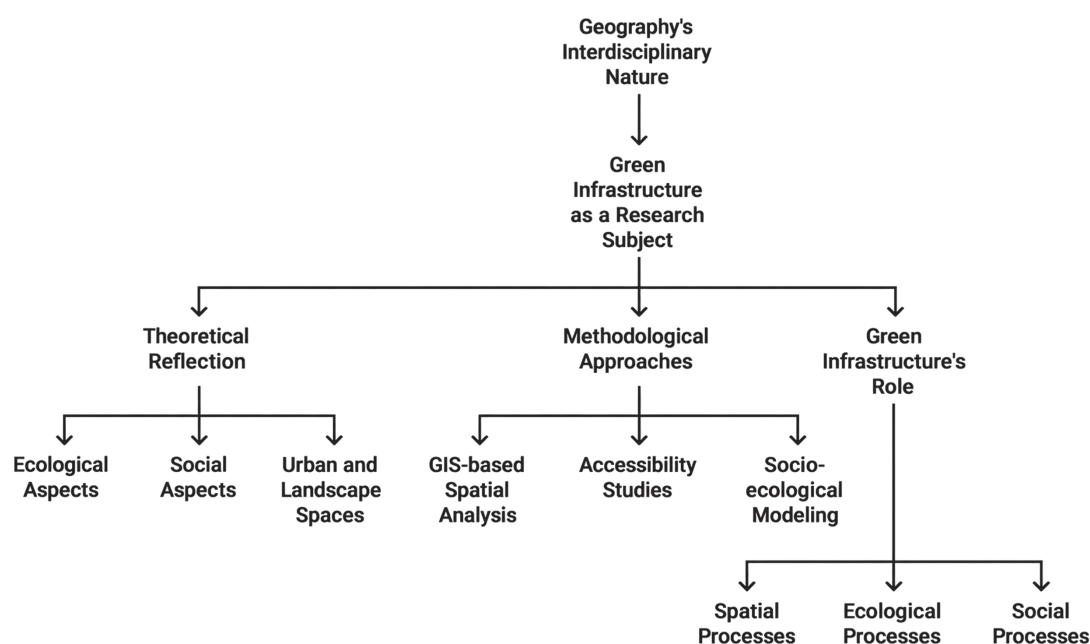


Fig. 1 Conceptual roadmap of the article's inquiry.

the first half of 2025. The search was performed in two major academic databases known for their broad coverage of environmental, geographical, and social sciences: Scopus and Google Scholar. The search prioritized Scopus as the primary source of high-impact, peer-reviewed literature due to its robust indexing of geographical and urban planning journals. To minimize potential geographical and publication bias—a common challenge in urban geography—this baseline was supplemented by targeted searches in Google Scholar, ensuring the inclusion of relevant regional studies and emerging interdisciplinary research on Nature-based Solutions (NBS) that might otherwise be under-represented.

- **Query 1 (Disciplinary Intersection):** Focused on identifying the broad overlap between green concepts and geographical inquiry. Terms like “spatial” and “urban” were included alongside “geography” to act as proxies for geographical research, ensuring the inclusion of relevant spatial analyses that might not explicitly use the term “geography” in their metadata.
 - *String:* ("green infrastructure" OR "urban green space*" OR "nature-based solution*") AND (geography* OR spatial* OR urban)
- **Query 2 (Thematic Pillars):** Focused on capturing specific conceptual applications. This query included “nature-based solutions” to reflect evolving terminology and targeted specific thematic clusters (e.g., justice, heat) to ensure coverage of interdisciplinary studies that contribute to geographical thought.
 - *String:* ("green infrastructure") AND ("urban heat" OR "biodiversity" OR "well-being" OR "spatial justice" OR "governance" OR "landscape ecology")

The results from both queries were combined to form the initial corpus. In addition to the database search, the reference lists of key review articles identified during the screening process were manually scanned to identify any further relevant studies (a process known as “snowballing”).

2.2 Study selection and eligibility criteria

The literature search and selection process followed the PRISMA guidelines. The initial broad search queries yielded a significant volume of records: 33,679 from Scopus and 8,810 from Google Scholar. To refine this massive corpus, automated database filters (limiting results to peer-reviewed journal articles in English within the subject areas of Social Sciences, Environmental Science, and Geography) were applied to the Scopus results, reducing its pool to 2,000 records. Concurrently, the top 500 ranked records from Google Scholar were extracted for further processing. This deliberate threshold is methodologically justified by the unique sorting algorithm of Google Scholar, which prioritizes records based on keyword weight and citation counts, leading to a significant drop in precision and relevance after the first few hundred results. Limiting the manual screening to the top 500 ranked records balances comprehensive coverage with resource efficiency, adhering to established guidelines for systematic reviews and evidence syntheses (Haddaway et al. 2015).

After merging these sources into an aggregated pool of 2,500 records, a total of 420 duplicate entries across the databases were identified and removed, leaving 2,080 unique records. To ensure a highly focused and rigorous analysis, these unique records were ranked by relevance, and the titles and abstracts

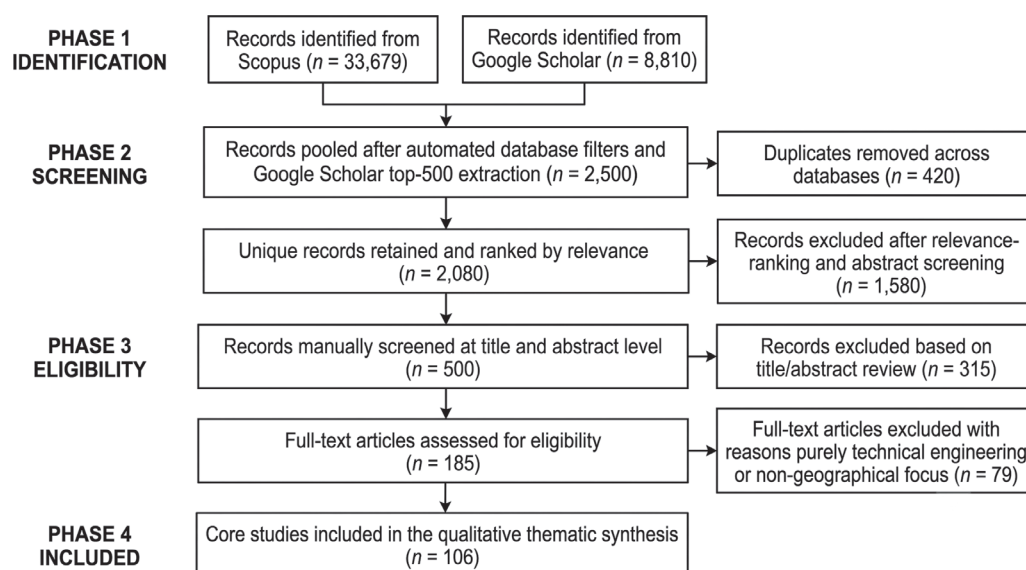


Fig. 2 PRISMA flow diagram showing the identification, screening, and inclusion of studies from WoS, Scopus, and Google Scholar.

2.3 Data extraction and thematic synthesis

synthesis was performed to identify the dominant research areas through an inductive, multi-stage coding process. While structured into three phases, this process was inherently iterative, involving constant comparison and refinement:

1. First, initial concepts and conceptual framings were identified via open coding of the extracted key findings.
2. Second, these codes were clustered into descriptive themes.
3. Finally, the themes were grouped into the overarching research areas presented in the Results section.

3. Results

The systematic analysis of 106 articles reveals a dynamic and rapidly maturing field of research. As an



Fig. 3 Word cloud representing the frequency of terms within the keywords and abstracts of the analyzed corpus (n=106).

initial step to map the conceptual landscape, we conducted a frequency analysis of author keywords and abstracts across the selected corpus. A visual summary of this terminological prevalence is provided in Fig. 3.

This visualization highlights the prominence of foundational concepts such as ‘parks’ and ‘green spaces’, while also revealing the growing importance of social dimensions through terms like ‘social’, ‘access’, and ‘gentrification’.

Based on the deeper thematic synthesis of the full texts, this chapter presents the results in two main parts. First, we outline the overarching characteristics and meta-trends that define the scholarly landscape of green infrastructure research as a whole. Second, we present a detailed breakdown of the five principal thematic areas that constitute the core substance of this research, which will be further detailed in subsequent sections.

3.1 Overarching characteristics of the research field

Before examining specific thematic areas, our synthesis identifies several overarching characteristics that define the character of contemporary GI scholarship. First and foremost, geographical scholarship on GI is profoundly interdisciplinary, drawing on a wide array of methods and perspectives from ecology, urban planning, public health, sociology, and geography to address the multifaceted nature of GI. This interdisciplinarity is often channelled into a strong applied orientation, with a significant portion of research focused on providing evidence for addressing tangible urban challenges such as heat island mitigation, air pollution, and public health risks.

The growing maturity of the field is evident in two parallel trends that signal a shift from early exploration to rigorous consolidation: a pronounced emphasis on developing robust methods for measurement and evaluation, and a growing awareness of the challenges, barriers, and negative aspects associated with GI, including issues of environmental justice and governance. Despite this maturity, a persistent theme emerging from the literature is the call for greater integration and standardization of definitions and methods to overcome the field’s fragmentation (Escobedo et al. 2019; Chatzimentor et al. 2020).

Finally, the large number of case studies from diverse regions underscores the critical importance of local context—be it geographical, socioeconomic, or political—in shaping GI outcomes. Taken together, these characteristics depict a vibrant and applied research field actively engaging with the complexities of real-world application.

3.2 The conceptual web: core concepts and their interconnections

To understand how the research field operates, our analysis identified 14 distinct core concepts that differentiate the analyzed literature. A detailed overview of these concepts, including their thematic affiliation and frequency within the corpus, is presented in Table 1. Importantly, Green Infrastructure (GI) itself is excluded from this comparative frequency table, as it serves as the universal overarching framework and primary search criterion defining the entire corpus; its inclusion would thus be empirically tautological. Instead, the analysis focuses on the secondary concepts that illustrate disciplinary fragmentation

Tab. 1 Overview of the 14 core concepts identified in the reviewed literature (n=106), including their thematic categorization, estimated frequency of occurrence, and dominant geographical focus.

Core concept	Thematic pillar	Frequency in corpus (%)	Dominant geographical focus
Ecosystem services (ES)	Benefits and functions	85%	Europe, North America, China
Health and well-being	Benefits and functions	78%	Europe, North America, Oceania
Climate regulation (UHI)	Benefits and functions	65%	East Asia (China), Europe
Biodiversity	Benefits and functions	55%	Europe, Global South (emerging)
Spatial planning	Conceptual frameworks	60%	Europe, North America
Spatial justice	Challenges and negative aspects	45%	North America, Europe
Environmental justice	Challenges and negative aspects	40%	North America
Accessibility	Methodology/frameworks	50%	Europe, China
Governance	Conceptual frameworks	40%	Europe, North America
Public participation	Challenges and negative aspects	35%	Europe
Brownfield remediation	Centrality of Case Studies	20%	Europe (esp. Eastern/Central)
Mental well-being	Benefits and functions	30%	Europe, North America
Poisonous/allergenic plants	Challenges and negative aspects	15%	Europe
Specific contexts (schools, etc.)	Centrality of case studies	25%	Europe, North America

and thematic shifts, including emerging variations like Green and Blue Infrastructure (GBI). These concepts emerged inductively from the coding process (Section 2.3) and do not exist in isolation but form a dense, interconnected web. By mapping their co-occurrence in the literature, we move beyond a simple list to reveal the underlying structure of the field, including its dominant themes and interdisciplinary connections.

At the heart of this web are several ‘hub’ concepts, representing the most established and frequently studied themes. Unsurprisingly, these include foundational topics such as Ecosystem Services, which frames GI in terms of its functional benefits for society (Escobedo et al. 2019), and Climate Regulation, with a strong focus on urban heat island mitigation (Oliveira et al. 2011; Wang et al. 2022). Similarly, Biodiversity stands out as a central pillar, linking GI to core ecological principles of conservation and habitat provision within urban environments (Lepczyk et al. 2017; Norton et al. 2016). These hubs act as gravitational centers, attracting significant research attention.

Connecting these major hubs are key ‘bridging’ concepts that facilitate interdisciplinary dialogue. For instance, themes like Spatial Justice and Governance serve as crucial links connecting the biophysical aspects of green infrastructure to critical social and political science questions (Hurley et al. 2015; Sharifi et al. 2021). These concepts are vital for preventing the field from fracturing into disconnected natural and social science silos.

At the very center of this web lies Green Infrastructure (GI), acting as the primary object of inquiry from which most research questions originate. It is inextricably linked to the concept of Ecosystem Services (ES), which serves as the principal framework for articulating the tangible and intangible benefits of GI. These benefits, in turn, are most frequently connected to the ultimate outcome of human Health and Well-being, encompassing both physical and mental dimensions. These three concepts (GI, ES, and Well-being) form the foundational core of the entire conceptual structure.

Surrounding this core, Spatial Planning acts as the primary applied framework that integrates scientific insights with on-the-ground implementation. Accessibility is a critical bridging concept here, linking the physical presence of GI to outcomes of Environmental and Spatial Justice by raising questions about the equitable distribution of benefits. Similarly, Governance and Public Participation connect high-level planning processes to the principles of equity and the practical realities of management, ensuring that diverse community needs are considered.

Orbiting these central and bridging concepts are specialized ‘satellite’ topics that relate to specific sub-fields and contexts. Topics such as Brownfield Remediation represent a particular opportunity for GI implementation within the urban renewal discourse.

Conversely, the study of Poisonous and Allergenic Plants represents a focus on specific ‘dis-services’ or health risks, forming a necessary, critical counterpoint to the uniformly positive narrative of GI benefits. Other satellites include focused inquiries into specific health outcomes, such as mental well-being (Helbich et al. 2019), or the unique dynamics of GI in specific contexts like school grounds (Jansson et al. 2018). All of these inquiries are underpinned by a sophisticated toolkit combining quantitative data and geospatial technologies (RS/GIS) with qualitative and participatory methods, providing a robust empirical foundation for analysis and evaluation across the conceptual web.

This entire conceptual web is visualized in Fig. 4, where GI itself sits at the center as the primary object of inquiry, underpinned by functional hubs and interconnected through bridging concepts that link biophysical functions to social realities.

3.3 The five thematic pillars of green infrastructure research

While the conceptual web illustrates the static connections between theoretical ideas, the thematic analysis of the corpus reveals how research activities are actively organized into five distinct pillars. These pillars represent the primary fronts on which GI scholarship is currently advancing. This section details the key findings within each of these pillars, supported by evidence from the 106 analyzed studies.

3.3.1 Conceptual and political frameworks

This foundational pillar addresses the definitions, theoretical underpinnings, and governance models of GI. The literature reveals a persistent ambiguity and inconsistency in the term ‘green infrastructure’ (Ghofrani et al. 2017; Escobedo et al. 2019), often

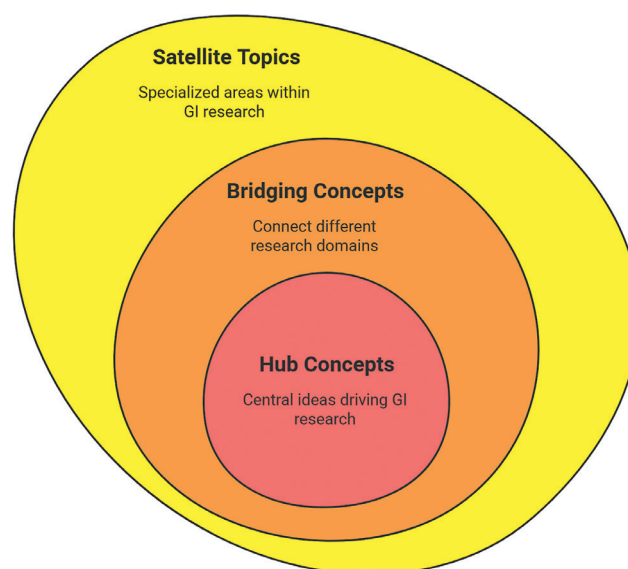


Fig. 4 A conceptual map illustrating the relationships between core concepts in GI research.

influenced by policy documents such as the EU's GI Strategy. This conceptual uncertainty complicates the integration of GI into coherent policy and planning.

Studies in this pillar often engage in deep theoretical analysis of the socio-natural relationship in urban spaces, examining how regulations, design, and discourse shape the function of green areas, as exemplified by historical analyses of parks in Olomouc (Daniel and Jirmus 2023). Furthermore, this research explores the crucial process of translating scientific knowledge into policy and practice, analyzing the roles of different actors, their interests, and the power dynamics that govern how GI frameworks are formed and implemented.

3.3.2 Benefits and functions

This is the most extensive pillar, robustly documenting the multitude of positive impacts of GI. The findings consistently confirm a strong link between green spaces and improved human health and well-being (Addas 2023; Grilli et al. 2020), covering both mental (e.g., stress reduction) and physical (e.g., encouraging physical activity) dimensions. A recurring theme is the role of GI in providing ecosystem services.

Regulatory services are a primary focus, with numerous studies quantifying GI's capacity for microclimate regulation and urban heat island mitigation (Lehnert et al. 2021; Jo et al. 2009), air pollutant reduction, carbon sequestration, and stormwater management (Green et al. 2021). Supporting services are also prominent, particularly the provision of habitats to enhance urban biodiversity (Kowarik et al. 2025; Lepczyk et al. 2017). Finally, cultural services, such as providing spaces for recreation and social interaction (Maryani et al. 2023), are highlighted as essential for community cohesion and subjective well-being.

3.3.3 Challenges and negative aspects

Providing a critical counterbalance to the previous pillar, this area of research investigates the significant obstacles and negative outcomes associated with GI. While challenges inevitably permeate all aspects of GI implementation, they have crystallized into a distinct body of critical literature that warrants independent examination. The analysis identifies a range of governance and institutional barriers, including fragmented responsibilities, a lack of political will, and insufficient long-term funding, which hinder effective implementation (Matthews et al. 2015). These are compounded by technical and biophysical barriers, such as limited space in dense cities and unsuitable site conditions.

Critically, this pillar addresses issues of environmental injustice, revealing how the benefits of GI are often inequitably distributed, with marginalized communities having less access to high-quality green spaces. The literature also explores GI's potential "dis-services" and negative externalities, from "green gentrification" to direct health risks posed by

poisonous and allergenic plant species in public areas, and the problem of overheated, poorly designed spaces like playgrounds.

3.3.4 The centrality of regional case studies

The empirical grounding for the entire field is overwhelmingly provided by regional case studies. The analyzed corpus shows a broad geographical scope, with studies located across Europe [e.g., Lisbon (Oliveira et al. 2011), Olomouc, Bratislava (Dobšínská et al. 2025)], North America, and East Asia [e.g., Nanjing (Jim and Chen 2003), Shanghai]. While less numerous, there is also a growing body of research from the Global South, including case studies from cities like Kolkata and Bogotá. These case studies are essential for demonstrating how universal concepts—such as ecosystem services or governance barriers—manifest and are navigated within specific local contexts. They cover a wide range of GI types, from individual memorial trees and urban parks to large-scale brownfield regeneration projects, providing the rich, context-specific evidence that informs both theory and practice.

3.3.5 Methodology and evaluation

The final pillar is focused on the diverse and evolving methodological toolkit used to study GI. Geospatial technologies like GIS and Remote Sensing (RS) form the backbone of much of the quantitative research, used for mapping, inventorying (Smreček 2013), accessibility analysis, and measuring indices like NDVI. The analysis also reveals a strong trend toward developing and applying holistic assessment metrics and tools that capture the multidimensional quality of green spaces beyond mere size or presence. This includes a wide array of statistical methods and survey-based approaches. There is a consistent call across the literature for more integrated and mixed-methods approaches that combine objective, quantitative data with subjective, qualitative insights from interviews and participatory methods to provide a more complete picture of GI's role and function.

While discussed here sequentially for clarity, the analysis reveals that these five pillars do not operate in isolation but form a deeply interconnected system of inquiry. Conceptual frameworks inform case studies, and methodological advances are driven by the need to better understand benefits and challenges. Rather than a linear chain, these pillars represent a symbiotic network where advancements in one area (e.g., new evaluation metrics) directly enable deeper insights in others (e.g., quantifying environmental justice).

3.4 The temporal evolution of GI research

The analysis reveals a distinct temporal evolution in GI research, characterized by shifting priorities that mirror broader scientific and societal changes.

Characteristic	Phase 1 (2000–2008)	Phase 2 (2009–2016)	Phase 3 (2017–2025)
 Core Focus	Ecological integrity	Systematization, social concerns	Integration, critical perspectives
 Methodologies	GIS, remote sensing, field surveys	Systematic reviews, LiDAR	Street View Imagery, AI, CFD
 Key Concepts	Urban Heat Island mitigation	Ecosystem Services framework	Spatial and environmental justice

Fig. 5 A summary of the temporal evolution of GI research across three phases.

Understanding this trajectory is crucial, as it explains the coexistence of different, sometimes conflicting, paradigms in contemporary scholarship. We identify three principal phases in this development (visualized in Fig. 5), tracing the field's maturation from an early focus on foundational concepts to the current era defined by integration and critical perspectives.

It should be noted that this chronological trajectory primarily reflects the mainstream academic discourse within the Global North, mirroring the geographic distribution of the analyzed literature. The breakthrough years defining each phase correspond to major global policy-epistemic milestones. The shift in 2008 represents the integration of green spaces into broader urban climate change adaptation strategies following the initial IPCC assessment cycles, while the 2016 transition marks a conceptual boom driven by the formal adoption of Nature-based Solutions (NBS) frameworks within the EU Research and Innovation agenda and international climate accords.

3.4.1 Phase 1 (2000–2008): foundational concepts and ecological functions

In this early period, which corresponds with the initial surge of GI terminology in academic literature, research was primarily concerned with establishing foundational definitions and recognizing the basic multifunctionality of Urban Green Infrastructure (UGI). The core focus was on ecological integrity, with studies concentrating on mapping habitats and assessing their environmental functions. Concepts such as the mitigation of the Urban Heat Island (UHI) effect were introduced, and the link between green spaces and general well-being began to be explored. Methodologically, this era was characterized by the foundational use of GIS and remote sensing for land use analysis, alongside field surveys.

3.4.2 Phase 2 (2009–2016): systematization and the rise of social concerns

This period saw a significant systematization of the field, largely through the widespread adoption of

the Ecosystem Services (ES) framework as a central organizing concept. Research began to differentiate more granularly between cultural, regulating, and provisioning services, with a strong focus on health outcomes and Subjective Well-being (SWB). Methodologically, this phase saw the rise of systematic reviews and the use of more advanced geospatial technologies like LiDAR. Crucially, questions of accessibility and spatial justice began to be explicitly discussed, with concepts like the “Just City” appearing in relation to the unequal distribution of green space benefits.

3.4.3 Phase 3 (2017–2025): integration, advanced technologies, and critical perspectives

The most recent phase is characterized by a high degree of conceptual integration, methodological sophistication, and a strong emphasis on critical perspectives. Spatial and environmental justice evolved from an emerging topic into a dominant theme, with research explicitly focusing on the needs of vulnerable communities (Ma et al. 2021) and documenting inequities in green space access and quality. The understanding of health benefits became more holistic, incorporating risks such as allergenic plants or heat stress in playgrounds, particularly in the context of the COVID-19 pandemic (Lehnert et al. 2024).

This period is also marked by the adoption of highly advanced technologies, including the use of Street View Imagery (SVI) for human-scale perception analysis (Helbich et al. 2019) and the integration of Artificial Intelligence (AI) with Computational Fluid Dynamics (CFD) for microclimate modeling. Deeper theoretical frameworks, such as assemblage theory, are increasingly employed to analyze the complex, co-produced nature of urban green spaces.

In summary, these three phases reveal a significant and defining trajectory: a clear shift from a primarily ecological and environmental focus towards a more integrated and critical engagement with social justice. While the early 2000s were concerned with documenting environmental functions, the post-2017 era is defined by a critical examination of the

heterogeneous impacts of GI on residents and the pursuit of equity in the distribution and quality of urban green spaces.

3.5 Methodological sophistication and geographical biases

The final layer of our analysis examines the interplay between methodological tools and geographical contexts. This reveals a field characterized by increasing methodological sophistication but simultaneously marked by significant geographical imbalances in its focus.

The methodological landscape is dominated by quantitative approaches, underpinned by Geographic Information Systems (GIS) and Remote Sensing (RS). While these geospatial techniques provide powerful tools for mapping and analysis, they are increasingly complemented by qualitative and mixed-methods research designed to capture subjective perceptions and experiences. However, rather than simply listing these tools, it is crucial to examine where they are applied.

The geographical focus of the reviewed literature is markedly imbalanced, with a heavy concentration of studies in the Global North. Research is predominantly driven by institutions and case studies in Europe (led by the UK, Germany, Italy, Spain, and Sweden), North America (primarily the USA and Canada), East Asia (overwhelmingly China), and Australia. In recent years, China, in particular, has become a hotspot for GIS-based UGI studies, leveraging local data sources to overcome limitations in global platforms.

Conversely, vast regions of the world remain significantly under-researched. This is particularly true for Africa, which is almost absent from studies on urban tree inventories, and South America. While some research exists in Eastern Europe (e.g., in Poland), it is often described as being on the periphery of the mainstream Anglophone academic debate. The analysis further reveals that studies conducted in the Global South and Low and Middle Income Countries (LMICs) are disproportionately scarce. This highlights a critical gap and a potential inequity in the production of GI knowledge itself, suggesting that the field's sophisticated methodologies are not yet being applied evenly across the diverse urban contexts of the world.

4. Discussion

4.1 Interpreting the landscape: a paradox of sophistication and imbalance

The findings presented in the previous chapter reveal a critical disconnect. On one hand, the field is characterized by impressive methodological sophistication, utilizing advanced geospatial tools (Shahtahmassebi et al. 2021) and nuanced conceptual models ranging

from ecosystem services (Escobedo et al. 2019) to environmental justice (Sharifi et al. 2021). On the other hand, this growing expertise is applied within a surprisingly narrow geographical context, heavily concentrated in the Global North (Shuvo et al. 2020).

This discussion argues that this disconnect stems from the lack of a sufficiently integrative conceptual framework that can travel across diverse socio-ecological contexts. Without a unifying lens, the sophisticated tools of the Global North remain difficult to translate into the complex realities of under-researched regions.

To fully grasp the challenges of integrating these dimensions, it is highly illustrative to compare global GI trends with specific national planning practices, such as those in Czechia. In the Czech planning context, the concept of green infrastructure is frequently conflated with the established 'Territorial System of Ecological Stability' (ÚSES), a legally binding landscape planning tool developed in the 1980s. While ÚSES is highly effective at the ecological process level (focusing on biocenters, biocorridors, and biodiversity conservation), it is fundamentally a landscape-ecological tool that historically lacks the socio-spatial dimensions central to contemporary GI literature. The global shift towards understanding GI as a provider of cultural ecosystem services, spatial justice, and active public participation (as outlined in our Form-Process-Power framework) is often missing in Czech municipal planning, where greenery is still predominantly treated as a technical or purely biophysical category. This local reality underscores our finding that without a strong conceptual framework bridging Process (ecology) and Power (governance and social needs), the implementation of modern GI concepts remains limited.

4.2 Towards an integrative framework: form, process, and power

To address this gap, we propose a three-dimensional framework that synthesizes the five identified thematic pillars into a coherent whole. This framework conceptualizes GI through three interdependent lenses: Spatial Form (the physical configuration of space), Ecological Process (the dynamic functions of nature), and Social Power (the governance and equity dimensions).

This approach moves beyond treating GI as a static object to be measured. Instead, it provides a common analytical language to bridge the divides between spatial analytics (e.g. Wu et al. 2025), ecological sciences (e.g., Norton et al. 2016), and critical social theory (e.g., Hurley et al. 2015). By grouping the fragmented findings into these three dimensions, we can better understand how specific spatial arrangements (Form) enable specific benefits (Process), and how these are distributed or constrained by political decisions (Power).

4.3 Deconstructing the framework

4.3.1 Spatial form as a socio-historical product

The first dimension, Spatial Form, posits that the physical layout of GI is more than mere geometry; it is a complex product of social, historical, and political forces. This directly responds to the “Conceptual and Political Frameworks” pillar identified in our results (3.3.1), where studies highlighted how definitions shape physical spaces. The reviewed literature shows that form is socially produced through design practices that transform space to align with discursive ideas of what a “proper” park should be (Angelo 2021). Form is also historically contingent, as demonstrated by the evolution of the Olomouc parks (Daniel and Jirmus 2023). Finally, form is molded by power relations, revealing how the physical shape of the urban landscape is not a neutral outcome but a contested political terrain (Hurley et al. 2015).

4.3.2 Ecological process as a dynamic socio-ecological system

The second dimension reframes Ecological Process away from a passive “provider” of ecosystem services towards a dynamic and co-produced socio-ecological system. This aligns with the findings in pillar 3.3.2 (Benefits), but adds a critical layer by acknowledging the role of human management. Theoretical lenses like assemblage theory reveal a park not as a static entity, but as a continuously unfolding process (Stuiver 2022). This perspective acknowledges that ecosystem services are actively shaped by maintenance levels (Dobšínská et al. 2025) and makes space for the “dis-services” identified in pillar 3.3.3, such as thermal discomfort or allergenic risks (Ma et al. 2021), viewing them as inherent parts of this dynamic interplay.

4.3.3 Social power in defining and distributing green infrastructure

The third dimension, Social Power, is crucial for understanding who defines, controls, and benefits from GI. This dimension synthesizes the critical insights from our analysis of environmental justice (3.3.3) and governance barriers. The literature demonstrates that definitions of GI are shaped by political interests (Taha 2023) and that control over GI is a site of power struggles (Matthews et al. 2015). Most critically, power dictates who benefits, as evidenced by findings on the inequitable distribution of green spaces (Nicholls 2001; Sharifi et al. 2021) and phenomena like green gentrification.

4.4 The integrative power of the framework

The primary strength of the Form-Process-Power framework lies in its ability to directly address the fragmentation identified in the Results. Unlike the “Conceptual Web” (Fig. 4), which descriptively maps the current state of disparate research themes, this

new framework offers a prescriptive analytical tool to integrate them. It creates a coherent lens that connects the five thematic pillars. For instance, benefits (thermal regulation) can be understood as an emergent property of the interaction between Form (physical characteristics) and Process (use and interaction), while their distribution is governed by Power. Similarly, challenges are not isolated topics but are woven through all three dimensions. The framework thus transforms a list of research topics into an integrated system, providing the “coherent conceptual core” that the field currently lacks.

4.5 Implications for research and practice

The primary contribution of this framework lies in its potential to reinvigorate geographical inquiry. For comparative urban research, it offers a tool to systematically compare GI development across diverse contexts. By deconstructing GI into its core components, geographers can compare not only the physical Form of green spaces in different cities but also the socio-cultural Processes and Power dynamics. For practice, the model encourages a transparent approach to governance. By mapping the Form, geographers and planners can jointly identify “green deserts” and target resources to achieve equity goals, ensuring that the benefits of GI are distributed more equitably.

4.6 A future research agenda

Despite the identified limitations, the Form-Process-Power framework opens up several innovative avenues for future inquiry. Based on the critical gaps identified in our thematic analysis, we propose the following key questions to guide future geographical scholarship:

1. Responding to the fragmentation of ecosystem services: How do the interactions between Form, Process, and Power shape specific outcomes in different urban contexts?
2. Responding to governance barriers: How can multidimensional assessment tools be effectively integrated into participatory processes to empower local communities?
3. Responding to the need for resilience: How does the dynamic “becoming” of green spaces (Process) contribute to urban resilience in the face of evolving climatic (Form) and political (Power) pressures?
4. Responding to the “dis-services” discourse: How can we develop planning models that explicitly quantify trade-offs between GI benefits and risks (e.g., green gentrification) across all three dimensions? By addressing these questions, future research can move the field towards a more globally relevant, critically informed, and ultimately more robust urban geography.

5. Conclusions

5.1 Summary of findings and main argument

This paper has charted the landscape of geographical research on green infrastructure (GI), revealing a field characterized by a critical disparity: while methodological and conceptual sophistication is rapidly advancing, the application of this expertise remains concentrated within the Global North. We have argued that this fragmentation stems not from a lack of data, but from the absence of an integrative framework capable of bridging spatial analytics, ecological functions, and critical social theory. To address this, we proposed the Form-Process-Power framework, which systematically connects the physical characteristics of green space (Form), the dynamic nature of its use (Process), and the crucial governance factors that shape its distribution (Power).

5.2 Limitations of the study

It is important to acknowledge the limitations of this review. First, its focus on peer-reviewed literature from major English-language databases inevitably introduces a geographical and linguistic bias, potentially underrepresenting non-Anglophone theoretical traditions. Second, the reliance on cross-sectional studies means that establishing definitive long-term causality remains a challenge. Finally, while our thematic analysis is broad, the specific qualitative lens used to interpret the findings and synthesize the core pillars may have inevitably influenced the selection and categorization of information.

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References

- Addas, A. (2023): Influence of Urban Green Spaces on Quality of Life and Health with Smart City Design. *Land* 12(5): 960, <https://doi.org/10.3390/land12050960>.
- Angelo, H. (2021): How green became good: Urbanized nature and the making of cities and citizens; University of Chicago Press: Chicago, USA, <https://doi.org/10.7208/chicago/9780226739182.001.0001>.
- Borges, J. G., Marques, S., Garcia-Gonzalo, J., Rahman, A. U., Bushenkov, V., Sottomayor, M., Carvalho, P. O., Nordström, E. M. (2017): A multiple criteria approach for negotiating ecosystem services supply targets and forest owners' programs. *Forest Science* 63(1), 49–61, <https://doi.org/10.5849/FS-2016-035>.
- Camacho-Cervantes, M., Schondube, J. E., Castillo, A., MacGregor-Fors, I. (2014): How do people perceive urban trees? Assessing likes and dislikes in relation to the trees of a city. *Urban Ecosystems* 17, 761–773, <https://doi.org/10.1007/s11252-014-0343-6>.
- Chatzimontor, A., Apostolopoulou, E., Mazaris, A. D. (2020): A review of green infrastructure research in Europe: Challenges and opportunities. *Landscape and Urban Planning* 198: 103775, <https://doi.org/10.1016/j.landurbplan.2020.103775>.
- Daniel, J., Jirmus, R. (2023): Becoming a park: The assemblage of Olomouc parks in the 19th and first half of the 20th century. *Geografie* 128(4), 459–481, <https://doi.org/10.37040/geografie.2023.018>.
- Dobšínská, Z., Šálka, J., Urbančík, J. M., Sedmak, R., Bahýl, J., Čerňava, J., Kropil, R. (2025): How can science solve forest management problems in urban forests? A case study of Bratislava Forest District. *Landscape and Urban Planning* 104: 128630, <https://doi.org/10.1016/j.ufug.2024.128630>.
- Eisenberg, B., Polcher, V. (2019): Nature based solutions – technical handbook; UNaLab, University of Stuttgart: Stuttgart, Germany, <https://doi.org/10.13140/RG.2.2.24970.54726>.
- Escobedo, F. J., Giannico, V., Jim, C. Y., Sanesi, G., Laforteza, R. (2019): Urban forests, ecosystem services, green infrastructure and nature-based solutions: Nexus or evolving metaphors? *Urban Forestry & Urban Greening* 37, 3–12, <https://doi.org/10.1016/j.ufug.2018.02.011>.
- Fang, X., Li, J., Ma, Q. (2023): Integrating green infrastructure, ecosystem services and nature-based solutions for urban sustainability: A comprehensive literature review. *Sustainable Cities and Society* 98: 104843, <https://doi.org/10.1016/j.scs.2023.104843>.
- Ghofrani, Z., Sposito, V., Faggian, R. (2017): A comprehensive review of blue-green infrastructure concepts. *International Journal of Environment and Sustainability* 6(1), 15–36, <https://doi.org/10.24102/ijes.v6i1.728>.
- Green, D., O'Donnell, E., Johnson, M., Slater, L., Thorne, C., Zheng, S., Stirling, R., Chan, F. K. S., Li, L., Boothroyd, R. J. (2021): Green infrastructure: The future of urban flood risk management? *WIREs Water* 8(6): e1560, <https://doi.org/10.1002/wat2.1560>.
- Grilli, G., Mohan, G., Curtis, J. (2020): Public park attributes, park visits, and associated health status. *Landscape and Urban Planning* 199: 103814, <https://doi.org/10.1016/j.landurbplan.2020.103814>.
- Haddaway, N. R., Collins, A. M., Coughlin, D., Kirk, S. (2015): The Role of Google Scholar in Evidence Reviews and Its Applicability to Grey Literature Searching. *PloS One*, 10(9): e0138237, <https://doi.org/10.1371/journal.pone.0138237>.
- Helbich, M., Yao, Y., Liu, Y., Zhang, J., Liu, P., Wang, R. (2019): Using deep learning to examine street view green and blue spaces and their associations with geriatric depression in Beijing, China. *Environment International* 126, 107–117, <https://doi.org/10.1016/j.envint.2019.02.013>.
- Honeck, E., Sanguet, A., Schlaepfer, M. A., Wyler, N., Lehmann, A. (2020): Methods for identifying green infrastructure. *SN Applied Sciences* 2: 1916, <https://doi.org/10.1007/s42452-020-03575-4>.
- Hurley, P. T., Emery, M. R., McLain, R., Poe, M., Grabbatin, B., Goetcheus, C. L. (2015): Whose Urban Forest? The Political Ecology of Foraging Urban Nontimber Forest Products. In Isenhour, C., McDonogh, G., Checker, M.

- (Eds.), *Sustainability in the Global City: Myth and Practice*. New Directions in Sustainability and Society; Cambridge University Press: New York, pp. 187–212, <https://doi.org/10.1017/CBO9781139923316.014>.
- Iungman, T., Cirach, M., Marando, F., Barboza, E. P., Khomenko, S., Masselot, P., Quijal-Zamorano, M., Mueller, N., Gasparrini, A., Urquiza, J., Heris, M., Thondoo, M., Nieuwenhuijsen, M. (2023): Cooling cities through urban green infrastructure: a health impact assessment of European cities. *The Lancet* 401(10376), 577–589, [https://doi.org/10.1016/S0140-6736\(22\)02585-5](https://doi.org/10.1016/S0140-6736(22)02585-5).
- Jansson, M., Mårtensson, F., Gunnarsson, A. (2018): The meaning of participation in school ground greening: a study from project to everyday setting. *Landscape Research* 43(1), 163–179, <https://doi.org/10.1080/01426397.2017.1306623>.
- Jim, C. Y., Chen, S. S. (2003): Comprehensive greenspace planning based on landscape ecology principles in compact Nanjing city, China. *Landscape and Urban Planning* 65(3), 95–116, [https://doi.org/10.1016/S0169-2046\(02\)00244-X](https://doi.org/10.1016/S0169-2046(02)00244-X).
- Jo, J. H., Golden, J. S., Shin, S. W. (2009): Incorporating built environment factors into climate change mitigation strategies for Seoul, South Korea: A sustainable urban systems framework. *Habitat International* 33(3), 267–275, <https://doi.org/10.1016/j.habitatint.2008.10.020>.
- Knobel, P., Dadvand, P., Maneja-Zaragoza, R. (2019): A systematic review of multi-dimensional quality assessment tools for urban green spaces. *Health & Place* 59: 102198, <https://doi.org/10.1016/j.healthplace.2019.102198>.
- Kowarik, I., Fischer, L. K., Haase, D., Kabisch, N., Kleinschroth, F., Konijnendijk, C., ... von Haaren, C. (2025): Promoting urban biodiversity for the benefit of people and nature. *Nature Reviews Biodiversity* 1, 1–19, <https://doi.org/10.1038/s44358-025-00035-y>.
- Lehnert, M., Brabec, M., Jurek, M., Tokar, V., Geletič, J. (2021): The role of blue and green infrastructure in thermal sensation in public urban areas: a case study of summer days in four Czech cities. *Sustainable Cities and Society* 66: 102683, <https://doi.org/10.1016/j.scs.2020.102683>.
- Lehnert, M., Jirmus, R., Květoňová, V., Geletič, J., Jurek, M., Štědová, H., Frajer, J. (2024): Overheated children's playgrounds in Central European cities: The effects of surfaces and shading on thermal exposure during hot summer days. *Urban Climate* 55: 101873, <https://doi.org/10.1016/j.uclim.2024.101873>.
- Lepczyk, C. A., Aronson, M. F., Evans, K. L., Goddard, M. A., Lerman, S. B., MacIvor, J. S. (2017): Biodiversity in the City: Fundamental Questions for Understanding the Ecology of Urban Green Spaces for Biodiversity Conservation. *BioScience* 67(9), 799–807, <https://doi.org/10.1093/biosci/bix079>.
- Long, H. (2022): Theorizing land use transitions: A human geography perspective. *Habitat International* 128: 102669, <https://doi.org/10.1016/j.habitatint.2022.102669>.
- Ma, X., Tian, Y., Du, M., Hong, B., Lin, B. (2021): How to design comfortable open spaces for the elderly? Implications of their thermal perceptions in an urban park. *Science of The Total Environment* 768: 144985, <https://doi.org/10.1016/j.scitotenv.2021.144985>.
- Malecki, E. J. (2010): Everywhere? The Geography of Knowledge. *Journal of Regional Science* 50(1), 493–513, <https://doi.org/10.1111/j.1467-9787.2009.00640.x>.
- Maryani, E., Safari, A., Riyanti, A., Mulyana, H. (2023): Green open space (GOS) in the form of a city park as a population's recreation place and their references on the thematic park in Bandung City. In *International Conference on Responsible Tourism and Hospitality (ICRTH) 2022*, pp. 124–128.
- Matthews, T., Lo, A. Y., Byrne, J. A. (2015): Reconceptualizing green infrastructure for climate change adaptation: Barriers to adoption and drivers for uptake by spatial planners. *Landscape and Urban Planning* 138, 155–163, <https://doi.org/10.1016/j.landurbplan.2015.02.010>.
- Morakinyo, T. E., Lam, Y. F. (2016): Simulation study on the impact of tree-configuration, planting pattern and wind condition on street-canyon's micro-climate and thermal comfort. *Building and Environment* 103, 262–275, <https://doi.org/10.1016/j.buildenv.2016.04.025>.
- Nesshöver, C., Assmuth, T., Irvine, K. N., Rusch, G. M., Waylen, K. A., Delbaere, B., Haase, D., Jones-Walters, L., Keune, H., Kovacs, E., Krauze, K., Külvik, M., Rey, F., van Dijk, J., Vistad, O. I., Wilkinson, M. E., Wittmer, H. (2017): The science, policy and practice of nature-based solutions: An interdisciplinary perspective. *Science of the Total Environment* 579, 1215–1227, <https://doi.org/10.1016/j.scitotenv.2016.11.106>.
- Nicholls, S. (2001): Measuring the accessibility and equity of public parks: A case study using GIS. *Managing Leisure* 6(4), 201–219, <https://doi.org/10.1080/13606710110084651>.
- Nordbø, E. C. A., Nordh, H., Raanaas, R. K., Aamodt, G. (2018): GIS-derived measures of the built environment determinants of mental health and activity participation in childhood and adolescence: A systematic review. *Landscape and Urban Planning* 177, 19–37, <https://doi.org/10.1016/j.landurbplan.2018.04.009>.
- Norton, B. A., Evans, K. L., Warren, P. H. (2016): Urban Biodiversity and Landscape Ecology: Patterns, Processes and Planning. *Current Landscape Ecology Reports* 1(4), 178–192, <https://doi.org/10.1007/s40823-016-0018-5>.
- Oliveira, S., Andrade, H., Vaz, T. (2011): The cooling effect of green spaces as a contribution to the mitigation of urban heat: A case study in Lisbon. *Building and Environment* 46(11), 2186–2194, <https://doi.org/10.1016/j.buildenv.2011.04.034>.
- Shahmahmasebi, A. R., Li, C., Fan, Y., Wu, Y., Lin, Y., Gan, M., Wang, K., Malik, A., Blackburn, G. A. (2021): Remote sensing of urban green spaces: A review. *Urban Forestry & Urban Greening* 57: 126946, <https://doi.org/10.1016/j.ufug.2020.126946>.
- Sharifi, F., Levin, I., Stone, W. M., Nygaard, A. (2021): Green space and subjective well-being in the Just City: A scoping review. *Environmental Science & Policy* 120, 118–126, <https://doi.org/10.1016/j.envsci.2021.03.008>.
- Shukla, P. R., Skea, J., Calvo Buendia, E., Masson-Delmotte, V., Pörtner, H.-O., Roberts, D. C., Zhai, P., Slade, R., Connors, S., van Diemen, R., Ferrat, M., Haughey, E., Luz, S., Neogi, S., Pathak, M., Petzold, J., Portugal Pereira, J., Vyas, P., Huntley, E., Kissick, K., Belkacemi, M., Malley, J. (Eds.) (2019): *Climate change and land: An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and*

- greenhouse gas fluxes in terrestrial ecosystems; IPCC: Geneva, Switzerland.
- Shuvo, F. K., Feng, X., Akaraci, S., Astell-Burt, T. (2020): Urban green space and health in low and middle-income countries: A critical review. *Urban Forestry & Urban Greening* 52: 126662, <https://doi.org/10.1016/j.ufug.2020.126662>.
- Siddaway, A. P., Wood, A. M., Hedges, L. V. (2019): How to Do a Systematic Review: A Best Practice Guide for Conducting and Reporting Narrative Reviews, Meta-Analyses, and Meta-Syntheses. *Annual Review of Psychology* 70(1), 747–770, <https://doi.org/10.1146/annurev-psych-010418-102803>.
- Smreček, R. (2013): Inventarizácia mestskej zelene z dát leteckého laserového skenovania. In *GIS Ostrava 2013: Sborník příspěvků z konference; VŠB – Technická univerzita Ostrava: Ostrava, Czechia*, pp. 167–189.
- Stuiver, M. (Ed.) (2022): *The symbiotic city: Voices of nature in urban transformations*; Wageningen Academic Publishers: Wageningen, The Netherlands, 300 p., <https://doi.org/10.3920/978-90-8686-935-0>.
- Sun, Y., Xie, S., Zhao, S. (2019): Valuing urban green spaces in mitigating climate change: A city-wide estimate of aboveground carbon stored in urban green spaces of China's Capital. *Global Change Biology* 25(5), 1717–1732, <https://doi.org/10.1111/gcb.14566>.
- Supuka, J., Šinka, K., Pucherová, Z., Verešová, M., Feriancová, L., Bihuňová, M., Kuczman, G. (2013): Landscape structure and biodiversity of woody plants in the agricultural landscape; Mendel University in Brno: Brno, Czechia, 187 p., <https://doi.org/10.15414/2014.978807375905>.
- Taha, F. (2023): *Urban geography: A discourse analysis of the literature on green infrastructure and nature-based solutions in Portland, OR*. Doctoral dissertation, Portland State University, Portland, OR, USA.
- Wang, C., Ren, Z., Dong, Y., Zhang, P., Guo, Y., Wang, W., Bao, G. (2022): Efficient cooling of cities at global scale using urban green space to mitigate urban heat island effects in different climatic regions. *Urban Forestry & Urban Greening* 74: 127635, <https://doi.org/10.1016/j.ufug.2022.127635>.
- Weerasuriya, R., Henderson-Wilson, C., Townsend, M. (2019): A systematic review of access to green spaces in healthcare facilities. *Urban Forestry & Urban Greening* 40, 125–132, <https://doi.org/10.1016/j.ufug.2018.06.019>.
- Wu, J., Plantinga, A. J. (2003): The influence of public open space on urban spatial structure. *Journal of Environmental Economics and Management* 46(2), 288–309, [https://doi.org/10.1016/S0095-0696\(03\)00023-8](https://doi.org/10.1016/S0095-0696(03)00023-8).
- Wu, X., Liu, J., Hou, Y. (2025): Data and methods for assessing urban green infrastructure using GIS: A systematic review. *PLoS One* 20(6): e0324906, <https://doi.org/10.1371/journal.pone.0324906>.
- Ying, J., Zhang, X., Zhang, Y., Bilan, S. (2022): Green infrastructure: systematic literature review. *Economic Research-Ekonomska Istraživanja* 35(1), 343–366, <https://doi.org/10.1080/1331677X.2021.1893202>.