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Filling the Gap: Development of Ecological Planning and Design Learning Network and Adaptive Smart Training Module for Disaster Resilient and Sustainable Cities

CONSOLIDATED LITERATURE / CASE STUDY / BEST PRACTICES REPORT

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EPD-Net Consolidated Literature / Case Study / Best Practices Report

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ABBREVIATIONS

AHP	Analytical Hierarchy Process
AI	Artificial Intelligence
ANN	Artificial Neural Networks
BI	Blue Infrastructure
BGI	Blue-Green Infrastructure
BIM	Building Information Modeling
BRIC	Baseline Resilience Indicators for Communities
CCAIRR	Climate Change Adaptation through Integrated Risk Reduction
CDRI	Coalition for Disaster Resilient Infrastructure
DEM	Digital Elevation Model
DPSIR	Drivers, Pressures, State, Impact, Response model of intervention
DRF	Disaster Ready Fund
DRR	Disaster Risk Reduction
DSM	Digital Surface Model
Eco-DRR	Ecosystem-Based Disaster Risk Reduction
EPA	U.S. Environmental Protection Agency
ES	Ecosystem Services
EU	European Union
GI	Green Infrastructure
GIS	Geographic Information Systems
IoT	Internet of Things
IUCN	International Union for Conservation of Nature
LCA	Life Cycle Assessment
LCZ	Local Climate Zones
LID	Low-Impact Development
LMICs	Low and Middle-Income Contexts
LSTM	Long Short-Term Memory
MCDA	Multi-Criteria Decision Analysis
MEA	Millennium Ecosystem Assessment
NbS	Nature-Based Solutions
NbS-SVT	Nature-Based Solutions Selection and Visualization Tool
NAPA	National Adaptation Programme of Action
RGS	Refuge Green Spaces
RS	Remote Sensing
SUHI	Surface Urban Heat Island
SVM	Support Vector Machines
UAVs	Unmanned Aerial Vehicles
UEES	Urban Environment Examination System
UHI	Urban Heat Island
ULLs	Urban Living Labs

Executive Summary

This literature review report was developed within the scope of the EPD-NET Project's Work Package-2 (WP2), aiming to establish the foundational knowledge and contextual understanding necessary for designing an AI-aided, adaptive, and transnational training module in ecological planning and design (EPD) for disaster management. WP2 aimed to consolidate knowledge by reviewing and categorizing academic literature, real-world case studies, and best practice examples relevant to ecological planning and disaster management. The review process was carried out collaboratively by project partners, reflecting the diversity of disciplines and national contexts represented in the consortium.

The reviewed materials were thematically categorized under key topics such as:

- Ecological planning and design and disaster management
- Nature-based solutions (NbS) and green infrastructure (GI)
- Technological tools integration, highlighting the increasing role of GIS, AI, RS, and data-driven platforms in disaster risk modeling, urban diagnostics, and scenario planning
- Cross-sectoral governance, stakeholder engagement, and co-design practices
- Educational program development.

The findings emphasize the growing relevance of NbS, climate-informed planning, and digital tools in the design of resilient urban and rural systems. The WP2 review also revealed common challenges across the reviewed materials, including limited institutional capacity, fragmented governance, and the need for more context-sensitive, interdisciplinary education in ecological planning and disaster resilience. These insights directly inform the development of the training module by highlighting both thematic priorities and methodological approaches that should be emphasized in educational design.

In conclusion, this report provides a consolidated, thematically structured knowledge base that will support the creation of a practice-oriented, digitally enhanced training program. The collected literature and case evidence not only respond to the strategic objectives of EPD_NET but also offer a roadmap for embedding ecological planning into disaster management curricula across Europe.

1. INTRODUCTION AND PURPOSE

Work Package 2 (WP2) of the EPD_NET project focuses on establishing a robust knowledge base to support the development of an AI-aided, smart training module for ecological planning and design (EPD) in disaster management. The primary aim of WP2 is to collect, analyze, and categorize relevant scientific literature, case studies, and best practices that demonstrate how EPD can contribute to sustainable and resilient urban environments, especially in the context of climate-related risks and natural disasters.

This consolidated report (Deliverable D2.1) presents the outcomes of the literature review and case documentation process conducted collaboratively by all WP2 partners. The review aimed to identify knowledge gaps, practical approaches, and transferable methods that align with the project's strategic goals: integrating deep tech, green infrastructure (GI), and resilience thinking into planning education and professional development. The collected materials are expected to inform the structure and content of the training module, while also fostering transnational collaboration and skill-building among stakeholders in academia, public authorities, NGOs, and the private sector.

The literature review was conducted through a collaborative process involving all WP2 partners of the EPD_NET project. During the initial coordination meetings, each partner was asked to identify and analyze literature, case studies, and best practices relevant to the project's thematic scope; particularly within their own disciplinary expertise and national or regional contexts. This approach ensured the inclusion of diverse geographic and institutional perspectives, reflecting the transnational and interdisciplinary nature of the consortium. To maximize inclusivity, no restrictions were placed on academic databases. This approach enhanced the visibility of context-specific knowledge, particularly from partner countries, and ensured the inclusion of peer-reviewed articles, institutional reports, policy briefs, case studies, and best practices related to ecological planning, disaster risk management, and climate-resilient development.

Each reviewed resource was summarized using a standardized format covering its objectives, methods, and key findings. To support collaborative use and accessibility, the reviewed materials were stored and organized using the Mendeley platform in line with the project's performance indicator PI2. Each entry was categorized and tagged according to its content as scientific publication, best practice, case study, educational program, or project, and systematically placed into corresponding folders. This structured classification facilitated traceability and enhanced interoperability with WP3 activities. Furthermore, these entries remain accessible to relevant WP partners to support ongoing and future collaborative activities.

After the initial collection phase, all sources were thematically categorized in alignment with the core objectives of the project, focusing on key concepts such as ecological planning and design, resilience, disaster management, NbS, and GI. However, due to the inherently interdisciplinary and cross-thematic nature of these concepts, some overlaps among categories were both

inevitable and intentional; allowing certain publications to be represented under multiple thematic headings when appropriate.

As part of the literature review conducted for this project, a total of 522 resources were examined ; including 197 publications, 250 case studies, and 75 best practice documents ; significantly exceeding the PI2 target value of 200 and demonstrating the breadth of topic coverage achieved. The complete list of scientific publications is listed in Annex 1, case studies are provided in Annex 2, and all best practice references are included in Annex 3.

The reviewed publications span a wide array of general thematic types that are highly relevant to ecological planning and disaster risk management. Key themes include disaster risk management (particularly urban flood risk and resilience mapping), NbS, urban resilience and governance frameworks, climate change adaptation strategies, ecosystem services and environmental health, and the integration of technological tools such as GIS, remote sensing, and artificial intelligence into planning processes. Notably, there is strong representation of NbS-focused studies, reflecting the growing emphasis on green and blue infrastructure in urban resilience. Additionally, the review captures an emerging interest in digital and smart tools that support scenario simulation, spatial diagnostics, and decision support; core components of the EPD_NET project's goals.

The case studies compiled for the EPD_NET literature review represent a diverse and practice-oriented collection of projects that align with the project's core themes; ecological planning and design, disaster resilience, and NbS. These examples span various geographic contexts, including European cities such as Riga, Rome, Milan, and Prague, as well as broader regional and rural settings. A common focus among many of the cases is the implementation of green and blue infrastructure as both ecological and climate-adaptive interventions. Methodologically, most case studies involve a combination of GIS-based spatial analysis, stakeholder engagement, pilot implementation, and monitoring of ecosystem services or resilience performance.

The set of best practice documents reviewed reflects a broad and interdisciplinary approach to disaster risk reduction and ecological planning. Many of the entries focus on urban flood management. Tools and concepts, with an increasing emphasis on resilience thinking, are commonly discussed. Technological innovation is another strong dimension of the best practices, with references to GIS-based assessments, risk simulation platforms, and multi-criteria decision analysis (MCDA) tools that support data-driven and transparent planning processes.

The findings of this consolidated review are expected to provide a robust foundation for the development of the EPD_NET project's smart training module. The reviewed sources reflect a rich and interdisciplinary body of knowledge that bridges ecological planning and disaster management, combining academic research with practical and context-specific insights. This report and its annexes will guide the creation of structured learning resources, support skill development in green and digital planning domains, and contribute to the broader goal of

fostering climate-resilient, inclusive, and adaptive planning education across Europe and beyond. The summary of the WP2 review process is provided in Annex 4.

2. INTRODUCTION TO ECOLOGICAL PLANNING AND DESIGN

The evolution of ecological planning reflects an increasingly integrated approach, merging ecological, social, and technological dimensions to address the growing complexity of human–environment interactions. Initially, ecological planning prioritized biophysical characteristics of landscapes, focusing on identifying and conserving ecological support processes such as carbon flux, topographic wetness, and restoration potential. These fundamental elements, often visualized through spatial planning tools, provided a crucial foundation for understanding ecosystem functions and their spatial configurations, a framework that continues to inform contemporary practice (Bezerra et al., 2022).

Over time, the conceptual and methodological scope of ecological planning has progressively expanded. Drawing on insights from landscape ecology, geography, and urban planning, it now seeks to respond to the multifaceted challenges posed by urban-environmental dynamics (Huang et al., 2019). The field has evolved beyond its traditional conservation-oriented focus to facilitate urban and regional development, promoting a comprehensive synthesis of ecological systems with the built environment.

Theoretical underpinnings of ecological planning are shaped by landscape ecology, systems thinking, and adaptive management paradigms. These frameworks underpin the design of urban spaces aligned with natural processes, recognizing cities as complex socio-ecological systems. In this context, spatial organization is envisioned as a dynamic structure that must respond to environmental constraints and opportunities, thereby supporting resilience and sustainability (Dong & Du, 2025; Moraci et al., 2025a). Landscape ecology, in particular, underscores the importance of spatial patterns and ecological connectivity. The design of ecological corridors exemplifies this approach, emphasizing habitat continuity to sustain biodiversity and ecosystem service flows. Thus, the spatial configuration of GI, hydrological systems, and built environments is fundamental for fostering sustainable urban development.

Adaptive management further reinforces this approach by advocating for flexible, iterative strategies capable of adjusting to uncertain and changing environmental conditions, especially in the context of climate change. Operational tools such as GIS-based hazard mapping and scenario planning enable proactive risk mitigation and adaptive responses (World Bank, 2024). Moreover, the integration of early warning systems and multi-hazard assessments enhances the adaptive capacity of urban systems (see Figure 1) (Dubovik et al., 2022).

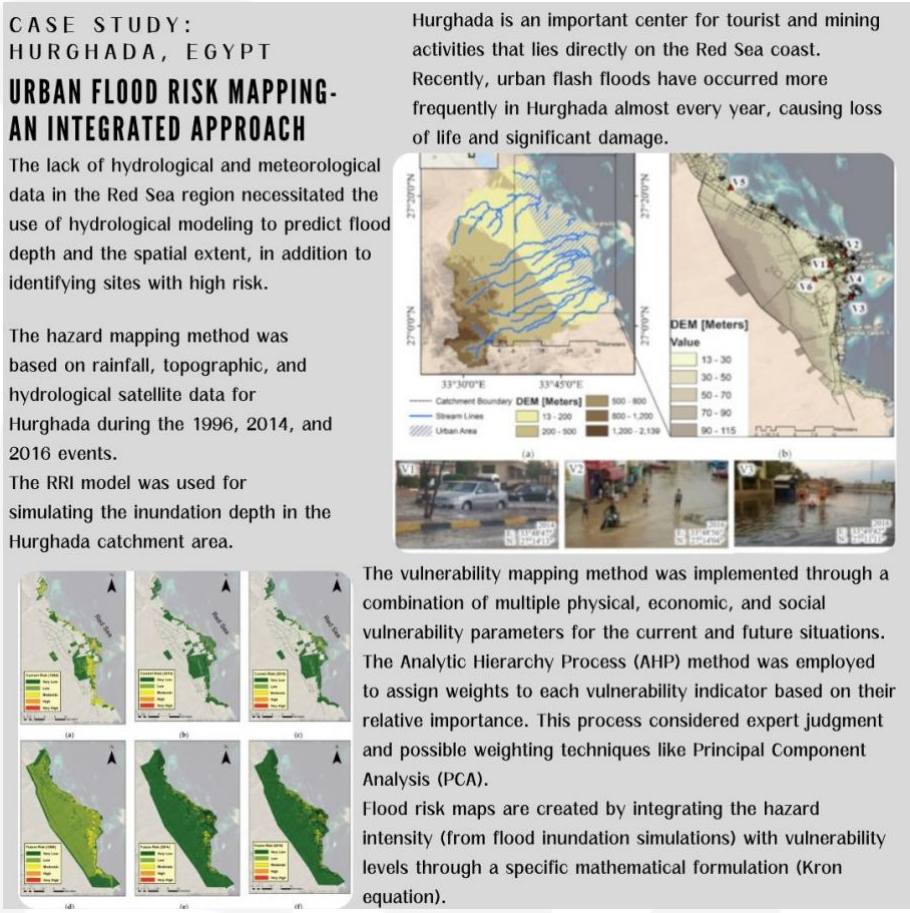

Figure 1. A case study from Egypt on urban flood risk mapping (Abdrabo et al., 2020).

The translation of these theoretical principles into practice owes much to Ian McHarg's seminal contributions. His work, Design with Nature (1969), pioneered the use of layered ecological mapping in land-use decision-making. By integrating environmental data into planning processes, McHarg's approach emphasized environmental consequences and laid a foundation for ecologically informed design, influencing academic curricula and planning practices worldwide (Steiner et al., 1988).

Sustainable spatial organization has consequently evolved, moving from static and utilitarian approaches towards integrated, adaptive, and technologically enhanced models. Initial urban development paradigms often prioritized economic efficiency at the expense of ecological integrity and long-term resilience. Industrialization, rapid urbanization, and environmental degradation further highlighted these shortcomings, prompting the emergence of ecological planning paradigms that seek to harmonize urban settlements with natural systems (Moraci et al., 2025a).

Technological advancements have played a pivotal role in enabling this transformation. Tools such as GREENPASS® facilitate quantitative assessment of microclimate impacts from buildings and vegetation, supporting evidence-based design alternatives (Kraus & Scharf, 2019). The

integration of digital twins and artificial intelligence (AI) enables real-time monitoring and long-term scenario analysis, shifting planning from reactive to proactive adaptive strategies (Samaei & Ghafari, 2025). Adaptive frameworks today emphasize flexibility and responsiveness, recognizing urban systems as dynamic and subject to continuous socio-economic and environmental uncertainties. Scenario planning and GIS-based risk assessments are thus integral, enabling planners to anticipate hazards, optimize land use, and enhance ecological connectivity and biodiversity (Shrestha et al., 2025; Wang et al., 2022).

NbS have become central to ecological planning, embedding ecosystems into urban design through green corridors, multifunctional landscapes, and water-sensitive infrastructure. Examples from cities such as Singapore and Cape Town illustrate how such integrations strengthen urban resilience to climatic extremes and resource constraints (Munonye & Ajonye, 2024).

Parallel to technological and ecological advancements, governance frameworks have also evolved. Participatory planning models, emphasizing inclusive and multi-stakeholder engagement, enhance social cohesion while advancing ecological sustainability (İzmir Metropolitan Municipality, 2020; Yang et al., 2024).

Building on ecological planning theories, sustainable urban design integrates environmental, social, and economic objectives to create adaptive, resilient, and resource-efficient urban systems. Through rational landscape design, cities can improve climatic conditions, sustain essential ecosystem services, and enhance ecological functionality (Dong & Du, 2025).

Acknowledging cities as complex socio-ecological systems, where human and natural processes interact across scales, requires a holistic planning perspective. Here, urban form, infrastructure, and ecological processes are coordinated to ensure long-term sustainability. Central to this approach is the integration of ecological theory into design frameworks. Childers et al. (2015) emphasize concepts such as patch dynamics, viewing urban landscapes as mosaics embedded within broader ecological and social systems. This perspective supports the enhancement of stormwater regulation, biodiversity, and microclimate moderation, contributing simultaneously to human well-being.

A key dimension of sustainable design is adaptive capacity; urban systems must withstand and recover from climatic, ecological, and social disturbances (Chen et al., 2023; R. Zhang et al., 2025). Adaptive strategies are iterative, learning-based, and can be protective, defensive, offensive, or opportunistic depending on context. Spatial considerations such as connectivity, pattern, and scale inform the design of BGI that harmonizes ecological and human needs. For example, urban tree management in Rome integrates historical and ecological values, reinforcing urban identity while supporting ecological functions (Clemente et al., 2025).

Beyond physical interventions, adaptive design also involves policy innovations, including green procurement, sustainable resource use, and carbon-neutral initiatives, which collectively

enhance resilience (CDRI & G20 Working Group on DRI, 2024). Effective governance requires cross-sectoral coordination and the engagement of public-private actors. However, fragmented governance structures and limited institutional capacity can impede implementation. Integrated planning tools that accommodate uncertainty are essential to overcome these barriers (Nahyan, 2017; Singh et al., 2021).

Case studies from Washington State's Floodplains by Design program and Copenhagen's climate adaptation strategies exemplify how ecosystem-based approaches can improve urban resilience and livability (Shi, 2020; Pancewicz, 2022). Similarly, initiatives in Singapore, Toronto, and Cape Town highlight the benefits of embedding ecosystems into urban fabric to foster responsive and efficient planning (Munonye & Ajonye, 2024).

Equity and inclusivity remain fundamental in sustainable design. Ensuring fair access to GI for vulnerable populations is critical for enhancing resilience. Campomanes et al. (2025) emphasize that underserved areas require targeted interventions to mitigate risks and improve living conditions.

Technological innovations, particularly geospatial tools and 3D GIS, further advance sustainable design. Yang and Delparte (2022) note that 3D GIS provides greater spatial accuracy and depth, supporting advanced scenario analysis and risk assessment.

Participation and co-creation are also central to sustainable design. Bezerra et al. (2022) highlight participatory tools such as geodesign workshops, where diverse stakeholders collaboratively shape spatial planning outcomes, enhancing social legitimacy.

Revisiting earlier paradigms, Steiner (2014) introduces ecological landscape urbanism, advocating for landscape as the organizing principle of urban design, integrating ecological processes at the core of urban systems. Waldheim's (2011) concept of ecological urbanism extends this approach, envisioning cities as co-evolving socio-ecological systems where human activities and environmental processes are intertwined, supported by GI and NbS (Munonye & Ajonye, 2024; Moraci et al., 2025b).

Finally, advanced spatial analytics tools such as spatial Markov chains and geographic detectors enable planners to identify resilience drivers and inform adaptive governance and spatial interventions (R. Zhang et al., 2025).

2.1. Urban Ecology

Urban ecology emerged in the 1970s as ecologists began to acknowledge the significant environmental impacts associated with expanding human settlements, prompting systematic studies of urban areas (McDonnell, 2011). This field examines the dynamic interactions between living organisms and urban environments, incorporating both biotic and abiotic components. It is inherently interdisciplinary, integrating perspectives from ecology, geography, urban planning,

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and social sciences to understand how urbanization shapes ecological processes and, conversely, how these processes influence urban form and function. Rather than focusing solely on green spaces or urban biodiversity, urban ecology emphasizes the complex interdependencies among human activities, built infrastructure, and natural systems that collectively determine urban sustainability and resilience (Cabuk et al., 2016; Newton & Rogers, 2020).

A core objective within urban ecology is to integrate ecological principles into urban planning and design to create cities that are not only habitable but also adaptable to environmental challenges such as climate change, flooding, and biodiversity loss. According to Cabuk et al. (2016), physiography; which encompasses both biotic and abiotic elements of the Earth's surface; provides a foundational framework for urban ecology by examining the interplay among these elements. Ecophysiography, a more detailed analytical framework, allows for a nuanced understanding of the relationships between ecological and natural components, which is critical for informed urban ecological planning.

Urban ecological research often adopts a long-term and historical perspective, acknowledging that urban landscapes are shaped by centuries or even millennia of human–environment interactions. Crummey et al. (2017) highlight that comprehending cultural landscape development necessitates an integration of economic, cultural, and ecological drivers, as well as a reconciliation of long-term landscape histories with recent land use and ecological data. This historical context is essential for identifying enduring patterns and drivers of change, which can inform strategies aimed at enhancing urban resilience and ecosystem services.

The application of NbS exemplifies the practical convergence of urban ecology, climate adaptation, and disaster risk management. Newton and Rogers (2020) highlight that the transition toward blue-green cities, which seek to restore natural water cycles and integrate NbS, addresses the dual objectives of minimizing ecological and carbon footprints while enhancing urban livability. These approaches necessitate a comprehensive understanding of urban hydrology, vegetation dynamics, and the spatial configuration of GBI. The balance between quantitative and qualitative dimensions of hydrological design, as articulated by Nahyan (2017), underscores the importance of integrating urban ecological insights into spatial strategies. Such integration enables effective management of stormwater, mitigation of flood risks, and improvement of water quality, thereby contributing to more resilient and sustainable urban environments.

Remote sensing (RS) and geospatial analysis have become indispensable in urban ecological research, providing essential data for assessing ecological processes and planning GI across multiple spatial scales. do Amaral and de Lima Bezerra (2024) underscore the value of proxy indicators for ecological processes, as these indicators simplify complex information and facilitate methodological replication across diverse urban contexts. The integration of RS, GI, and restoration ecology supports the creation of robust planning foundations for regional-scale landscape design, ensuring adequate consideration of essential ecological support processes.

Urban ecology also engages with the study of landscape mosaics, where the spatial configuration of ecological patches and corridors is pivotal to urban ecosystem resilience. The concept of ecological support patches, as described by do Amaral and de Lima Bezerra (2024), aims to preserve vegetation around river and stream sources, thereby enhancing the resilience of critical ecological processes. These patches often intersect with ecological corridors, strengthening landscape connectivity and supporting biodiversity within urban environments. Designing such corridors within cities is crucial for facilitating species movement, promoting sustainable development, and reinforcing ecosystem functionality (Dong & Du, 2025; Wang et al., 2022).

Moreover, the application of circuit theory in modeling landscape connectivity exemplifies the use of probabilistic approaches to identify ecological source areas and simulate the flow of hazards or resources within urban landscapes (Dong & Du, 2025). By representing movement as random walks, circuit-based models can delineate critical corridors and barriers, thereby informing the identification of areas most vulnerable to hazard propagation or in need of ecological intervention.

The governance of urban ecological systems presents further complexities, particularly when institutional frameworks are fragmented and departmental authorities are restricted to specific ecological components within their jurisdiction. Luo et al. (2024) emphasize that such fragmentation often results in disjointed, piecemeal projects lacking an integrated vision. Recognizing mountains, waters, forests, fields, and lakes as interconnected components of a unified life community is essential to overcome these limitations and achieve holistic and effective urban ecological planning.

2.2. Ecological Planning and Disaster Resilience

Ecological planning and disaster resilience are increasingly recognized as interdependent domains that mutually inform and reinforce each other within the broader context of sustainable development and risk management (Steiner et al., 2013). Ecological planning seeks to harmonize human activities with natural system functions, while disaster resilience emerges as a crucial dimension within this integration. Incorporating disaster risk reduction (DRR) strategies into ecological planning is essential for building adaptive capacity and minimizing vulnerability to both natural and anthropogenic hazards. This integration is not only a technical necessity but also a policy imperative, as emphasized by global frameworks that advocate embedding DRR and resilience within the core of sustainable development and poverty alleviation strategies (UNISDR, 2015). Such approaches ensure that resilience is not treated as a standalone objective but rather integrated into planning, policy formulation, and resource allocation across governance levels.

The concept of resilience has evolved to encompass ecological, engineering, and socio-ecological dimensions, particularly within natural resource management and conservation contexts (Liao, 2012; Wilkinson, 2011). Theoretical advancements have significantly influenced ecological planning by incorporating resilience science perspectives. Initially, resilience was

conceptualized in terms of engineering and ecological systems, focusing on the capacity to resist and return to pre-disturbance states. However, this perspective was critiqued for its static nature and tendency to regard systems as passive. The emergence of social-ecological systems theory marked a pivotal shift, linking ecological resilience with social dimensions and introducing the concept of evolutionary resilience. This paradigm views systems as dynamic, adaptive, and capable of transformation in response to changing conditions (R. Zhang et al., 2025; Chen et al., 2023). Such a multidimensional understanding enables planners and managers to anticipate, absorb, and adapt to a range of shocks and stresses, supporting the long-term sustainability of ecosystems and dependent communities (Risna et al., 2023).

The DRI Lexicon (2023) defines resilience planning as the process of setting goals and coordinating policies, programs, and actions across infrastructure sectors and stakeholder groups to reduce risks and enable communities to adapt and thrive despite hazards. This aligns fundamentally with the objectives of ecological planning, emphasizing adaptive capacity and vulnerability reduction within socio-ecological systems.

Urban environments, characterized by high population densities and complex infrastructure networks, present both challenges and opportunities for applying ecological planning principles to enhance disaster resilience. The rising frequency and severity of climate-induced hazards, such as floods and heatwaves, highlight the need for urban design strategies grounded in ecological understanding and adaptive management (Childers et al., 2015; Van Pham et al., 2025). As noted by Childers et al. (2015), a knowledge-to-action agenda that bridges urban ecology and design is essential for developing cities that are both sustainable and climate-resilient. Effective urban risk governance requires the active engagement of diverse stakeholders; including governmental agencies, local communities, and private sector actors; to ensure robust mitigation, preparedness, and response measures (Rezvani et al., 2023; UNISDR, 2015).

Technological advancements, particularly in Geographic Information Systems (GIS) and RS, have significantly strengthened capacities for environmental impact assessments, risk mapping, and real-time emergency response (Samaei & Ghahfarokhi, 2023; Liu et al., 2018). These technologies facilitate the systematic collection, analysis, and visualization of spatial data, which are critical for identifying vulnerable areas, monitoring ecosystem health, and supporting coordinated disaster response efforts. Enhanced situational awareness during emergencies and improved long-term adaptive planning are among the key benefits of these tools.

The evolution of disaster management frameworks has shifted away from traditional, top-down approaches toward more participatory, data-driven, and context-sensitive strategies. This transition reflects a growing recognition of the interconnectedness between ecological systems and human societies. Recent research emphasizes the importance of engaging local stakeholders in decision-making processes, particularly regarding water resource management and allocation, in response to escalating climate and drought challenges (Tosan et al., 2025).

The development of community disaster resilience indices represents another methodological advancement in this field. These indices, which are often constructed through semi-quantitative approaches incorporating expert judgment and stakeholder input, enable the quantification and comparison of resilience across different communities and contexts (Choi & Song, 2022; Nguyen & Akerkar, 2020). By identifying and appropriately weighting key parameters, these models support targeted interventions and resource distribution, thereby enhancing the effectiveness of DRR efforts (Choi & Song, 2022).

Governance structures are central to operationalizing the synergies between ecological planning and disaster resilience. Effective disaster risk governance requires a clear strategic vision, coordinated action, and meaningful involvement of all relevant stakeholders (UNISDR, 2015). National and local governments play critical roles in formulating and implementing policies, land-use plans, and emergency procedures that address current risks while anticipating future uncertainties, including those associated with climate change (Rezvani et al., 2023).

The importance of recovery, rehabilitation, and reconstruction phases; encapsulated by the principle of "Build Back Better"; is increasingly acknowledged as a critical stage in the disaster management cycle (Furuta & Shimatani, 2018; UNISDR, 2015). This phase offers opportunities to integrate resilience considerations into development planning and decision-making processes (UNISDR, 2015).

Lessons learned from recent disaster experiences underscore the necessity of combining hard infrastructure investments with soft measures such as community engagement and capacity building to achieve effective disaster risk management. The example of Legazpi city, which has embedded disaster resilience into its development agenda, demonstrates the practical benefits of a holistic, citizen-centric approach that integrates socio-economic and ecological considerations (Rezvani et al., 2023; Van Pham et al., 2025).

This perspective aligns with a broader trend toward multidisciplinary and innovative approaches in academic curriculum development, designed to equip future professionals with the technical and interpersonal skills needed to address complex challenges at the intersection of ecology and disaster resilience. Systematic review methodologies, as outlined by Perini and Wubbels (2024), provide valuable frameworks for synthesizing evidence and identifying best practices in this evolving field. Through rigorous, transparent, and replicable review processes, researchers can generate robust evidence to inform policy, practice, and education, ultimately contributing to more resilient and sustainable societies (Perini & Wubbels, 2024).

2.3. Resilient Cities

Ecological planning and disaster resilience have become increasingly essential across both urban and rural contexts, driven by their distinct vulnerabilities, resource distributions, and socio-economic dynamics. Within ecological planning, disaster resilience is fundamentally grounded in principles that enhance the capacity of communities, systems, and infrastructures

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to anticipate, absorb, adapt to, and recover from a wide array of hazards. In this context, resilience is not merely about enduring immediate shocks but also about fostering adaptive strategies that support long-term sustainability and collective well-being.

Urban areas, in particular, are subject to heightened risks from climate-related hazards such as extreme weather events, flooding, and air pollution. The pace of rapid urbanization and the expansion of built environments frequently outstrip the development of adaptive capacity. Although resilience principles have been incorporated into major international frameworks, including the UNISDR's 2015 Sendai Framework and the 2005 Hyogo Framework (Cutter et al., 2016), a persistent gap remains between high-level policy intentions and local implementation realities, hindering effective resilience-building (Bano et al., 2025; Ebrahim, 2025). Bridging this gap requires context-sensitive approaches that integrate global best practices with advanced, data-driven technologies tailored to specific urban and regional needs.

Urban resilience is widely conceptualized as the ability of a city to maintain essential functions, structures, and identity while undergoing transformation. This concept encapsulates both the capacity to resist sudden disruptions and to adapt to slow-onset stresses, such as environmental degradation and demographic shifts (Moraci et al., 2025a; Samaei & Ghafari, 2025; Yang et al., 2024). Central to this conception is the emphasis on adaptability as a core feature of resilience.

Chen et al. (2023) further argue that resilience also involves reorganization and transformation. The interplay among ecological, social, and economic systems fundamentally shapes urban vulnerability and adaptive capacity (Nahyan, 2017; CDRI & G20 Working Group on DRI, 2024). Early frameworks, including those from the International Council for Sustainable Development and the Rockefeller Foundation's 100 Resilient Cities initiative, contributed significantly to shaping integrated approaches to urban risk management (Chen et al., 2023).

Distinct typologies of resilience elucidate different strategic emphases. Engineering resilience prioritizes rapid recovery through robust infrastructure, whereas ecological resilience underscores flexibility, redundancy, and the incorporation of green spaces as buffers to accommodate change (Marzouk & Azab, 2024). Urban green spaces not only provide vital ecosystem services but also serve as critical resources during disasters such as floods and earthquakes (Alawi & Chu, 2024; Villagra Islas & Alves, 2016). NbS and GBI are key components in mitigating hazards and enhancing urban sustainability (Kraus & Scharf, 2019). NbS offer structured pathways for ecological restoration and risk reduction (Luo et al., 2024; CDRI & G20 Working Group on DRI, 2024). Their assessment requires consideration of thermal regulation, water management, and carbon sequestration. The strategic deployment of GBI, guided by geospatial analysis, can enhance urban aesthetics, improve livability, and strengthen resilience (Czyza & Kowalczyk, 2024). Evaluating these spaces for disaster preparedness entails considerations of accessibility, safety, and proximity to essential infrastructure (Li et al., 2013).

Beyond physical infrastructure, urban resilience is shaped by social and institutional dimensions. Social resilience emphasizes the ability of communities to self-organize and adapt, often

fostered through participatory planning and local empowerment (URBAN GreenUP, 2020). Active stakeholder engagement is crucial in embedding resilience within community-based frameworks (Ståhlbröst et al., 2018). Institutional resilience refers to the capacity of governance systems to coordinate effectively, allocate resources, and implement adaptive policies (Sánchez et al., 2023; Sang et al., 2021). Effective governance must articulate clear risk frameworks, define objectives, and develop actionable strategies. This process requires technical expertise as well as the cultivation of multidisciplinary skills through education and training (Debnath et al., 2022). International agreements, including the Yokohama Strategy, the Hyogo Framework for Action, and the UN Conference on Sustainable Development, further guide the alignment of urban planning with resilience objectives (UNISDR, 2015). Together with spatial considerations such as urban morphology and historical context (Clemente et al., 2025), these elements inform place-based, adaptive strategies.

Traditional indicators and rule-based models often struggle to capture the evolving and dynamic nature of urban risks. Multi-scenario design models and integrated geospatial data panels support decision-making by linking social and ecological datasets (Wang et al., 2022; URBAN GreenUP, 2020). Tools such as digital elevation models (DEM), digital surface models (DSM), and GIS technologies enhance spatial accuracy and enable refined risk assessments. GIS and scenario planning tools are instrumental in resource allocation and in supporting the development of climate-responsive urban forms. Emerging technologies like Long Short-Term Memory (LSTM) neural networks and advanced RS data allow for more precise resilience evaluations (Ren et al., 2025). Additionally, digital twins and smart city systems provide opportunities for real-time monitoring and optimization of urban assets. Nevertheless, data quality remains a critical challenge. As Davis et al. (2020) highlight, limitations in data access hinder effective hazard assessment and resilience planning, emphasizing the need for sustained investments in monitoring infrastructure.

Various frameworks, including the Disaster Resilience Indicators (USA), the City Resilience Profiling Tool (UN Habitat), and the City Resilience Index (The Rockefeller Foundation), have been developed to quantify urban resilience. Yet, only a few frameworks comprehensively capture the multifaceted nature of urban systems (Suarez et al., 2024). The resilience index methodology, which assesses preparedness, response, and recovery capacities, underscores the importance of quantifying robustness within DRR contexts (Gerges et al., 2022). However, the appropriateness of measuring resilience continues to generate debate among scholars (Cheek & Chmutina, 2022).

Resilience thinking, which bridges scientific, managerial, and policy domains, enables systems to address uncertainty through differentiated strategies, including prospective, corrective, and compensatory approaches (Risna et al., 2023; Rezvani et al., 2023). Central to this approach are strategies for knowledge sharing, education, and collaborative partnerships (Asian Disaster Reduction Center, 2005). Contemporary frameworks emphasize relational and reflexive planning processes that accommodate risk complexity and uncertainty (Esmail et al., 2025). Furthermore, acknowledging cultural values and local knowledge is vital to ensure community legitimacy and

effectiveness (Huang et al., 2019). Social indicators, such as land use, population density, and infrastructure quality, remain critical for evaluating vulnerability (Ren et al., 2024). Tools like the Urban Environment Examination System (UEES) offer comprehensive assessments, although data collection challenges persist (Acosta-Fernández et al., 2025).

Disaster risk management fundamentally integrates hazard assessment, exposure, vulnerability, and adaptive capacity. Ecological planning contributes to risk reduction through strategic land use, asset protection, and ecosystem restoration. Practical examples, including Odisha's Disaster Resilient Power Systems and India's rural roads initiative, highlight the importance of risk-informed planning and capacity-building efforts (CDRI & G20 Working Group on DRI, 2024). Financial mechanisms such as catastrophe bonds and insurance instruments further support post-disaster recovery and incentivize resilience-oriented design.

2.3.1 Resilience in low -and middle- income contexts

In low and middle-income contexts (LMICs), resilience is shaped by intricate interdependencies among environmental hazards, poverty, informal housing conditions, and institutional constraints. In these settings, community participation and local knowledge play a critical role in producing accurate risk assessments and informing effective planning strategies (Campomanes et al., 2025; Taylor et al., 2020). Vulnerabilities are particularly pronounced among low-income populations, who often face limited access to basic services and reside in fragile housing structures that exacerbate their exposure to hazards (Hussain et al., 2023).

The understanding of resilience itself frequently varies across cultures. For many local communities, resilience is not merely defined by technical capacity or infrastructural robustness, but rather by the ability to maintain dignity and preserve quality of life in the face of recurrent threats and stresses (Taylor et al., 2020). Bridging the gap between policy frameworks and on-the-ground practice in LMICs depends largely on inclusive governance structures, targeted education, and ongoing innovation (Bano et al., 2025). Collaborative, bottom-up strategies have gained prominence, particularly in critical areas such as water resource management, where local engagement enhances both legitimacy and effectiveness (Tosan et al., 2025).

The Sendai Framework underscores the importance of governance, investment, and knowledge exchange, elements that are especially pertinent for LMICs given their often-limited institutional capacities (UNISDR, 2015). Ecosystem-based disaster risk reduction (Eco-DRR) initiatives illustrate the transformative potential of community-led restoration efforts in building both environmental and social resilience (UNEP, 2022a). Integrating technical expertise with soft skills and designing context-specific educational programs are fundamental for cultivating long-term capacity within these communities (Bano et al., 2025; Risna et al., 2023).

Spatial resilience within LMICs is similarly uneven. While some regions are able to leverage strengths from neighboring areas or networks, others lack both internal resources and external support, leaving them disproportionately vulnerable (Chen et al., 2023). Addressing these

disparities requires tailored, multi-scale interventions that are sensitive to spatial dynamics and local specificities. Such approaches are essential to fostering effective, inclusive, and sustainable resilience-building efforts in these contexts.

2.4. Climate Change

Disaster management has become increasingly complex in the context of accelerating climate change, which intensifies the frequency, severity, and unpredictability of natural hazards. This evolving landscape necessitates a critical reassessment of traditional disaster management strategies and underscores the importance of integrating emerging scientific insights with technological advancements. Climate-induced hazards, including floods, droughts, heatwaves, and storms, present escalating risks for both urban and rural populations. These risks are especially pronounced in areas where rapid urbanization, inadequate infrastructure, and deep-rooted social inequalities heighten vulnerability.

Cerbaro et al. (2022) highlight that cities in regions such as the Amazon are particularly exposed to multiple, overlapping hazards and often have limited adaptive capacity. This reality underscores the urgency of developing context-specific resilience strategies that account for local ecological, infrastructural, and social dynamics. As climate risks become increasingly systemic and unpredictable, disaster management must evolve from reactive responses toward proactive, data-informed, and multidisciplinary frameworks that emphasize long-term adaptability.

Recent research has identified several critical gaps in both knowledge and implementation concerning climate resilience. Among these gaps are the development of predictive models for resilience performance, the need for deeper local participation in planning and response processes, and the application of real-time data technologies in regions facing water scarcity or high hazard exposure (Tosan et al., 2025).

The interconnected nature of climate stressors and socio-ecological systems calls for integrative responses that transcend traditional institutional boundaries. Coordination between global organizations and national DRR platforms is essential for mobilizing knowledge and resources across multiple scales and supporting comprehensive risk management.

The expansion of resilience thinking invites us to perceive cities as dynamic systems capable of learning from past disruptions, adapting to emerging risks, and evolving alongside environmental and societal changes. Enhancing resilience in the era of climate change requires sustained commitment to collaborative governance, community empowerment, scientific advancement, and educational reform. Effective disaster management relies heavily on coherent policy integration across diverse sectors. Policies must bridge areas such as sustainable development, food security, public health, environmental management, and DRR to achieve systemic resilience (UNISDR, 2015). The success of these policies is further enhanced by participatory governance models that integrate scientific knowledge with local perspectives.

The importance of inclusive risk information is widely acknowledged. Risk communication strategies should be tailored to different populations, considering variations in sex, age, and disability to ensure accessibility and usability (UNISDR, 2015). Incorporating traditional and indigenous knowledge into planning processes can further strengthen adaptive capacity by revealing locally validated responses and culturally embedded practices.

Community participation is both an ethical obligation and a strategic necessity. Actively involving local stakeholders in the design of GI and passive urban design strategies ensures that interventions reflect the social, cultural, and ecological realities of each neighbourhood (Innella, Ansanelli et al., 2024). Participatory approaches have demonstrated effectiveness in increasing public support, improving long-term maintenance, and enhancing overall success.

Educational frameworks must also evolve to meet the interdisciplinary demands of disaster management in the context of climate change. Professionals require a comprehensive understanding of the relationships among climate systems, urbanization, energy use, and ecological processes. However, many students are still limited to general topics such as the greenhouse effect or broad discussions of global warming, without fully engaging with the specific implications of climate change on disaster risk (Bano et al., 2025).

To address this gap, curricula should incorporate not only technical content such as mitigation and adaptation strategies, GIS applications, and resilience frameworks, but also critical policy analysis and participatory planning approaches. Carefully designed interdisciplinary courses are essential for bridging knowledge across engineering, environmental science, public health, and urban planning.

Furthermore, the development of soft skills including collaboration, communication, negotiation, and stakeholder engagement is increasingly recognized as vital. Future professionals need to be equipped not only to analyze data and manage infrastructure systems but also to navigate complex institutional environments and engage communities in a meaningful and effective manner.

2.5. Ecosystem Services and Disaster Resilience

Ecosystem services play a vital role in enhancing urban and regional resilience through their regulatory, supporting, cultural, and provisioning functions. The well-being of urban populations depends not only on the built environment but also on natural capital, particularly on biologically productive ecosystems located nearby, in peri-urban zones, or farther afield. These ecosystems provide a wide range of essential services that support daily life and promote long-term sustainability (Guadagno et al., 2013). The Millennium Ecosystem Assessment (MEA, 2005) offers a foundational classification of these services, including climate regulation, water purification, soil retention, and biodiversity support, each of which significantly contributes to DRR by strengthening natural buffers and lowering overall vulnerability (Dong & Du, 2025; Moraci et al., 2025a).

Recent studies emphasize how these services mitigate hazards such as floods, heatwaves, and droughts by reinforcing ecological resilience and reducing exposure to risk. The integration of ecosystem services into planning enhances both ecological functionality and socio-economic resilience, in line with the priorities of the Sendai Framework for DRR (UNISDR, 2015). This approach also enriches vulnerability mapping by highlighting the critical role of GI and NbS in reducing exposure and enhancing adaptive capacity (Başoğlu Acet et al., 2024; Sang et al., 2021).

The degradation of ecosystems increases the frequency and severity of disasters while diminishing the capacity of natural and human systems to cope with climate change impacts (Munang et al., 2013). Consequently, the restoration of degraded ecosystems and their services, such as wetland rehabilitation, afforestation, and embankment stabilization, has become a vital strategy for disaster-resilient planning. Literature underscores that such restoration activities improve water regulation, soil stabilization, and biodiversity support (UNEP, 2022a; UNEP, 2022b).

The spatial distribution and design of urban green spaces are also essential for maximizing their ecological functions and ecosystem services. Well-planned green spaces improve air quality, reduce noise and heat, and enhance urban biodiversity (Yu, 2022; Derkzen, 2015). Additionally, forests and vegetated areas around cities facilitate groundwater recharge by allowing greater water infiltration, reducing surface runoff, and mitigating stormwater impacts. These areas also contribute to improved water quality through natural filtration and absorption of nutrients and pollutants (Guadagno et al., 2013). NbS and GI represent key strategies for enhancing ecosystem services in urban contexts. Examples include reforestation, green roofs, urban wetlands, and green corridors, all of which help mitigate disaster risks and improve urban habitability (Luo et al., 2024; Kabisch et al., 2016).

The strategic implementation of these approaches in cities such as Copenhagen and several Polish municipalities demonstrates the benefits of urban nature in supporting climate adaptation and public health (Pancewicz, 2022). However, integrating GI into densely built environments with high levels of impervious surfaces remains challenging. Addressing these challenges requires targeted spatial interventions to reduce ecological deficits and improve equitable access to green spaces (Vignoli et al., 2021).

The effective integration of ecosystem services into spatial planning depends on data-driven tools. GIS-based models, expert-informed suitability mapping, and three-dimensional geoprocessing techniques are essential for evaluating the potential of different landscapes to deliver regulatory services (Li et al., 2022). Frameworks like the United Nations System of Environmental and Economic Accounting ; Ecosystem Services (UN SEEA-EA) support the quantification and spatial visualization of ecosystem benefits, offering a robust foundation for planning decisions (Moraci et al., 2025a; Perosa et al., 2021). These tools enable a shift from reactive disaster responses to proactive risk reduction by guiding targeted interventions and optimizing resource allocation. Spatial assessments of ecosystem services also inform urban

transformation strategies, particularly in high-risk areas with limited green cover (Vignoli et al., 2021).

Applying ecosystem services in DRR planning is not only a technical exercise but also a multidimensional process that requires coherent frameworks, practical tools, and inclusive governance structures. Successful implementation depends on interdisciplinary competencies, cross-sector collaboration, and strong community engagement. Literature highlights the necessity of integrating ecological science, spatial planning, and participatory approaches (Kabisch et al., 2016; Meerow & Newell, 2017). Strengthening institutional capacity further requires educational programs that combine theoretical knowledge of NbS with practical planning skills. Collaboration with expert networks and local organizations enhances the credibility and effectiveness of early warning systems and restoration initiatives.

As emphasized by IPBES (2019), transformative change in environmental governance relies on inclusive, knowledge-based decision-making that values both scientific expertise and traditional knowledge systems. While the ecological and infrastructural roles of ecosystem services are well recognized, successful implementation ultimately depends on structured planning, context-specific restoration, and coordinated institutional action. Anchoring these efforts within internationally recognized frameworks, including MEA (2005), IPBES (2019), and the Sendai Framework, ensures alignment with global resilience and sustainability objectives.

2.6. Systems Thinking in Disaster Contexts

Systems thinking in disaster contexts is essential for understanding and managing the complex, interconnected nature of ecological and social systems under stress. The concept of resilience, originally introduced by Holling in 1973, provides a foundational perspective by defining resilience as the capacity of a system to absorb disturbances before shifting into an alternative stable state (Kosova et al., 2022; Allan & Bryant, 2010). This approach underscores the importance of recognizing thresholds and the potential for systems to reorganize following shocks, rather than merely returning to a previous equilibrium.

The distinction between engineering resilience, which focuses on rapid recovery to a single stable state, and ecological resilience, which acknowledges multiple potential stable states and emphasizes adaptive capacity, further enriches the systems perspective in disaster management (Chen et al., 2023; Risna et al., 2023). In disaster contexts, systems thinking demands the integration of diverse disciplinary insights from ecology, engineering, social sciences, and economics to fully capture the multifaceted impacts of hazards. Hussain et al. (2023) highlight that resilience-based flood management strategies rely on self-organization, learning, and adaptation capacities, allowing communities and ecosystems not only to recover but potentially to achieve improved states after a disaster. This understanding aligns with the broader perspective that resilience is not merely about resistance to change but also encompasses adaptability and transformability in response to ongoing environmental and social challenges (Risna et al., 2023).

The application of systems thinking is evident in the utilization of advanced technological tools such as GIS and RS. These technologies facilitate the collection, analysis, and visualization of geospatial data, thereby supporting comprehensive risk assessments and informed decision-making across all phases of disaster management (Han & Liu, 2025). The integration of GIS with hydrological models exemplifies how systems thinking enables the synthesis of environmental, infrastructural, and social data to assess flood risks and guide mitigation strategies. Scenario planning and GIS-based risk assessments are increasingly used to simulate various intervention scenarios, thereby supporting evidence-based and adaptive planning approaches (Arianti et al., 2024; Santhosh Kumar et al., 2025). This integration allows for dynamic responses to changing environmental conditions and helps identify critical vulnerabilities within interconnected systems.

Additionally, there is a growing need for metrics that capture social, economic, and functional dimensions of disaster resilience. Ghaffarian et al. (2018) emphasize that while RS-based proxies have traditionally focused on the physical aspects of urban environments, a systems-oriented approach requires the simultaneous consideration of built, economic, social, and natural components to enable comprehensive disaster risk management.

Implementing urban resilience concepts necessitates a multidisciplinary approach involving all relevant stakeholders. This includes early warning systems, emergency operations planning, and risk mitigation measures as integral components of a resilient system (Villani et al., 2023). The systemic nature of disaster impacts, including disruptions to life safety, business continuity, access to emergency services, and overall socioeconomic stability, highlights the necessity of holistic risk and vulnerability assessments. An integrated approach considers the probabilistic risk and vulnerability of critical infrastructure networks and accounts for both immediate and cascading disaster effects (Rezvani et al., 2023). As a result, effective systems thinking in disaster contexts requires the development of multidisciplinary competencies. Practitioners must possess technical skills in data analysis, modeling, and spatial technologies alongside soft skills such as collaboration, communication, and adaptive problem-solving. The integration of these competencies enables stakeholders to co-create meaningful metrics and scenarios for both pre-event and post-event evaluations of resilience strategies, ensuring that interventions are contextually relevant and responsive to local needs (Villani et al., 2023).

Systems thinking in planning is further reinforced by integrating stakeholder perspectives at multiple scales. Li et al. (2022) argue that collaborative design processes allow planners to recognize both challenges and opportunities in achieving environmental sustainability. The use of geodata and geodesign tools has been found to effectively integrate complex relationships and support dynamic, comprehensive redesign processes (Ernst & Yenigün, 2023). This approach is particularly valuable in disaster management, where the interplay between ecological, social, and infrastructural systems must be addressed holistically.

Eikelboom and Janssen (2015) evaluated the collaborative use of multiple geodesign tools in the Netherlands and found that these tools influenced planner and researcher decisions by providing

interactive, data-driven support for spatial planning in response to climate change. Arciniegas et al. (2019) further suggest that integrating technological advances, analytical methods, and collaborative frameworks such as geodesign and Urban Living Labs (ULLs) creates a methodological environment that promotes stakeholder involvement and cross-scale coordination. ULLs function as experimental governance platforms where stakeholders from academia, industry, public administration, and civil society collaborate to co-create solutions addressing sustainability, climate adaptation, and quality of life challenges (Innella, Barberio et al., 2024; Innella, Ansanelli et al., 2024). The participatory nature of ULLs ensures that diverse perspectives inform both the design and implementation of interventions, enhancing their legitimacy and overall effectiveness.

2.6.1 Scenario planning and foresight methods

Scenario planning and foresight methods are essential components within systems thinking approaches to ecological planning, especially in the context of disaster management and resilience building. These methods enable planners and decision-makers to anticipate a range of possible futures, assess vulnerabilities, and design adaptive strategies that accommodate the uncertainty and complexity inherent in socio-ecological systems (Debnath et al., 2022). By integrating scenario planning, practitioners can systematically explore how different drivers, including climate change, urbanization, and policy shifts, may interact and produce diverse outcomes (Esmail et al., 2025; Pang & Deal, 2024).

The use of scenario-based approaches is closely associated with geodesign, which combines spatial analysis, stakeholder engagement, and iterative simulation to evaluate the impacts of alternative planning proposals in real time (Huang et al., 2019). Yexuan et al. (2020) emphasize that neglecting process relationships can result in the oversight of system hierarchies and dynamic changes, which are critical for identifying appropriate intervention scales. Process models inform evaluation methods and criteria, linking stakeholder participation directly to impact assessments. Geodesign workshops employ GIS and modeling tools to rapidly assess the suitability and consequences of various interventions, enabling participants to visualize and compare scenarios under different assumptions and constraints. This integrative process encourages the combination of scientific evidence with societal values, leading to more coherent and context-sensitive visions for the future (Esmail et al., 2025; Huang et al., 2019).

Scenario planning further facilitates dialogue among diverse stakeholders by integrating indigenous knowledge, local priorities, and global best practices to develop context-appropriate solutions (Crummey et al., 2017; Davis, 2020). Its iterative nature, combined with transparent communication and participatory engagement, enhances the legitimacy and effectiveness of planning outcomes.

The inclusion of stakeholders in co-design supports the development of innovative infrastructure and building solutions. The iterative and recursive structure of co-design frameworks enable the co-evolution of design problems and solutions. Quan et al. (2019) argue that such frameworks

allow for the integration of scientific evaluation, advanced AI search techniques, and human expertise, thus guiding the exploration of the design space. Newton and Rogers (2020) illustrate how regenerative redevelopment approaches result in distributed renewable energy systems, integrated water management, and water-sensitive urban design, all contributing to enhanced disaster resilience and sustainability.

Scenario planning also provides a valuable framework for addressing "wicked problems" in urban and ecological systems, where multiple, interconnected risks and uncertainties must be managed simultaneously (Yexuan et al., 2020). When combined with systems thinking, scenario analysis enables planners to identify feedback loops, cascading effects, and trade-offs between objectives such as economic development, environmental protection, and social equity (Debnath et al., 2022). Pang and Deal (2024) note that vulnerability in urban systems can be understood as the degree to which ecological, social, or infrastructural components are susceptible to stresses and shocks. Scenario planning assists in mapping these vulnerabilities and testing adaptation strategies before implementation.

Furthermore, scenario planning promotes diversity, redundancy, and multifunctionality in urban and ecological systems. By considering a wide spectrum of plausible futures, planners can design interventions that remain robust under unexpected changes or disruptions (Yexuan et al., 2020; Debnath et al., 2022). This approach aligns with the principles of sustainable urban planning, which emphasize balancing environmental, social, and technological factors to achieve long-term resilience and sustainability (Shilky et al., 2024).

The literature highlights the importance of linking scenario planning with NbS and GI, which offer innovative pathways for enhancing resilience while delivering co-benefits to ecosystems and communities (Kabisch et al., 2016). By simulating the impacts of NbS interventions under various scenarios, planners can identify strategies that maximize benefits and minimize trade-offs (Andersson et al., 2019; Kabisch et al., 2016). Campagna et al. (2020) present an operative example where geodesign workshops facilitate the integration of GI into regional strategic planning. Involving undergraduate and graduate students, this process demonstrates how stakeholder engagement can be embedded in educational settings, thereby building competencies for collaborative planning.

The integration of foresight methods into planning education and practice is critical for developing multidisciplinary competencies. Training in scenario development, participatory modeling, and impact assessment equips practitioners to navigate uncertainty and complexity effectively, fostering a culture of continuous learning and adaptation (Esmail et al., 2025; Shilky et al., 2024). The willingness to revise conclusions and adapt strategies considering new evidence is recognized as a core competency for effective planning.

2.7. The Sendai Framework for Disaster Risk Reduction

Adopted at the Third UN World Conference on Disaster Risk Reduction in 2015, the Sendai Framework marked a significant paradigm shift in global disaster risk governance. Unlike earlier strategies, it emphasizes proactive risk reduction, the prevention of new risks, and the systemic strengthening of resilience across all societal levels (Whelchel et al., 2018). Importantly, the framework defines disasters not merely as the occurrence of hazards but as outcomes arising from the interaction between hazards and vulnerabilities. This reframing supports integrated risk management approaches that combine physical, social, and ecological dimensions.

A notable innovation of the Sendai Framework is its explicit recognition of ecosystems as protective infrastructure. It promotes ecosystem-based approaches, including NbS and GI, for reducing exposure and enhancing adaptive capacity (Furuta & Shimatani, 2018; Whelchel et al., 2018). Healthy ecosystems such as wetlands, forests, and mangroves are acknowledged as natural buffers that mitigate the impacts of floods, storms, and landslides. These perspectives have encouraged the adoption of Eco-DRR[1] by governments and agencies. For example, the Japan International Cooperation Agency (JICA) now includes Eco-DRR as a core strategy within its nature conservation portfolio (Furuta & Shimatani, 2018). The United Nations Environment Programme (UNEP, 2022a) similarly emphasizes the role of Eco-DRR in strengthening community resilience, particularly in areas where conventional infrastructure may be inadequate or unsustainable.

The framework advocates for context-specific risk governance strategies, which include risk avoidance such as restricting development in hazard-prone areas, along with risk reduction, risk transfer, and risk retention measures (UNISDR, 2015). It further prioritizes education, professional training, and stakeholder engagement to build cross-sectoral competencies (UNISDR, 2015). In addition, it promotes knowledge co-production and continuous learning to address emerging and complex risks in urban and ecological planning contexts (Whelchel et al., 2018). These strategies are operationalized through prevention, preparedness, mitigation, and financing tools, all aiming to reduce both the probability and the consequences of hazards (Asian Disaster Reduction Center, 2005). This comprehensive approach illustrates a transition from reactive emergency response toward sustainable resilience planning.

The influence of the Sendai Framework extends well beyond international policy declarations. It has been incorporated into national legislation, planning frameworks, and funding mechanisms. Australia's Disaster Ready Fund (DRF) exemplifies this integration by supporting community-scale projects focused on systemic risk reduction (CDRI & G20 Working Group on DRI, 2024). Likewise, Bangladesh's National Adaptation Programme of Action (NAPA) aligns with the Framework's dual-track approach of intervention, such as hazard mitigation, and facilitation,

[1] Ecosystem-based disaster risk reduction (Eco-DRR) is the sustainable management, conservation and restoration of ecosystems to reduce disaster risk, with the aim of achieving sustainable and resilient development (Estrella & Saalismaa, 2013).

This project is funded by the European Union

including enabling governance structures, demonstrating how DRR is embedded within national development agendas (Nahyan, 2017).

Framework adoption is further reinforced through initiatives like the Coalition for Disaster Resilient Infrastructure (CDRI) and the G20, which disseminate case studies and promote best practices among member states (CDRI & G20 Working Group on DRI, 2024). Capacity-building efforts include the development of integrated curricula and knowledge platforms that address the relationships between ecosystems, infrastructure, and risk (CDRI & G20 Working Group on DRI, 2024). This emphasis on inclusive and participatory governance ensures that interventions remain locally relevant and scientifically robust, in line with the framework's overarching vision.

3. NATURE-BASED SOLUTIONS & GREEN INFRASTRUCTURE

NbS and GI are closely interconnected concepts; however, they differ in scope and emphasis across the literature. Although both approaches aim to enhance ecosystem services and strengthen resilience, NbS generally emphasizes multifunctional and adaptive solutions that are deeply rooted in ecological processes. In contrast, GI typically refers to spatial networks of natural and semi-natural features, particularly within the context of urban planning. Pauleit et al. (2017) suggest that NbS serve as an overarching concept that encompasses ecosystem-based adaptation, GI, and ecosystem services. Meanwhile, GI, which has its origins in planning disciplines, provides a strategic framework for integrating both NbS and ecosystem-based adaptation into urban development initiatives at multiple scales.

3.1 Nature-Based Solutions (NbS)

UNEP (2022c) defines NbS as "actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits." The concept emerged in the late 2000s through the efforts of the World Bank and the International Union for Conservation of Nature (IUCN) to highlight the importance of biodiversity in climate change mitigation and adaptation strategies (Pauleit et al., 2017). NbS are fundamental for enhancing resilience to climate-induced disasters, as they deliver ecological, social, and economic co-benefits (CDRI & G20 Working Group on DRI, 2024; Tang, 2024; do Amaral & de Lima Bezerra, 2024; UNDRR, 2021). By protecting, managing, and restoring natural or modified ecosystems, NbS help to reduce the impacts of disasters and strengthen overall adaptive capacity.

NbS operate by mimicking or enhancing natural processes to provide essential ecosystem services, including stormwater management, air purification, and temperature regulation. Examples of these interventions include green roofs, permeable pavements, rain gardens, constructed wetlands, and blue-green corridors, all of which address pressing urban challenges such as heatwaves, flooding, and air pollution (see Figure 2) (Munonye & Ajonye, 2024; Burda & Nyka, 2023; UNDRR, 2021; Arslantaş et al., 2020). Beyond their protective functions, NbS generate multiple co-benefits for biodiversity, social well-being, and local economic vitality. These diverse interventions, which range from floodplain restoration projects to the creation of urban green spaces, exemplify the synergistic relationship between ecological planning and disaster resilience.

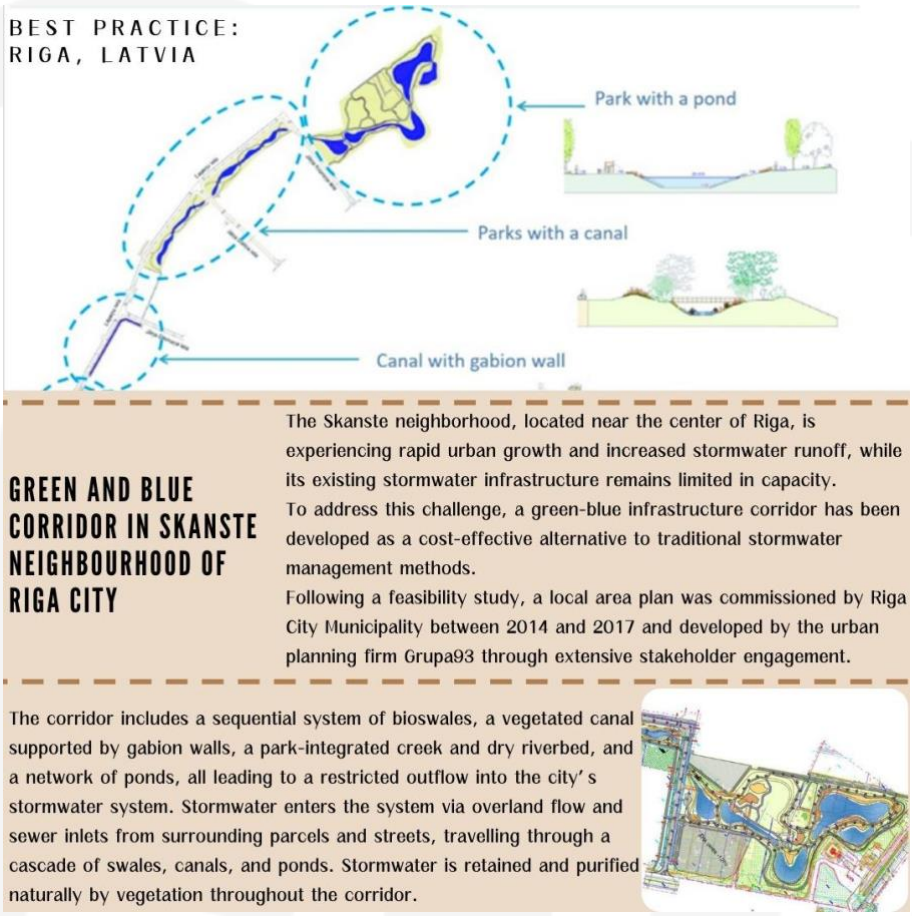

Figure 2. Green and blue corridor practice from Riga (Baltic Smart Water Hub, 2020)

IUCN identifies three main types of NbS: solutions that utilize existing natural or protected ecosystems more effectively, solutions based on creating sustainable management protocols and procedures for managed or restored nature-based ecosystems, and solutions that involve creating entirely new ecosystems (Cohen-Shacham et al., 2016). This classification provides a clear framework for systematically integrating NbS into urban development and spatial planning processes. However, the effectiveness of NbS depends on their ability to address multiple hazards and adapt to evolving risk landscapes. Their multifunctionality is a key strength, as they often deliver co-benefits across environmental, social, and economic domains. For example, restoring riverfronts can simultaneously achieve flood control, ecological restoration, and offer recreational and educational opportunities (Li et al., 2022). Successful design and implementation require careful consideration of trade-offs and synergies among different functions, as well as the active involvement of stakeholders to ensure inclusive and context-appropriate solutions. By promoting resource loop closure and adaptive reuse of materials and spaces, NbS support more efficient use of natural resources and help reduce ecological footprints. This approach reinforces their multifunctionality by addressing environmental challenges while simultaneously generating social and economic co-benefits, such as improved public health, enhanced recreational opportunities, and increased urban aesthetics.

NbS encompass a diverse range of strategies that leverage natural processes and ecosystem functions to address societal challenges including DRR, climate adaptation, and urban resilience. According to do Amaral and de Lima Bezerra (2024), NbS can be further categorized into GI, blue infrastructure, water and food supply systems, and cultural elements. GI comprises vegetated systems such as urban parks, green roofs, and greenways, while blue infrastructure refers to water bodies including rivers, wetlands, and sustainable urban drainage systems. These typologies frequently overlap and interact, offering a suite of multifunctional benefits. The functions of NbS are closely aligned with these typologies. For instance, GI supports urban biodiversity, mitigates the urban heat island (UHI) effect, and improves air quality. It also plays a critical role in stormwater management by increasing infiltration and reducing surface runoff, thereby lowering flood risks (Tang, 2024). BI contributes to water regulation, flood control, and the maintenance of aquatic habitats. The integration of GBI supports comprehensive water-cycle management at multiple scales, which is essential for creating water-sensitive cities (Newton & Rogers, 2020).

Ecosystem-based approaches, which form a core component of NbS, are increasingly recognized for their capacity to enhance resilience to disasters and climate extremes. These approaches aim to manage land, water, sea, and living resources holistically and equitably to promote both conservation and sustainable use (UNDRR, 2021). Well-managed ecosystems function as natural infrastructure, buffering floods, stabilizing shorelines, and mitigating the impacts of extreme weather events. Whelchel et al. (2018) highlight the growing global interest in such approaches, noting that governments, communities, and private sector actors are increasingly implementing NbS for DRR and climate adaptation.

Urban areas present unique challenges and opportunities for implementing NbS. As major contributors to global greenhouse gas emissions and resource consumption, cities require the integration of NbS into urban planning to address sustainability and resilience goals effectively (Shilky et al., 2024). Urban greening initiatives, such as converting abandoned infrastructure into greenways or installing green roofs and green walls, illustrate how NbS can revitalize cities while delivering essential ecosystem services (Meerow & Newell, 2017; Tang, 2024). These interventions not only improve environmental quality but also promote social well-being by providing recreational spaces and fostering community engagement.

Another important dimension of NbS concerns their scale and integration within urban planning. At the site or building scale, NbS might include green walls, permeable pavements, and rain gardens, which help manage water and local microclimates. At the neighborhood or city scale, broader interventions such as urban parks, river restoration, and green corridors enhance ecological connectivity and reduce disaster risks (Figure 3) (World Bank, 2024). To support multi-scalar planning and implementation, the EU-funded URBAN GreenUP project developed an open-source decision support system tool[2] designed to help identify appropriate NbS and strengthen

[2] For further information please visit https://networknature.eu/product/26098

local implementation capacity.

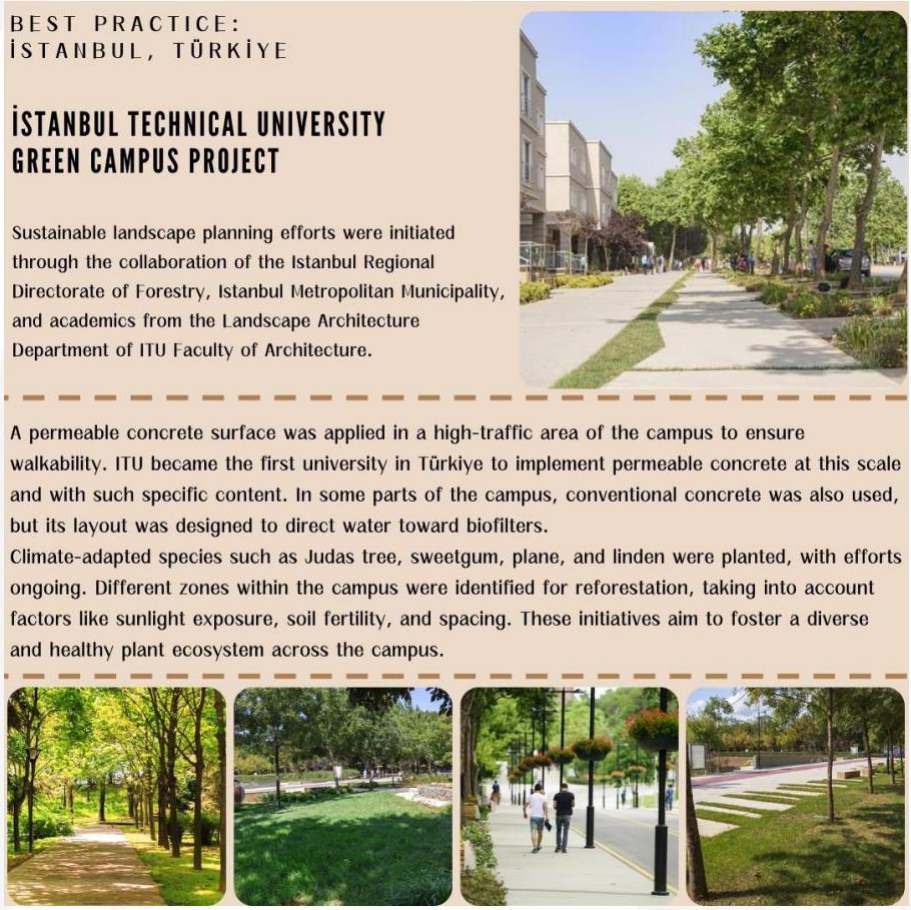

Figure 3. İTÜ Green Campus Project (URL-1)

IUCN (2020) has developed a comprehensive framework for evaluating NbS projects, incorporating best practice codes, management guidelines, and governance mechanisms. This standard offers a systematic learning framework designed to improve NbS applications and build confidence among decision makers. It also fosters a global user community that guides implementation, accelerates policy development, and advances conservation science related to NbS. The IUCN Global Standard for Nature-based Solutions outlines eight key criteria to ensure that NbS are effectively designed, implemented, and managed to deliver societal, environmental, and economic benefits. These criteria include effectiveness in addressing societal challenges, consideration of scale, achieving net gains in biodiversity and ecosystem integrity, economic viability, inclusive and transparent governance, equitable trade-off balancing, adaptive management based on evidence, and long-term sustainability and mainstreaming. Luo et al. (2024) emphasize that guidelines like the IUCN Global Standard have facilitated systematic implementation in ecological protection and restoration projects, highlighting the importance of context-specific solutions that balance ecological integrity with human needs.

Pre-disaster planning and recovery frameworks are increasingly incorporating NbS as essential components of resilient infrastructure strategies. Their integration into reconstruction efforts supports sustainable construction practices, encourages technological innovation, and promotes the adoption of alternative energy sources, contributing to the overarching goal of "building back better." Community-centered approaches are critical to ensure that benefits are distributed equitably and that rebuilt infrastructure effectively addresses diverse societal needs (CDRI & G20 Working Group on DRI, 2024). Case studies from Hungary and South Africa demonstrate how NbS can address challenges ranging from flood management to community empowerment, illustrating their adaptability and effectiveness across different socio-ecological contexts (CDRI & G20 Working Group on DRI, 2024).

The evolution of NbS typologies and functions signals a broader shift toward more integrated, adaptive, and participatory approaches in disaster-resilient planning. Aligning energy, climate, and urban policies with NbS principles is essential to address sectoral and spatial dimensions of disaster risk and resilience (Newton & Rogers, 2020). Targeted interventions in urban planning and disaster risk management, particularly when co-designed with communities, can substantially improve living conditions and enhance resilience, especially for populations residing in high-risk areas. NbS represent an innovative dimension of community-led initiatives. Solutions such as ecosystem restoration and the rehabilitation of degraded landscapes not only mitigate disaster risks like flooding but also provide co-benefits for ecosystem health, support sustainable tourism, and enhance local livelihoods (CDRI & G20 Working Group on DRI, 2024). The effectiveness of NbS is maximized when communities are actively involved in planning and maintenance, as local knowledge informs the selection of appropriate strategies and ensures long-term viability. According to Mitrovic et al. (2023), urban landscape forms that align with the natural context of a city are inherently more resilient, and involving local stakeholders in shaping these forms is essential for fostering adaptability to changing conditions.

Community participation and co-creation are fundamental to the successful implementation and sustained maintenance of NbS. The UNaLab co-creation toolkit, for example, supports Urban Living Labs (ULLs) by facilitating collaborative design processes that address local water and climate challenges (Ståhlbröst et al., 2018). Involving citizens in the co-creation of NbS, often through ULLs, not only raises awareness and generates public demand for healthier environments but also fosters new forms of collaborative urban governance.

While NbS can significantly enhance the performance of conventional drainage and water management systems, their integration may also alter air and water flow patterns, potentially leading to unintended consequences such as increased or decreased flow rates (Dubovik et al., 2022). Addressing these challenges requires adaptive design approaches, context-specific solutions, and ongoing education on NbS mechanisms to ensure effective implementation.

The integration of advanced technologies further strengthens the capacity of spatial planning to respond to complex urban challenges. Digital twin systems, AI, and smart city tools, when combined with NbS and GI, create synergistic frameworks that support resilient and adaptive

urban systems (Samaei & Ghafari, 2025). These technologies enable real-time monitoring, scenario analysis, and data-driven decision-making, contributing to reduced reliance on carbon-intensive materials and enhancing the ecological responsiveness of infrastructure.

Recent research underscores the importance of integrating NbS and geodesign frameworks within ecological planning. Ecological planning enriches disaster management paradigms by offering a systems-based perspective that accounts for the dynamic interactions between natural and built environments. Childers et al. (2015) argue that cities, as habitats for people, require urban design processes that incorporate social components and acknowledge the value of GBI. These infrastructures, which encompass terrestrial and aquatic ecological features, deliver vital ecosystem services such as flood attenuation, heat reduction, and biodiversity support. However, the authors also note that these categories may not fully capture the diversity of urban ecological features, suggesting the need for more nuanced integration into disaster management frameworks.

The geodesign process facilitates the optimization of infrastructure and community planning by systematically evaluating alternative scenarios that balance ecological, social, and economic objectives. This methodological innovation allows planners to address broader planning challenges, such as the siting of critical infrastructure, while maintaining ecological integrity (Li & Kim, 2022). The application of geodesign and similar frameworks reflects a growing recognition of the need for multidisciplinary approaches that leverage technological advancements, including GIS, to support decision-making in complex urban environments (Han & Liu, 2025). The work of Yexuan et al. (2020) highlights the underutilization of geodesign in landscape architecture, despite its demonstrated value in sustainable and climate adaptation planning. They argue for a broader adoption of geodesign practices to achieve more resilient outcomes, suggesting that such integration could bridge existing research gaps and enhance the effectiveness of urban ecological planning.

Moreover, knowledge transfer across cities and regions is crucial, as climate and environmental conditions necessitate tailored approaches rather than direct replication of solutions. The Urban Nature Atlas, developed as part of the “Nature-based Urban Innovation (Naturvation)” project, offers a global interactive platform presenting NbS case studies. This platform enables users to search, analyze, and contribute new cases, thereby facilitating the transfer of practical knowledge and experience. Additional case examples are provided in documents prepared by Cohen-Shacham et al. (2016) and UNDRR (2021). Annex 2 also includes summary information on the case studies reviewed as part of this project.

3.2 Foundations and Functions of Green Infrastructure (GI)

As defined by the European Union (EU), GI is “a strategically planned network of natural and semi-natural areas, which include other environmental features designed and managed to deliver a wide range of ecosystem services” (EEA, 2019). These services encompass carbon sequestration, urban cooling, stormwater management, biodiversity support, and improved air

quality, all of which are crucial for mitigating the impacts of urbanization and climate change (Sánchez et al., 2023; Moraci et al., 2025a; İzmir Metropolitan Municipality, 2020).

Rooted in the principles of landscape ecology and landscape architecture (Pauleit, 2017), GI places strong emphasis on ecological networking to ensure that infrastructure remains functional even during disturbances (Nahyan et al., 2017). While GI projects in Europe often prioritize biodiversity enhancement (Pauleit, 2017), in the United States the focus is predominantly on stormwater management (EPA, 2022).

GI has emerged as a foundational element in transforming urban systems toward greater ecological sustainability and resilience. The EU's Biodiversity Strategy for 2030 (European Commission, 2020a) underscores the importance of investing in GI to mitigate the impacts of natural disasters and to support biodiversity conservation. The spatial organization of GI aligns closely with the principles of ecological planning and design, which emphasize harmonizing human activities with natural processes. When embedded within urban environments, GI enhances cities' adaptive capacity to a variety of hazards including flooding, heatwaves, hurricanes, tsunamis, and air pollution. For example, wetlands and urban green areas provide essential buffering functions that reduce flood risks and moderate urban temperatures through processes such as evapotranspiration and shading.

From a landscape planning perspective, GI functions not only as a conservation tool but also as a transformative agent capable of delivering ecosystem services across broader territorial scales. The core principles of GI include multifunctionality, connectivity, and the integration of ecological, social, and economic systems. Approaches addressing green structure as proposed by Pauleit (2017) are summarized in Table 1.

Table 1. Principles of GI planning (Pauleit, 2017).

Approach	Definition
Multifunctionality	GI planning considers and seeks to combine ecological, social and economic/abiotic, biotic and cultural functions of green spaces.
Connectivity	GI planning includes physical and functional connections between green spaces at different scales and from different perspectives.
Integration	GI planning considers urban green as a kind of infrastructure and seeks the integration and coordination of urban green with other urban infrastructures in terms of physical and functional relations (e.g., built-up structure, transport infrastructure, water management system).
Multi-scale approach	GI planning can be used for initiatives at different scales, from individual parcels to community, regional and state. GI should function at multiple scales in concert.
Multi-object approach	GI planning includes all kinds of (urban) green and blue space; e.g., natural and semi-natural areas, water bodies, public and private green space like parks and gardens.

The concept of GI, which emerged in the 1990s, encompasses natural and semi-natural land-based elements, while the more recent concept of blue infrastructure includes water-based

elements in the landscape such as rivers, lakes, coastal areas, artificial channels, and constructed wetlands (UNDRR, 2021). The integration of BI elements, such as urban streams and wetlands, with green spaces enhances cities' capacity to absorb and manage heavy precipitation events. The combined use of blue-green infrastructure (BGI), including green roofs, wetlands, and vegetated corridors, within peri-urban and urban systems is increasingly recognized as an effective strategy for mitigating hydrometeorological extremes and improving local microclimates. These strategies are supported by advanced hydrological and thermal dynamic analyses, including water flow modeling and flood-risk mapping. To ensure effective spatial deployment of GI components, urban planning employs tools such as surface urban heat island (SUHI) mapping and demographic overlays, which help ensure that interventions are both environmentally sound and socially equitable (Czyza & Kowalczyk, 2024).

An additional emerging concept related to GI is “hybrid infrastructure.” The importance of hybrid infrastructure as a realistic and cost-effective approach to climate change adaptation and disaster risk mitigation is gaining wider recognition (Mulligan et al., 2020; UNDRR, 2021). Hybrid infrastructure refers to the integration of blue, green, and grey infrastructure to reduce disaster risk and enhance climate resilience, effectively combining the strengths of natural and engineered systems (UNDRR, 2021). Examples include drainage networks, seawalls, green roofs, and bioswales. This approach not only enhances protective functions and reduces long-term maintenance costs but also supports the sustainability of built environments by requiring interdisciplinary collaboration, particularly in urban NbS applications such as green roofs and permeable pavements.

In the literature, GI is defined as an integrated and coherent system of multifunctional green areas that connect urban and rural landscapes through both biophysical and social infrastructure (Nahyan, 2017). This multifunctionality is particularly significant in the context of diverse global climatic challenges, as GI needs to be adapted to local environmental conditions to maximize its resilience and the delivery of ecosystem services (Andersson et al., 2019). For example, GI design, function, and effectiveness vary considerably across different climatic contexts. In temperate climates, GI initiatives often prioritize enhancing urban biodiversity, managing stormwater, and mitigating the UHI effect. The presence of moderate rainfall and seasonal temperature variation in these regions supports the inclusion of a wide variety of plant species and ecosystem types within urban landscapes (see Figure 4). Green roofs and vertical greening are feasible in such areas, provided that building structures meet requirements for load-bearing capacity and durability. Furthermore, the compact urban form typical of many temperate cities offers opportunities for integrating GI within dense city cores, while larger open spaces at the urban periphery can function as infiltration zones and floodplains, contributing significantly to flood risk reduction (Nahyan, 2017).

Figure 4. Designed Plant Communities for different microclimates (URL-2).

In contrast, arid and semi-arid climates present distinct challenges for the implementation of GI. The scarcity of water and high evapotranspiration rates necessitate the selection of drought-tolerant plant species and the application of water-efficient landscaping techniques. In these regions, the design of GI often prioritizes water conservation, soil stabilization, and the creation of microclimates that help to reduce ambient temperatures.

Tropical climates, characterized by high rainfall and humidity, require GI strategies that address rapid vegetation growth, soil erosion, and the management of excess stormwater. In such settings, GI plays a crucial role in flood mitigation, erosion control, and the maintenance of urban green corridors. The integration of BI, including wetlands and urban streams, with green spaces further strengthens cities' capacities to absorb and manage intense precipitation events (see Figure 5).

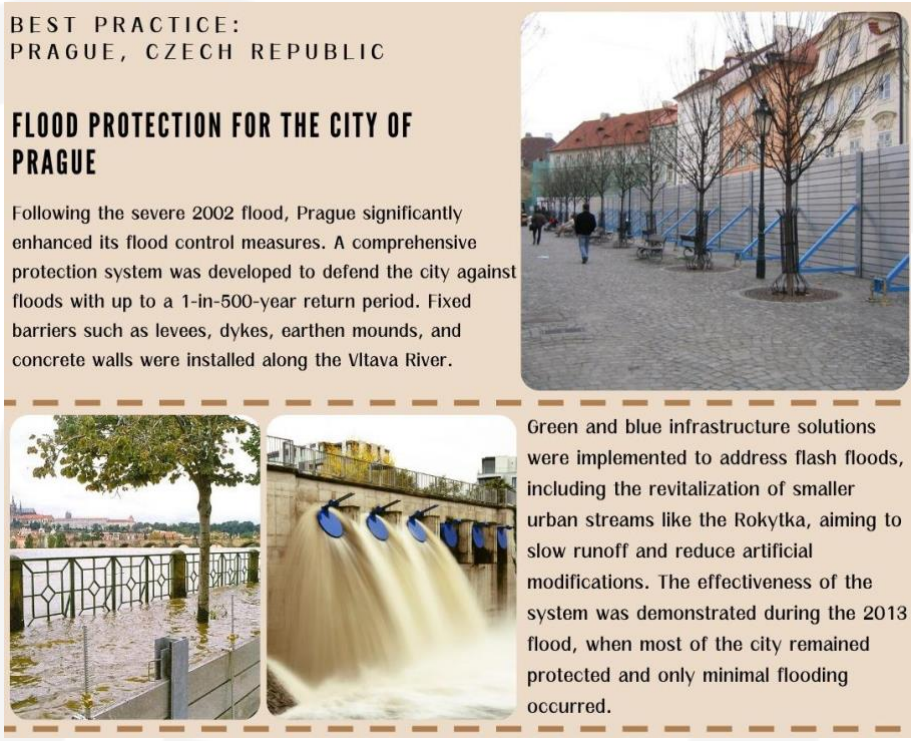

Figure 5. Hybrid infrastructure best practice (URL-3).

Scenario-based planning has become instrumental in assessing the performance of GI. Standardized reference scenarios, which range from fully sealed surfaces to moderately greened landscapes, enable the evaluation of various design strategies and their implications for urban resilience (Kraus & Scharf, 2019). These scenarios support evidence-based decision-making by clearly illustrating trade-offs between impervious surface coverage, green area distribution, and ecosystem service provision.

The geodesign process, which leverages spatial data and participatory planning, facilitates more targeted and proactive interventions in GI. This method aligns ecological objectives with broader urban development goals, which is particularly vital considering increasing urbanization and the associated pressures on natural resources. By addressing the exhaustion of ecosystems' self-regeneration capacities, geodesign supports the maintenance and enhancement of ecosystem services (do Carmo de Lima Bezerra et al., 2022).

Governance plays a critical role in the effective implementation and long-term maintenance of GI. The success of GI initiatives often depends on coordination across different administrative levels and the active involvement of diverse stakeholders. The Stockholm Green Wedges initiative serves as a compelling example of this shift toward collaborative governance. In this case, municipalities and non-governmental organizations worked together to manage green spaces across the metropolitan region, moving beyond isolated conservation efforts toward an integrated, landscape-scale approach (Frantzeskaki et al., 2017). This collaborative framework

embedded ecological values into urban development planning and demonstrated the importance of governance structures that promote horizontal and cross-sectoral integration.

The spatial structure of cities is deeply shaped by their underlying natural environment. Street networks and green areas are often designed to reflect and strengthen ecological conditions. By linking major green spaces; such as parks and urban forests; with street greenery and vegetated corridors, cities can establish coherent ecological networks that enhance both connectivity and urban livability (Skujāne & Spage, 2022). Within these networks, parks and squares function as essential nodes that support biodiversity and provide multiple ecosystem services. The targeted planting of street trees and the development of urban forests serve as critical interfaces between ecological systems and urban life. These elements not only mitigate pollution and heat stress but also contribute significantly to residents' well-being, particularly in underserved or densely populated neighborhoods.

Equity considerations are fundamental to GI planning, yet they are often underemphasized in practice. Unequal access to green spaces can exacerbate existing social vulnerabilities. Strategic interventions, such as urban tree planting and the development of green corridors, offer cost-effective solutions to promote environmental justice and spatial equity. Clemente et al. (2025) highlight that a nuanced understanding of the relationships among street morphology, vegetation types, and social demographics can inform more inclusive and context-sensitive designs (Figure 6). Tailoring interventions to local climatic and ecological conditions ensures that GI does not merely serve aesthetic or ecological functions but also strengthens social resilience and equitable access.

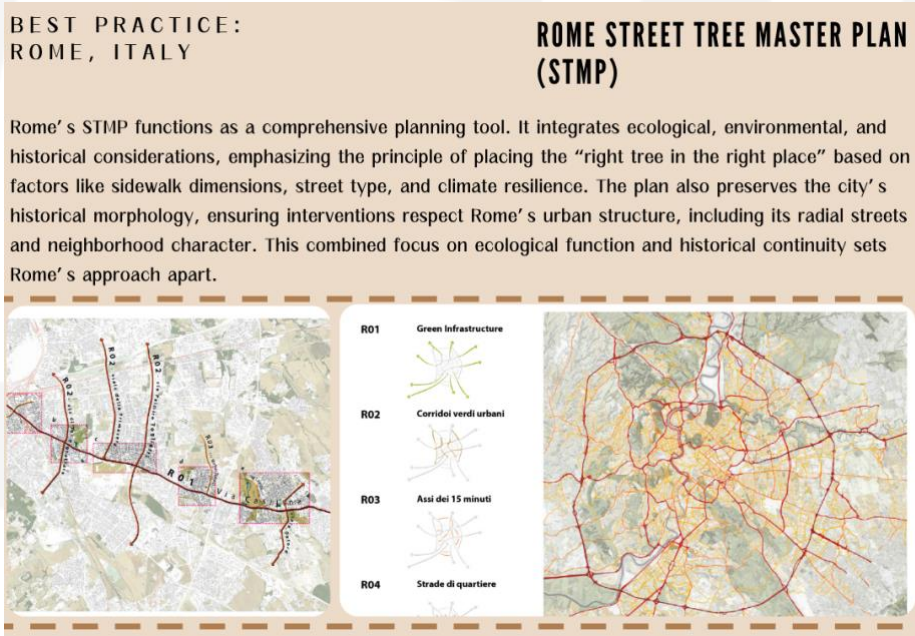

Figure 6. Street tree management plan for Rome (Clemente et al., 2025).

Case studies from Cambodia and Odisha underscore the importance of context-specific governance and investment mechanisms in climate-vulnerable regions. In Cambodia, GI was integrated into rural road development to manage flooding and erosion, illustrating the need for technical standards adapted to local conditions. In Odisha, India, the incorporation of GI into disaster-resilient power systems emphasized the role of risk assessments, policy reviews, and targeted financing in supporting infrastructure that can withstand cyclones and floods.

Globally, the integration of GI into urban planning frameworks is increasingly recognized as a best practice for enhancing resilience to climate-induced disasters. The A Compendium of Good Practices on Disaster Resilient Infrastructure (CDRI & G20 Working Group on DRI, 2024) demonstrates that sectors such as transportation, energy, and water benefit significantly from GI and NbS, both in terms of improved operational performance and long-term economic returns. Additionally, performance-based approaches are gaining prominence, encouraging the systematic evaluation of GI contributions to resilience. These evaluations include strategies such as minimizing new development in hazard-prone areas and enhancing the adaptive capacity of urban systems (Debnath et al., 2022).

The successful implementation of GI across diverse climatic and governance contexts ultimately depends on sustained investments in capacity building and education. The literature consistently emphasizes the importance of interdisciplinary skill development, continuous professional training, and the careful localization of global best practices. Cultivating a professional culture that prioritizes equity, sustainability, and collaborative planning ensures that GI strategies are not only technically effective but also socially legitimate and resilient.

3.3 Connectivity, Habitat Networks, and Biodiversity

Blue-green networks and their connectivity are increasingly recognized as foundational components in disaster-resilient urban planning, particularly within the context of landscape approaches and NbS. Together, these networks form multifunctional landscapes that enhance both ecological connectivity and urban resilience (Amenta & Arena, 2020; do Carmo de Lima Bezerra et al., 2022). The functional integration of green and blue elements plays a critical role in mitigating risks such as flooding and heatwaves while also delivering social and cultural benefits (Amenta & Arena, 2020).

Blue-green corridors function as essential conduits for species migration, water flow, and the exchange of energy and materials across fragmented urban areas (K. Zhang et al., 2025). Designing effective GBI requires interdisciplinary collaboration among experts in hydrology, geodesy, geography, and demography (Czyza & Kowalczyk, 2024). These corridors are designed not only for ecological restoration but also to support spatial organization that reduces disaster risks, enhances biodiversity, and improves human well-being (Başoğlu Acet et al., 2024).

Ecological corridors connect isolated habitat patches, sustain material flows, support biodiversity, and facilitate species movement. Such networks are essential for maintaining

genetic diversity and the continued provision of ecosystem services. The literature increasingly highlights the importance of creating, restoring, and enhancing habitat connectivity in urban contexts as a strategy to counteract habitat fragmentation, which is an inevitable consequence of urbanization (Dubovik et al., 2022). Planners employ stepping stones and interconnected green spaces, including green roofs, street trees, and parks, to encourage species dispersal and facilitate adaptation to environmental changes (Clemente et al., 2025; K. Zhang et al., 2025). Expanding urban tree cover and incorporating diverse vegetation types not only support ecological resilience but also contribute to climate adaptation by providing shade, regulating temperature, and enhancing evapotranspiration.

Habitat networks deliver a wide range of ecosystem services beyond biodiversity protection, including air purification, water infiltration, soil stabilization, and microclimate regulation. These benefits are amplified when GI is functionally and spatially connected to BI elements such as rivers, wetlands, and stormwater management systems (Karamoutsou et al., 2024). Case studies, including Oslo's urban stormwater management initiatives, demonstrate how integrated blue-green networks can effectively address infrastructural and ecological challenges (Karamoutsou et al., 2024). Research conducted in cities like Jiaozuo indicates that spatially well-connected habitat networks correspond to higher resilience against environmental stresses (K. Zhang et al., 2025). This spatial perspective is crucial for prioritizing interventions and designing networks that maximize ecological benefits.

Nature-based interventions such as renaturing urban watercourses, creating rain gardens, and implementing catchment forestry illustrate the multifunctionality of habitat networks. These actions strengthen ecological connectivity while also delivering co-benefits such as carbon sequestration, flood mitigation, and recreational opportunities. Their effectiveness is further enhanced when embedded within broader urban planning frameworks that prioritize ecological processes and social well-being (Moraci et al., 2025a; Gholami et al., 2024). Connectivity in blue-green networks relies not only on physical linkages but also on functional integration. Spatial attributes such as road density, building concentration, drainage infrastructure, and proximity to water bodies significantly influence the effectiveness of blue-green networks in mitigating disaster risks (Z. Zhang et al., 2023; Czyza & Kowalczyk, 2024). By analyzing these spatial indicators, planners can identify critical nodes and corridors, improve ecosystem service flow, and reduce hazard vulnerability. This approach underscores the broader application of geospatial analysis in the design and governance of climate-resilient landscapes (Han & Liu, 2025; Z. Zhang et al., 2023). Localized projects, such as the Hatirjheel Lake redevelopment, illustrate how context-specific knowledge and cultural insight enhance the planning and effectiveness of GBI (Nahyan, 2017).

Designing green-blue corridors requires the integration of ecological, hydrological, and socio-cultural considerations. These corridors should support biodiversity, manage urban water cycles, and provide cultural and recreational value. Their spatial configuration must reflect sustainable design principles that minimize resource consumption while honoring the historical, aesthetic, and cultural significance of the built environment (Sugiyama et al., 2024). This approach aligns

with international frameworks such as the Paris Agreement (United Nations, 2015a) and the UN's 2030 Agenda for Sustainable Development (United Nations, 2015b), both of which advocate for adaptive and inclusive urban design.

Land reservation for GBI within urban plans, combined with systematic monitoring, is essential for translating strategic objectives into tangible outcomes (Bohman et al., 2020). For example, dividing urban landscapes into subsystems; gray (leisure), yellow (provision), green (GI), and blue (BI); enables planners to balance ecological, social, and infrastructural needs within a unified framework (do Carmo de Lima Bezerra et al., 2022). Emerging technologies and big data platforms allow planners to quantify and spatially model ecosystem services across urban and peri-urban areas, integrating ecological datasets with economic models to inform corridor planning (Moraci et al., 2025b). This supports regenerative urban systems aligned with circular economy principles by promoting closed-loop processes and resource efficiency (Munonye & Ajonye, 2024).

The use of high-resolution geospatial data, including OpenStreetMap and digital elevation models, helps identify gaps in connectivity and prioritize locations for corridor development (Pappaccogli et al., 2025a). Smart city tools and digital platforms further facilitate adaptive management and iterative improvement of corridor performance.

Long-term success in ecological connectivity also requires participatory governance. Involving communities in the planning, implementation, and stewardship of habitat networks ensures responsiveness to local values and fosters public ownership. Technologies such as digital twins, exemplified in the case of Imola (Gholami et al., 2024), support the ongoing monitoring and optimization of GI, enabling adaptive management. Stakeholder involvement guarantees that interventions are contextually relevant, socially inclusive, and environmentally effective.

NbS embedded within blue-green networks provide significant co-benefits beyond DRR. These include improved air and water quality, enhanced biodiversity, and strengthened social cohesion (Amenta & Arena, 2020). However, challenges remain in governance, funding, and cross-sectoral coordination. Frantzeskaki et al. (2017) caution that short-term, project-based funding models may compromise the continuity and effectiveness of such initiatives. Therefore, strategic, long-term investment is essential to sustain BGI initiatives and fully realize their potential. In conclusion, blue-green networks and their connectivity embody a multidisciplinary, spatial, and adaptive planning paradigm for resilient cities. By aligning ecological processes with urban infrastructure, cities can create landscapes that are both protective and regenerative, serving the needs of people and nature alike.

3.4 Flood Mitigation & Stormwater Management

GI plays a central role in mitigating urban flood risks by absorbing, storing, and gradually releasing stormwater. These functions help reduce peak runoff and alleviate pressure on conventional grey infrastructure systems such as pipes and culverts (Czyza & Kowalczyk, 2024). Urban flood

mitigation is increasingly regarded not merely as an engineering challenge but as a core component of ecological planning and DRR. GI elements such as wetlands, riparian buffers, urban forests, and permeable surfaces stabilize soil, increase infiltration, and filter pollutants, contributing not only to flood risk reduction but also to improved water quality and overall ecosystem resilience (Marzouk & Azab, 2024; Karamoutsou et al., 2024).

Flood mitigation efforts benefit significantly from landscape-based approaches that align with natural topography, ecosystem dynamics, and watershed behaviors. By understanding water flow mechanisms and regional watershed characteristics, planners can identify flood-prone areas and prioritize interventions that maintain or restore natural hydrological functions. Datta (2020) explains how watershed analysis informs land classification for development and conservation, guiding infrastructure placement and supporting ecologically sustainable planning. This approach prevents the intensification of flood risks and ensures the preservation of essential ecosystem services. Adaptive design principles are integral to these strategies, allowing urban systems to respond flexibly to evolving flood hazards. Pang and Deal (2024) describe a phased approach to flood risk management, including retreat from high-risk areas, implementation of mitigation measures, and construction of control infrastructure. Each phase undergoes cost-benefit analysis and is evaluated using landscape performance tools to ensure economic viability and long-term effectiveness. These strategies emphasize protecting, restoring, and sustainably managing both terrestrial and aquatic ecosystems (CDRI & G20 Working Group on DRI, 2024). Integrating multifunctional ecological networks allows cities to maintain hydrological balance while simultaneously enhancing biodiversity and social well-being (do Amaral & de Lima Bezerra, 2024).

Incorporating GBI into urban water systems enables dual functionality: managing stormwater while restoring ecological cycles. The United Nations Environment Programme (2022) advocates for Eco-DRR strategies that are tailored to each city's hydrological and ecological contexts. For example, a study in Dordrecht (Sophronides et al., 2016) shows that enhancing building resilience and emergency preparedness can be more cost-effective than constructing new flood defenses, particularly in areas where engineered solutions have limited returns. NbS such as rain gardens, bioswales, and restored floodplains are particularly effective when strategically guided by hydrological modeling and risk mapping. Weighted overlay analysis, as demonstrated by Maru et al. (2025), identifies high-risk zones and supports prioritizing GI investments based on flood vulnerability and land-use compatibility.

To operationalize these strategies, urban landscape planning must rely on robust metrics and spatial analyses. Tools such as resilience indices, watershed assessments, and geodesign platforms enable the identification of vulnerabilities and the measurement of intervention effectiveness (Mitrovic et al., 2023; Datta, 2020). Mapping tree density and analyzing infiltration rates provide empirical evidence for selecting locations for vegetated GI (do Amaral & de Lima Bezerra, 2024). Incorporating climate projections and consulting climate experts ensure that landscape-based strategies remain effective under various future scenarios. The use of resilience scorecards and geodesign tools further strengthens capacity to assess vulnerabilities

and evaluate proposed strategies, supporting evidence-based decision-making (Pang & Deal, 2024). Mitrovic et al. (2023) highlight the importance of quantifying resilience to guide modular approaches in landscape planning, ensuring interventions are both targeted and effective. This quantitative foundation is complemented by qualitative insights from community engagement and spatial knowledge, which are crucial for identifying local flood risks and tailoring mitigation strategies (Davis, 2020).

Built case studies illustrate how cities are implementing GI in practice. Hunter's Point South Park in New York integrates floodable grasslands and wetlands, while Oro Loma's horizontal levee in California combines flood mitigation with wastewater treatment and habitat creation (Shi, 2020). These multifunctional projects showcase a range of benefits from stormwater control and biodiversity enhancement to recreation and public health improvements. Their success demonstrates how adaptive design, rooted in landscape ecology, supports both human and environmental resilience. Key GI elements such as parks, green roofs, urban forests, and permeable surfaces collectively reduce surface runoff, improve infiltration, and enhance water quality. Blue-green roofs, for example, retain and detain stormwater through evaporation and transpiration, thereby reducing volumes entering drainage systems and mitigating flood risks (Karamoutsou et al., 2024). Restorative practices like mangrove reforestation and dune stabilization buffer urban areas against flooding while enhancing ecosystem health and resilience (Marzouk & Azab, 2024). Urban renaturation projects, as demonstrated by the URBAN GreenUP project, show practical applications of these concepts. By integrating multidisciplinary expertise, cities have restored natural hydrological cycles, strengthened green space connectivity, and improved their capacity to absorb and manage stormwater (Sánchez et al., 2023).

While flood mitigation addresses immediate hydrological risks, stormwater resilience emphasizes systemic and proactive capacities to manage water volume fluctuations over time, particularly in the context of intensifying climate extremes. As cities face more frequent and severe rain events, integrated water management solutions that enhance both flood protection and long-term ecological resilience are increasingly essential. Stormwater resilience is becoming a fundamental pillar of climate-responsive urban adaptation. Cities now require infrastructure that can absorb, filter, and convey stormwater while providing social and environmental co-benefits. This vision is embodied in blue-green networks, interconnected systems of natural and engineered elements such as urban wetlands, green corridors, water plazas, and floodable parks, which regulate water flows and reduce flood exposure (İzmir Metropolitan Municipality, 2020; Burda & Nyka, 2023). These networks not only store excess water but also improve urban livability and support biodiversity.

Effective stormwater management relies on multifunctional landscapes integrating hydraulic, ecological, and social functions, with NbS at the core. Decentralized systems like rain gardens and green streets use natural processes such as infiltration, filtration, and evapotranspiration to manage water sustainably. Structural elements including reinforced quays, elevated earth mounds, and retention basins are complemented by adaptive public spaces like floating squares,

flood-resistant boardwalks, and recreational water edges (Dubovik et al., 2022). These interventions improve water quality, reduce pollution, and create habitats for native species, demonstrating how water-resilient design serves both environmental and social systems.

The success of stormwater resilience measures depends on their integration into broader urban planning frameworks. Municipal strategies are evolving to incorporate adaptive governance and climate-conscious zoning. For instance, the İzmir Green Infrastructure Strategy integrates flood risk reduction within citywide plans for transport, energy, and land use, ensuring coherence between ecological goals and spatial development (İzmir Metropolitan Municipality, 2020). Measures include zoning high-risk areas for retention or ecological use, safeguarding water quality during emergencies, and improving public access to safe water infrastructure.

Advances in urban informatics are transforming stormwater planning by integrating sophisticated technologies into decision-making processes. RS, GIS, and data modeling now support real-time monitoring of GI and ecosystem services, enabling evidence-based resource allocation and more adaptive management strategies (Moraci et al., 2025a; 2025b). Scenario planning models, such as those developed by Wang et al. (2022), allow planners to simulate the impacts of adaptation strategies under diverse climate conditions, facilitating a more comprehensive assessment of potential outcomes. Another significant tool is the Netherlands Hydrological Instrument[3], which serves as a platform for integrated water management and policy analysis. This tool enables stakeholder-informed decision-making by combining scientific modeling with scenario analysis, helping planners map high-risk areas, evaluate infrastructure performance, and formulate responsive stormwater policies (Sophronides et al., 2016).

As challenges related to stormwater increase due to intensifying rainfall, rapid urbanization, and the expansion of impervious surfaces, cities are urged to shift from conventional grey infrastructure toward decentralized, nature-based systems. In this context, low-impact development (LID) and the broader sponge city paradigm have emerged as transformative approaches for enhancing urban climate resilience. LID represents a strategic retrofit approach designed to alleviate pressure on traditional stormwater infrastructure while increasing overall climate adaptability. At its most ambitious, LID aims to restore pre-development hydrological regimes by achieving hydrologic neutrality and emulating natural water cycles through biomimicry (Eckart et al., 2017).

The application of LID is widespread in the United States, where the term is often used interchangeably with GI. The EPA (U.S. Environmental Protection Agency) actively promotes and mandates LID practices for municipal separate storm sewer system permits, integrating these measures into mainstream regulatory frameworks (EPA, 2022). LID emphasizes decentralized, small-scale hydrological interventions designed to replicate pre-development water cycles. Core features of this approach include minimizing impervious surfaces, encouraging source-level

[3] For further information please visit https://nhi.nu/en/

infiltration, and enhancing evapotranspiration. Specific LID practices encompass rain barrels and cisterns for water harvesting, green roofs for stormwater retention, permeable pavements for infiltration, and biotreatment systems such as bioswales and infiltration trenches (EPA, 2022).

While LID focuses on site-level interventions, the sponge city model extends these principles to an urban scale. Initially piloted in China, this model envisions urban environments capable of absorbing, storing, and gradually releasing stormwater, thereby mimicking the natural sponge-like capacity of landscapes (Li & Kim, 2022; İzmir Metropolitan Municipality, 2020). The sponge city strategy aims to improve stormwater capture and reuse, enhance evapotranspiration, and increase infiltration across metropolitan areas (Hampshire & Sipes, 2019). The construction guideline developed by China's State Council in 2014 identifies six strategies for sponge cities: infiltration, stagnation, storage, purification, utilization, and discharge of stormwater (Li & Kim, 2022).

However, several limitations hinder the widespread implementation of sponge city concepts. According to Li et al. (2017), these challenges can be categorized as technical, physical, financial, and regulatory. Technical and physical obstacles include uncertainties related to project outcomes, standards, techniques, and operational procedures. Additionally, urban land scarcity poses significant constraints, as allocating space for sponge city measures becomes difficult in densely populated areas. Financial barriers arise from insufficient funding resources and uncertainties regarding the economic returns of large-scale sponge city investments. Regulatory challenges are compounded by the absence of comprehensive local regulations and specific permitting processes tailored to sponge city practices.

3.5 Urban Heat Island (UHI) Mitigation

As cities adapt to the escalating impacts of climate change, UHI mitigation has emerged as a central pillar of climate-sensitive urban planning. UHI describes the localized warming of urban environments resulting from heat-absorbing materials, high building densities, and the reduction of vegetative cover (Rizwan et al., 2008; Pappaccogli et al., 2025a; Pappaccogli et al., 2025b). The magnitude of UHI is closely linked to a city's size and population (Oke, 1967). Rizwan et al. (2008) emphasize that indirect solar heating, influenced by urban fabric and material properties, along with anthropogenic heat emissions, are the principal drivers of UHI.

Mitigating UHI effectively requires a multifaceted approach that integrates ecological planning, spatial strategies, and NbS to create cooler and more livable urban environments. Broadly, mitigation measures can be categorized into reducing anthropogenic heat release, optimizing roof design, and incorporating other design elements such as humidification and photovoltaic canopies (Rizwan et al., 2008). A fundamental strategy involves integrating GI elements like green roofs, urban forests, street trees, and vegetated facades (Pappaccogli et al., 2025a). Urban greening contributes to lowering temperatures, thereby mitigating UHI impacts (UNDRR, 2021; Gago et al., 2013).

Chen et al. (2020) analyzed the thermal characteristics of local climate zones in high-density urban areas using multi-source satellite data and found that areas with higher vegetation cover exhibited lower land surface temperatures. Urban green spaces also moderate temperature fluctuations caused by building materials, stabilizing local microclimates (Gago et al., 2013). Cao et al. (2010) demonstrated that the size, shape, and design of parks significantly influence their cooling effects, with larger parks generally providing greater temperature reductions. Strategically planned vegetation can further reduce building heating and cooling demands through thermal insulation benefits (Gago et al., 2013). Expanding tree canopies in heat-vulnerable, high-density neighborhoods can substantially reduce urban temperatures and mitigate extreme heat impacts, especially for vulnerable populations (Clemente et al., 2025). The careful selection of tree species and their integration into street design must account for climate resilience and local environmental conditions. The comparative analysis of BGI cartographic models with surface UHI data highlights the potential of targeted GI interventions to alleviate localized heat stress, particularly in densely populated or socioeconomically vulnerable neighborhoods (Czyza & Kowalczyk, 2024).

The spatial configuration and typology of cities, including building density, street orientation, and GI integration, play critical roles in shaping local microclimates (see Figure 7). The UHI effect is strongly modulated by urban form, particularly the extent of impervious surfaces and vegetation distribution. Pappaccogli et al. (2025a) note that cities with high building density and limited green spaces, such as Milan, experience more severe thermal anomalies compared to less dense urban areas. Elwakil et al. (2023) argue that the accessibility, size, and connectivity of GI must be adapted to the specific urban context to maximize cooling benefits. Integrating green corridors and strategically located parks facilitates airflow, disperses heat, and enhances urban comfort, while simultaneously supporting circular production cycles that become more tangible and accessible to residents. Hybrid solutions, such as combining green roofs with permeable surfaces, are particularly effective in dense urban contexts where space constraints and heritage protections limit more extensive interventions. These insights underscore the importance of city-specific adaptation strategies that consider localized microclimatic responses to urban morphology.

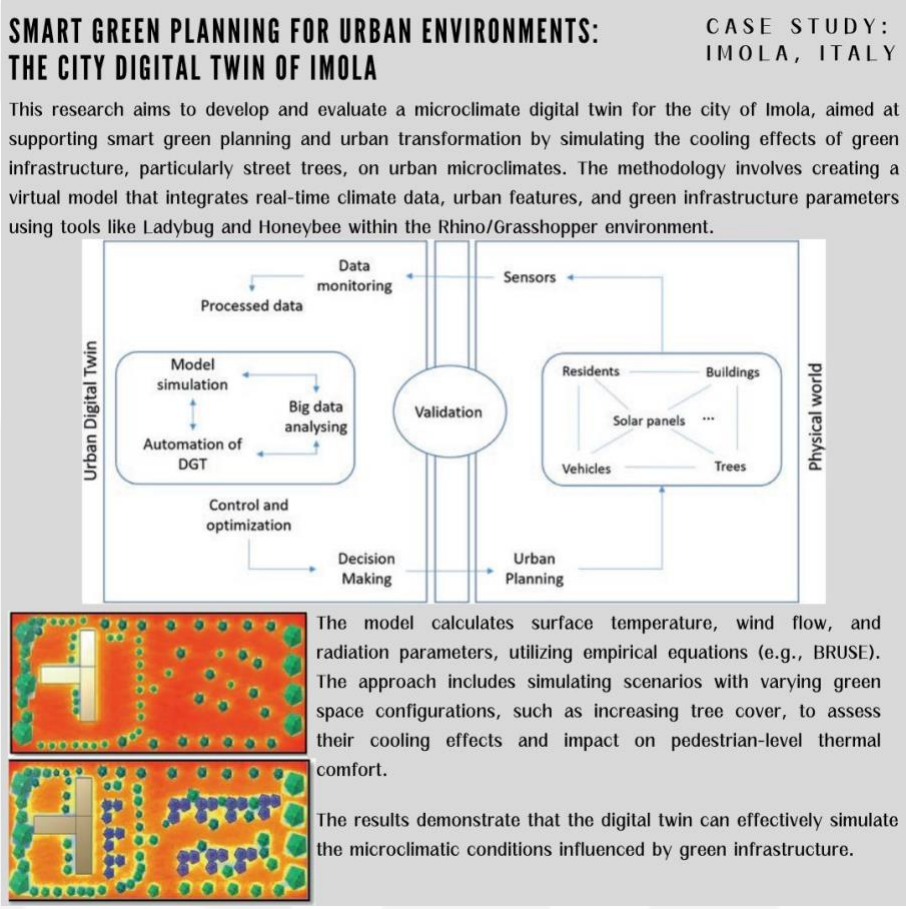

Figure 7. A digital twin to simulate urban microclimate (Gholami et al., 2024).

3.6 Refuge Green Spaces (RGS)

RGSs can be defined as urban green spaces designed to mitigate harm and provide areas for evacuation and temporary shelter during and after natural disasters (Cao et al., 2022). These spaces are equipped with essential emergency services, including access to fresh water and electricity (Liu et al., 2022). RGSs play a pivotal role in enhancing urban resilience, especially against earthquakes. When effectively integrated into urban form, they ensure accessible and equitable distribution of open spaces during emergencies, a critical need in high-density urban areas (see Figure 8).

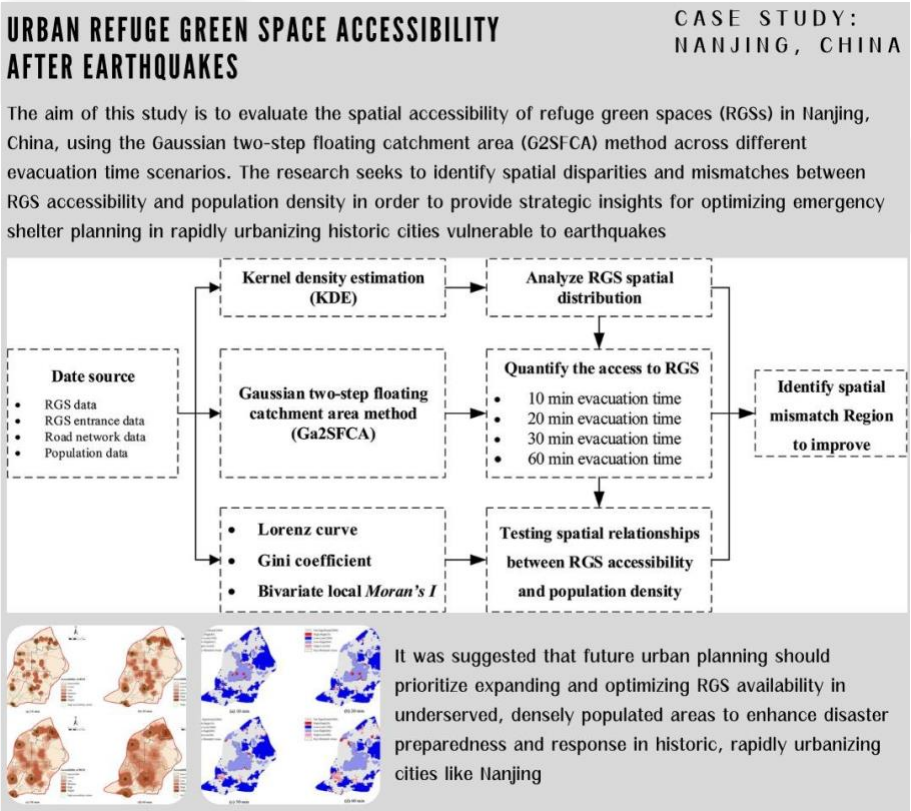

Figure 8. Urban refuge green space accessibility analysis (Liu et al., 2022).

However, uneven urban development characterized by dense and irregular layouts can severely limit access to RGSs, particularly in disaster-prone zones (Liu et al., 2022). Historic cities face additional challenges due to spatial constraints that hinder the provision of emergency infrastructure, evacuation routes, and temporary shelters (Li et al., 2024). Liu et al. (2022) highlight that in Nanjing, China, densely populated urban centers are often underserved because of limited green space availability and complex urban fabrics, which make constructing large RGSs difficult without compromising historical heritage. Furthermore, top-down disaster planning frequently overlooks local informal social networks and indigenous knowledge, which are critical for effective disaster response (Li et al., 2024). As emphasized by Wei et al. (2020), community-specific refuge requirements and social dynamics must be carefully examined when selecting and designing shelter sites. Therefore, achieving spatial equity and considering demographic dynamics are essential when planning GI.

Multifunctional spaces contribute to earthquake resilience by integrating disaster response functions into daily use, thereby enhancing their utility, adaptability, and community integration. These spaces serve dual purposes: they provide venues for recreation, social interaction, and environmental services under normal conditions while transforming into evacuation areas, shelters, and emergency access points during and after earthquakes (French et al., 2019). Urban green spaces thus offer not only immediate post-disaster assembly and sheltering but also support ecological and psychological well-being for urban populations under stress (Kabisch et

al., 2015). Design strategies incorporating resilient, multifunctional open spaces optimize their usefulness across both every day and crisis contexts (Allan & Bryant, 2010).

Key criteria for selecting urban green spaces as evacuation areas include multifunctionality, accessibility, availability of essential utilities such as functional water and road networks, site characteristics like size and distribution, and security considerations including proximity to hazardous points (Alawi & Chu, 2024; Paramita, 2015; Li et al., 2013). In a study utilizing multi-criteria decision-making through analytical hierarchy process (AHP) and GIS, Aman and Aytac (2022) identified safe post-earthquake assembly areas for Bağcılar district in Istanbul. They included geomorphological and hydrogeological factors in their analysis to ensure safety during seismic events. Factors such as slope, spatial size, and capacity were found to significantly influence the ability of these spaces to accommodate displaced populations safely. Villagra-Islas and Alves (2016), in their study on landscape attributes in Concepción, Chile, revealed that water availability determines open space use in emergencies, as water becomes essential for coping and recovery when access to resources is disrupted. Water is prioritized for personal collection and use, underscoring its importance in the functionality of refuge sites.

The literature review by Alawi and Chu (2024) underscores the increasing recognition of public open spaces in disaster response and mitigation. However, they also highlight a lack of clear guidance for planners and designers on integrating disaster resilience into public open space planning. For instance, Turkish planning legislation offers limited direction on emergency assembly and temporary shelter areas, and higher-level environmental plans often lack detailed strategies for these functions (Çınar et al., 2019). Additionally, gaps between policy and practice can undermine effective and sustainable implementation. After the 2011 Great East Japan Earthquake, GI initiatives such as coastal protection forests and new green spaces were reconstructed, yet these often led to unintended ecological damage, including the loss of unique ecosystems and wetlands (Kurosawa, 2021). Kurosawa (2021) further criticized that despite official promotion of Eco-DRR and GI, these concepts were insufficiently integrated into actual reconstruction projects.

In Japan, the designation of green open spaces as emergency refuge zones, supported by public facilities, sanitation infrastructure, and accessibility plans, has enhanced urban preparedness. Following the Great Kanto Earthquake in the 1920s, RGSs gained prominence, and urban parks began to be integrated into disaster prevention systems (Cao et al., 2023). The Tokyo Metropolitan Regional Disaster Prevention Plan, for example, designates many metropolitan parks as large-scale rescue and evacuation operation bases and helicopter operation bases. These parks are equipped with facilities to support citizens' basic needs during post-disaster periods (Figure 9). The Tokyo Rinkai Disaster Prevention Park serves as a key example, functioning as the main disaster prevention hub for the Tokyo Metropolitan Area. It houses emergency response facilities, including local disaster management headquarters and organizations responsible for collecting disaster-related data and planning emergency actions (URL-4).

Figure 9. Emergency services in disaster prevention parks of Tokyo (URL-5).

4. TECHNOLOGICAL TOOLS

Digital tools and data-driven approaches have become foundational components of disaster-resilient and adaptive urban planning. The integration of GIS, RS, AI, and simulation models enables urban planners and disaster managers to assess vulnerabilities, anticipate hazards, and implement timely, effective responses with greater accuracy and scalability (Acosta-Fernández et al., 2025; Samaei & Ghafari, 2025). The capacity to synthesize real-time and historical data streams supports scenario analysis, resource allocation, and adaptive decision-making, all of which are critical in rapidly transforming urban contexts. Advanced technologies such as deep learning and multi-sensor fusion facilitate fine-grained resilience classification and contribute to the design of robust climate adaptation strategies. GIS, in particular, enhances spatial awareness by aggregating and visualizing diverse data sets, thereby enabling a comprehensive systems-level understanding of risks and opportunities (Taylor et al., 2020).

These digital capabilities are further bolstered by spatial decision support tools that allow stakeholders to simulate intervention outcomes, compare risk scenarios, and integrate social, environmental, and economic dimensions into holistic planning processes (Dubovik et al., 2022). User-centered platforms, such as the Nature-based Solutions Selection and Visualization Tool (NbS-SVT) [4], facilitate interactive exploration of hazard data, making complex information more accessible to both experts and the broader public (see Table 2) (Dubovik et al., 2022). In parallel, urban informatics and big data analytics are increasingly employed to detect and map GI, providing an evidence-based foundation for material selection, spatial configurations, and site-specific GI planning.

Practical applications of these technologies are also evident in mobility planning and climate-sensitive urban design. Innovations such as mobility as a service (MaaS) and the "15-Minute City" framework illustrate how integrated, data-driven systems can reduce unsustainable transportation patterns, enhance equity in urban resource distribution, and support progress toward the Sustainable Development Goals (Lima et al., 2023). These models exemplify a broader shift toward intelligent, climate-responsive urban systems that adaptively address environmental, infrastructural, and social stressors.

[4] For further information please visit https://unalab.eu/en/ict-tools-nbs-monitoring-and-data-management

Table 2. Examples of digital tools (URL-5 & URL-6).

Tool Name	Theme/ Focus	Description
City Performance Monitor	Climate change adaptation & mitigation	Provides graphical features to manage and visualize performance indicators related to the urban conditions and the social and environmental impact of the NBS.
GREENPASS	Climate resilience	A Software-as-a-Service (SaaS) tool for evaluation, optimization and certification of climate-resilient urban planning and architecture
GIS Vulnerability Web Map	Climate vulnerability	Integrates various factors, including vegetation, land use, building materials, and social vulnerability data, such as the Index of Multiple Deprivation (IMD), to identify areas more susceptible to climate hazards.
iSCAN	Energy & architecture	A data analytics platform that enables building engineers to analyse in-use building data and reduce the performance gap.
NBS Simulation Visualisation Tool (SVT)	Climate change adaptation & mitigation	A map-based view that enables users to compare baseline (no NBS) conditions with the forecasted impacts of different proposed NBS strategies, incorporating anticipated local population and climate changes in future scenarios.
TN GAIN	Biodiversity	Visualises the impact of urban biodiversity restoration for city revitalization. TN GAIN uses macro-ecological AI models that integrate satellite remote sensing with species/vegetation distribution data.
The Komunidad Climate Action Suite	Climate change adaptation & mitigation	An all-in-one platform that integrates tools for climate risk assessment, sustainability performance tracking, and ESG data reporting
Para	Climate & architecture	Digital twin and building analytics platform that helps to make assets more energy-efficient, cost-effective, and sustainable. Provides real-time monitoring of environmental parameters and carbon emissions at the equipment level, floor level, and by functional area.

However, challenges related to data quality, accessibility, and integration continue to constrain the full operationalization of these tools. Interoperability between platforms remains limited due to incompatible data formats and lack of standardized protocols (Han & Liu, 2025). This problem is compounded by inadequate training among practitioners and municipal personnel, which hinders effective use of advanced tools (Ebrahim, 2025). Addressing these technical and institutional gaps will require long-term investment in education, infrastructure, and collaborative research.

4.1 GIS and RS for Ecological Planning & Risk Assessment

GIS and spatial analysis represent foundational technical competencies in resilient ecological planning, enabling the collection, processing, and interpretation of spatial data essential for disaster management and environmental assessments. GIS facilitates the creation, storage, editing, and analysis of geographically referenced information, supporting digital representations

of real-world phenomena and the simulation of design outcomes based on spatial relationships (Davis, 2020). These capabilities underpin informed decision-making by enabling hazard modeling, risk mapping, and resource allocation in increasingly complex urban contexts.

The reliability of these systems depends significantly on robust data processing and cleansing practices. For example, in fragility mapping, removing incompatible or implausible building data improves the accuracy of subsequent spatial analyses and strengthens the foundation for disaster preparedness (Choi & Song, 2022). Spatial analysis transforms raw datasets into actionable insights by overlaying and evaluating layers such as land use, building footprints, and hydrological networks. These interactions reveal critical spatial patterns, such as flood-prone zones near impermeable surfaces, guiding targeted interventions using tools like flood risk indexes (Maru et al., 2025). Advanced methodologies, including machine learning and multi-criteria decision-making, further enhance predictive capacities and offer robust frameworks for urban resilience (Eikelboom & Janssen, 2015).

GIS also plays a critical role in assessing the environmental impacts of planning decisions. When integrated with life cycle assessment (LCA), GIS enables scenario analysis to compare construction materials and design alternatives in terms of emissions, durability, and resilience (Li et al., 2021). This integration links urban design choices to broader sustainability objectives, aligning technical decisions with environmental goals. Nonetheless, accuracy and interoperability of geospatial data remain ongoing challenges, underscoring the need for standardized protocols and improved training for emergency responders and planners (Ebrahim, 2025). The spatial variability of climate-related hazards, including wind and heat, is often shaped by urban morphology, requiring high-resolution data models to capture localized risk conditions, especially in heterogeneous urban landscapes (Gholami et al., 2024).

The application of GIS extends to strategic planning for emergency infrastructure. GIS-based multi-criteria analyses have been used to identify optimal locations for green spaces serving as earthquake evacuation areas, considering factors such as proximity to risk zones, terrain, and accessibility (Paramita, 2015; Li et al., 2013). Integrating these spatial factors ensures that ecological interventions, such as green buffers or ecological protection units, are both technically sound and socially relevant (Datta, 2020; do Amaral & de Lima Bezerra, 2024).

RS and unmanned aerial vehicles (UAVs) significantly improve the temporal and spatial resolution of data used in resilience planning. These technologies support real-time monitoring, damage assessments, and long-term evaluations of ecological performance. By integrating RS indicators such as NDVI and leaf area index (LAI) with GIS datasets, planners can monitor vegetation health, material degradation, and the effectiveness of GI in delivering ecosystem services (Moraci et al., 2025b). Furthermore, platforms like NASA's SRTM DEM and the Global Surface Water dataset provide accurate terrain analysis and water dynamics modeling, supporting flood risk assessments and climate adaptation strategies (Onaopemipo Akintola, 2024).

Drones equipped with high-resolution sensors enable rapid assessments and post-disaster response in otherwise inaccessible regions. Their integration with AI and machine learning facilitates predictive modeling of erosion, shoreline changes, and other geohazards using data from Internet of Things (IoT) and bathymetric sources (Samaei & Ghahfarokhi, 2023). The combined use of RS, hydrological data, and spatial modeling techniques advances GBI planning by identifying optimal placement strategies for resilience-enhancing features (Czyza & Kowalczyk, 2024). Digital terrain models enable fine-grained analysis of slope, runoff, and groundwater dynamics, all critical factors in designing climate-sensitive infrastructure.

Participatory planning, integrated with geospatial technologies, strengthens disaster resilience by incorporating local knowledge and enhancing transparency. Tosan et al. (2025) emphasize that public participation in water resource management, supported by participatory GIS tools, enhances community ownership and the effectiveness of response strategies. Institutional coordination and the dissemination of risk information, as promoted by UNISDR (2015), ensure that these tools inform inclusive and science-based DRR strategies.

Spatial tools have proven particularly effective in data-scarce environments. For instance, in the Sif Oidak District, spatial modeling informed community-led planning processes, demonstrating the potential of these approaches even in resource-constrained contexts (Pang & Deal, 2024). Smart design platforms and geodesign frameworks enable stakeholders to co-create solutions, enhancing disaster management through collaborative, digitally supported design processes (Quan et al., 2019). Transitioning from 2D to 3D representations allows for more accurate depiction of complex terrains, an essential advancement for ecological planning in diverse topographies (Li et al., 2022).

Finally, spatial indicators are increasingly utilized to assess ecological resilience, including metrics such as forest biomass and vegetation structure, in the context of disturbance and recovery cycles. Risna et al. (2023) underscore the challenge of establishing measurable thresholds for resilience monitoring, reinforcing the necessity for spatially accurate and technically sophisticated assessment tools.

The GIS software market continues to evolve as a critical asset in disaster risk management and ecological planning, offering enhanced capabilities for data integration, predictive modeling, and spatial decision-making. As a global leader, ESRI supports disaster management efforts through its Disaster Response Programme, providing advanced GIS solutions that enable real-time data monitoring, situational awareness, and spatial analysis across all phases of the disaster lifecycle, from preparedness and response to recovery and mitigation. As GIS and RS technologies continue to advance, ongoing training and workforce development will be crucial to ensure that these innovations translate into actionable resilience strategies (Bano et al., 2025).

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4.2 Scenario Planning and Risk Assessment

Scenario planning and simulation constitute structured methodologies essential for anticipating, modeling and responding to complex and uncertain hazards. The increasing unpredictability and frequency of disasters, driven by climate change and rapid urbanization, require robust tools capable of integrating multiple variables and capturing dynamic socio-ecological conditions (R. Zhang et al., 2025). Instead of focusing solely on predicting specific events, scenario planning emphasizes analyzing cascading impacts and system interdependencies, enabling stakeholders to evaluate potential interventions proactively (Chen et al., 2023; Rezvani et al., 2023).

Simulation technologies, particularly when integrated with GIS, support the incorporation of critical data such as precipitation, water levels and land use into flood risk models. These tools facilitate participatory hazard mapping and vulnerability analyses by generating simulations that inform early warning systems and long-term urban planning (Asian Disaster Reduction Center, 2005). With advancements in simulation capabilities, real-time applications such as evacuation route optimization and dynamic resource allocation have become increasingly feasible. Moreover, these models are pivotal in developing NbS by assisting planners in designing landscape mosaics that enhance ecological recovery and mitigate risks (do Amaral & de Lima Bezerra, 2024).

Digital tools such as the PLEIADES® simulation platform enable dynamic energy modeling and life cycle assessments, accounting for local microclimates, surface temperatures and turbulence patterns (Saadé et al., 2022). The integration of GIS, Building Information Modeling (BIM), RS and AI further enhances early warning systems and supports iterative adaptation strategies (Han & Liu, 2025). The concept of evolutionary resilience, which emphasizes continuous learning and structural adaptation, is operationalized through scenario simulations that test strategies under diverse conditions (Chen et al., 2023; Rezvani et al., 2023).

Participatory scenario planning grounds these simulation models in local realities by incorporating community knowledge and diverse stakeholder perspectives, including marginalized groups (UNISDR, 2015; UNEP, 2022a). This approach ensures that disaster response strategies are context sensitive and socially inclusive. At regional and international scales, participatory models contribute to harmonized policy design and the development of multi-hazard early warning systems that transform data streams into actionable intelligence (UNISDR, 2015; Han & Liu, 2025).

Environmental modeling plays a central role in assessing technical interventions such as building retrofits and ecological buffers. Simulation tools assist in evaluating the long-term performance of design alternatives under different climate scenarios (D'Ambrosio et al., 2023). Flood damage simulations, for example, model water depth, spatial extent and repair costs, supporting risk-based resource allocation (Asfandyar et al., 2025). These models are increasingly integrated into

smart city platforms to enable real-time risk monitoring and dynamic data management, although challenges related to cost, data reuse and interoperability remain (Ren et al., 2024).

Local climate zone (LCZ) mapping is another frequently studied topic in climate-based scenario planning, classifying urban areas based on built form and land cover characteristics. LCZ mapping allows planners to identify neighborhoods vulnerable to UHI effects and supports simulations of thermal hazards under various land-use scenarios. This spatial typology informs zoning and infrastructure interventions such as reflective materials, green roofs and climate shelters by aligning adaptive strategies with microclimatic conditions. When integrated into GIS-based models, LCZ data provide granular insights that improve both the relevance and precision of urban heat mitigation strategies.

Advanced analytical methods now extend risk assessment beyond static land-use classifications. Indices like the Largest Patch Index (LPI) and Fractal Dimension Index (FRAC_MN) offer insights into ecological fragmentation and connectivity (Wang et al., 2022). These metrics enrich scenario planning by providing a nuanced understanding of spatial structure and resilience. Furthermore, simulation outputs benefit from advanced data processing techniques such as fusion algorithms and data-cleaning protocols that enhance model reliability, particularly in flood risk prediction (Gyang et al., 2025).

Scenario-based modeling increasingly integrates social, economic and institutional dimensions. Tools such as the Specialized Flood Resilience Index (S-FRESI) and Baseline Resilience Indicators for Communities (BRIC) offer composite assessments of vulnerability by capturing variables including infrastructure robustness, governance capacity and social cohesion (Hussain et al., 2023). Iterative modeling frameworks such as 4R-TOSE (robustness, redundancy, resourcefulness and rapidity with four interrelated dimensions: technical, organizational, social and economic) and DPSIR (drivers, pressures, state, impact and response) enable continuous evaluation and adaptation of planning strategies (do Carmo de Lima Bezerra et al., 2022). Educational platforms that leverage interactive simulations and visualizations help build capacity in these areas, ensuring that future planners are equipped with both technical expertise and systems-thinking skills (Bano et al., 2025).

4.3 Real-Time Monitoring, Early Warning, and Participatory Intelligence

The integration of real-time monitoring and early warning systems into disaster-resilient planning illustrates the convergence of technological innovation, institutional capacity building and community engagement. These systems are not merely technical infrastructures but also social mechanisms that require continuous adaptation, education and collaboration to effectively address the complex and dynamic nature of disaster risks (UNISDR, 2015).

Technological advancements in GIS, RS and AI have transformed traditional disaster management approaches by enabling dynamic risk assessments, real-time situational awareness and rapid dissemination of alerts (Han & Liu, 2025). The transition from static hazard maps and post-disaster evaluations to real-time evacuation planning and automated decision support represents a significant evolution in disaster response capabilities. Cloud-based platforms and big data analytics further enhance these capacities by allowing the collection, processing and visualization of vast, heterogeneous datasets in real time. When integrated with IoT sensors and mobile devices, these systems generate live disaster maps that guide emergency responders and facilitate coordinated resource allocation. The incorporation of blockchain technology into GIS adds a layer of data integrity and trust, ensuring secure and transparent data sharing across emergency response networks (Ebrahim, 2025; Hindarto et al., 2025; Hanspal & Behera, 2024).

Beyond their technical functions, digital tools facilitate public consultations and participatory processes in disaster risk reduction policy development. These tools empower community representatives to play active roles and enable the establishment of coordination platforms across multiple governance levels, fostering transparency and inclusive decision-making (UNISDR, 2015). Participatory hazard and vulnerability mapping supported by GIS empowers communities to integrate local knowledge into risk reduction strategies, enhancing the accuracy of assessments and strengthening ownership of disaster management plans. As emphasized by the Asian Disaster Reduction Center (2005), the capacity to measure, record and interpret spatial data is fundamental for bolstering preparedness and early warning capabilities among both professionals and local stakeholders.

The integration of GIS with BIM, RS and AI enhances predictive modeling and evacuation logistics. Machine learning algorithms combined with GIS and environmental data such as rainfall and land-use changes improve the accuracy of hydrological models and support early warning systems (Gyang et al., 2025). These integrated models enhance the classification of urban resilience, particularly in vulnerable coastal areas, by utilizing multi-sensor inputs and enabling predictive infrastructure failure monitoring (Ren et al., 2025).

Early warning systems are emphasized within global adaptation frameworks as crucial indicators of adaptive capacity. However, to be effective, these systems must be embedded within institutional structures and tailored to local contexts. User-centered design that incorporates gender-sensitive approaches and cultural considerations is essential to developing inclusive and actionable warning systems (UNISDR, 2015). Platforms such as the ARCH[5] Geoportal illustrate how real-time and historical spatial data can be consolidated to inform risk assessments and emergency planning (Villani et al., 2023). Additionally, the rise of crowd-sourced GIS data

[5] ARCH is a EU-funded project that aims to preserve cultural heritage from hazards and risks. ARCH HUB is a platform developed within this project that includes tools related to disaster management and resilience. For detailed information, please visit the page at https://savingculturalheritage.eu/solutions/tools

collection enhances the speed and accuracy of alerts, especially in resource-constrained settings (Ebrahim, 2025). At the local scale, initiatives such as Uganda's Eco-DRR project demonstrate the practical use of real-time monitoring systems in managing micro-catchments (UNEP, 2022b). These systems support hydrological disaster management, including flash floods and droughts, and highlight the flexibility of monitoring approaches across diverse geographical and institutional contexts. The combination of digital twins with real-time monitoring and geospatial dashboards facilitates predictive maintenance and resilience planning by visualizing environmental risks and infrastructure vulnerabilities across spatial and temporal dimensions (Samaei & Ghafari, 2025). Such tools enable planners and policymakers to optimize GI investments, ensuring interventions are adaptive and future-ready.

The resilience of critical infrastructure systems, including transportation, water and telecommunications, is closely tied to the effectiveness of monitoring and early warning mechanisms. Strengthening and maintaining these systems is essential for ensuring continuity during immediate disaster responses and supporting long-term recovery efforts (Gerges et al., 2022; UNISDR, 2015). Real-time spatial data also plays a vital role in protecting public health by enabling the rapid dissemination of alerts and reducing health-related risks during disaster events (Ebrahim, 2025).

Education and capacity building are integral to the effectiveness of these systems. Integrating risk knowledge into formal and informal education and professional training strengthens the technical and social competencies necessary for disaster preparedness and system operation (UNISDR, 2015). Public awareness campaigns further reinforce societal resilience by encouraging proactive risk management behaviors.

Collaboration and co-production have emerged as core principles in the development of early warning systems. Multi-stakeholder partnerships involving governments, civil society and the private sector facilitate the sharing of data, knowledge and resources, thereby enhancing the adaptability and effectiveness of these systems in the face of evolving climate and disaster risks (Tosan et al., 2025).

4.4 Artificial Intelligence (AI) and Machine Learning (ML) for Predictive Ecological Modelling

The integration of AI and ML with GIS enables the efficient processing and analysis of large, heterogeneous spatial datasets, which is crucial for identifying risk patterns, forecasting disasters and supporting informed decision-making (Han & Liu, 2025). AI significantly enhances response efficiency by swiftly identifying critical areas, prioritizing rescue operations and coordinating resource allocation during disaster events (Hanspal & Behera, 2024). When combined with cloud computing and IoT, this integration facilitates robust disaster response systems that can predict hazard impacts such as earthquakes, floods and wildfires while optimizing strategies for evacuation planning and critical infrastructure protection.

Over recent decades, AI and ML models, including artificial neural networks (ANN) and support vector machines (SVM), have increasingly been employed in flood forecasting and risk assessment, substantially improving preparedness and mitigation efforts (Van Pham et al., 2025). These methods have also gained traction in coastal management and erosion prediction, where they enhance environmental monitoring and the resilience of marine infrastructure (Samaei & Ghahfarokhi, 2023). Such applications reflect a broader shift towards the adoption of AI-driven analytics to address multifaceted challenges related to disasters.

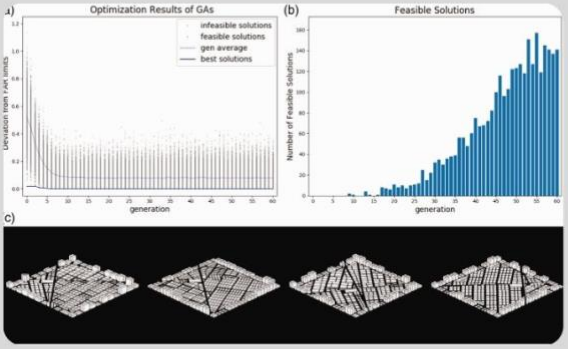
The synergy between AI, ML, GIS and big data platforms has proven especially effective in enhancing spatial hazard identification and supporting adaptive management strategies (Ren et al., 2025; Ebrahim, 2025). AI-supported analyses of large-scale spatial datasets improve the delineation of high-risk zones and inform proactive urban planning. For instance, the development of flood sensitivity maps through big data analytics is critical for identifying vulnerable areas, particularly in urban regions with inadequate drainage systems (Van Pham et al., 2025). Deep learning techniques provide scalable frameworks for resilience assessments, contributing to long-term sustainability objectives in DRR and ecological planning (Ren et al., 2025).

In the context of coastal resilience, machine learning models enable refined predictions of shoreline changes by leveraging spatial datasets that capture dynamic interactions between climate variables and human-induced pressures (Samaei & Ghahfarokhi, 2023). This predictive capability strengthens adaptive planning and supports technical competencies in ecological management (see Figure 10). However, the effectiveness of these models depends on the availability of high-resolution spatial data and the capacity to manage and interpret such data. Therefore, building technical expertise in GIS, data collection protocols and spatial analysis is critical. Capacity-building initiatives that incorporate hands-on training and participatory data stewardship not only enhance the quality of analysis but also foster stakeholder engagement and strengthen community resilience (Bano et al., 2025).

CASE STUDY:
SEOUL, SOUTH KOREA

ARTIFICIAL INTELLIGENCE-AIDED DESIGN: SMART DESIGN FOR SUSTAINABLE CITY DEVELOPMENT

This research developed a Smart Design framework, which treats urban design as an emergent pattern formation process with contextualized and dynamic objectives.
The framework integrates design thinking, AI search techniques, urban scale performance simulations, and participation to better inform decision-making.



The design begins with an initial interpretation of design problems. Human knowledge and creativity are coded to support the advanced AI search techniques.
Experts in design, engineering, and computation are greatly involved in integrating design generation, scientific modeling, and computational algorithms to search for optimal designs.

Results:

- First Iteration: Focused on maximizing floor area ratio, resulting in a design with smaller, more vitality-boosting urban blocks, which fostered street vitality and pedestrian friendliness.
- Second Iteration: Introduced an energy efficiency objective, leading to alternative designs with variations in parcel layouts that balanced energy use with urban form criteria.
- The computational system efficiently handled the complex optimization, with the first iteration taking approximately 10 hours and the second around 70 hours on distributed GPU/CPU resources.
- The iterative process allowed visualization and stakeholder participation, enabling informed decision-making. Stakeholders favored the first iteration's design due to its walkability and vitality features.

Figure 10. AI-aided smart design (Quan et al., 2019).

As AI and cloud-based analytics continue to advance, future research should prioritize balancing data privacy and security concerns with the need for actionable insights in ecological planning. Continued investment in technological infrastructure, training programs and standardization efforts is essential to fully harness the potential of AI and machine learning for predictive modelling and disaster resilience (Ebrahim, 2025; Ren et al., 2025).

5. COMMUNITY-BASED URBAN RESILIENCE

Community-based urban resilience has increasingly emerged as a foundational principle in disaster-resilient planning, reflecting a paradigm shift from hierarchical governance models toward inclusive and participatory frameworks. This transition highlights the integration of local knowledge systems, social capital and collaborative governance mechanisms, all of which enhance the adaptive capacity of urban communities confronting intensifying climatic and environmental hazards. As emphasized by UNISDR (2015), the active involvement of civil society, volunteers and community-based organizations plays a pivotal role in DRR by providing context-specific insights and fostering a culture of prevention through public awareness and pragmatic guidance.

Within this context, co-management, which refers to the shared governance of resources and responsibilities between institutions and residents, functions as a crucial strategy for sustainability and resilience (Tosan et al., 2025). By aligning institutional capacities with local knowledge, co-managed systems enable communities to respond more effectively to the complex challenges posed by climate change and rapid urbanization. This dynamic is evident in Eco-DRR strategies promoted by UNEP (2022a, 2022b), which highlight case studies from Uganda and India where community-led wetland restoration has successfully reduced vulnerability to floods, droughts and cyclones. These initiatives underscore the value of linking ecological restoration with social empowerment, ensuring that resilience-building efforts deliver both environmental and socio-economic benefits.

Community-based approaches further strengthen the social and institutional dimensions of resilience. Chen et al. (2023) argue that social cohesion, trust networks and local capacity-building are mutually reinforcing, and targeted interventions in one area can produce cascading improvements across others. Moreover, spatial and infrastructural conditions significantly influence the baseline resilience of urban communities. Rezvani et al. (2023) demonstrate that proximity to essential infrastructure, including transportation networks and emergency services, correlates strongly with improved disaster preparedness and recovery capacities. These spatial disparities underscore the need for equity-oriented planning interventions that promote inclusive access to resources and services.

Advancements in digital technologies, including RS, ML and GIS-based modeling, are increasingly integrated into community resilience assessments. These tools facilitate fine-grained analyses of urban vulnerabilities, supporting adaptive planning and efficient resource allocation. Choi and Song (2022), for example, highlight the utility of neighborhood-level clustering based on vulnerability and recoverability profiles, enabling municipalities to design tailored disaster preparedness plans and targeted educational campaigns. Similarly, adaptive public space interventions, such as those implemented in Copenhagen, illustrate how localized and context-

sensitive designs can simultaneously enhance ecological integrity and strengthen the social value of urban environments (Pancewicz, 2022).

Projects such as UNaLab and URBAN GreenUP exemplify the importance of co-creation in climate adaptation. By embedding citizen perspectives into the design and implementation of urban interventions, these projects ensure that outcomes are technically robust, socially inclusive and publicly accepted. Such participatory processes also reinforce procedural justice, transforming climate adaptation into a shared civic responsibility rather than a top-down directive.

Integrating community perspectives into broader urban regeneration and social infrastructure planning is increasingly recognized as essential. Childers et al. (2015) emphasize that involving residents throughout both planning and implementation phases fosters a sense of ownership and long-term stewardship, both of which are critical for sustaining resilience initiatives.

Marginalized communities often face disproportionately high vulnerability to disasters due to intersecting social, economic and environmental disadvantages. These populations, frequently among the poorest and most socially excluded, tend to reside in hazard-prone areas and lack the resources necessary for adequate disaster preparedness, response and recovery. Addressing their vulnerability requires more than physical protection; it demands equitable access to sustainable livelihoods and robust social safety nets. Ecosystem-based interventions such as reforestation and soil stabilization contribute to resilience by reducing property damage and minimizing disruption to income-generating activities, thereby reinforcing rights to home and livelihood (UNEP, 2022b). Complementary livelihood strategies, including apiculture, sustainable agriculture and nursery management, have demonstrated their capacity to break cycles of poverty, particularly among disadvantaged groups (UNEP, 2022b).

Geographic and topographic characteristics further shape the spatial distribution of resilience. Rezvani et al. (2023) note that urban neighborhoods located in plains often exhibit greater resilience compared to those in mountainous regions, where challenging terrain exacerbates isolation and exposure to hazards. These disparities underscore the necessity for spatially differentiated resilience policies, especially in under-researched and structurally disadvantaged regions. Targeted studies and planning frameworks are needed to ensure that communities in topographically vulnerable areas are not overlooked in broader disaster adaptation strategies (Rezvani et al., 2023).

Addressing the vulnerability of marginalized groups also requires a strong focus on community empowerment. Effective adaptation depends on inclusive stakeholder engagement, transparent data access and institutional coordination, especially in contexts where formal representation and informational equity are lacking (Bano et al., 2025). Tailoring adaptive strategies to localized needs is essential. Tosan et al. (2025) stress that future research must prioritize climate and water-related resilience in socioeconomically and ecologically vulnerable areas, recognizing that

these populations face compounded risks arising from both environmental hazards and structural inequalities.

Together, these insights call for a justice-oriented approach to resilience planning that integrates socioeconomic equity, spatial sensitivity and bottom-up engagement as core principles in DRR frameworks.

5.1 Stakeholder Collaboration and Conflict Resolution

Stakeholder collaboration and conflict resolution represent essential soft skills in resilient ecological planning, given that the complexity of urban and ecological systems requires the integration of diverse perspectives and expertise. Cities, as complex socio-ecological systems, are shaped by the dynamic interplay of economic, social and ecological subsystems, each involving stakeholders with potentially conflicting interests (R. Zhang et al., 2025). Building climate resilience, for instance, demands that technical solutions and building typologies be tailored to the specific urban fabric and local context, which is only achievable through active engagement and negotiation among local authorities, technical experts, community representatives and other relevant actors (D'Ambrosio et al., 2023).

Effective stakeholder collaboration extends beyond technical coordination to include the co-production of knowledge and the joint formulation of management plans. UNEP emphasizes the importance of establishing partnerships with reputable local scientific think tanks and integrating both indigenous and scientific knowledge into DRR and ecological planning efforts (UNEP, 2022a; UNEP, 2022b). These partnerships support the mainstreaming of Eco-DRR measures into local sectoral plans, ensuring that interventions are contextually relevant and widely supported (UNEP, 2022a).

Conflict resolution emerges as a critical capacity when stakeholders hold competing interests or when decisions regarding resource allocation generate tensions. The literature underscores that resilience is not only a technical property but also a social one, dependent on the capacity of communities and institutions to negotiate, adapt and recover from shocks while maintaining acceptable levels of functioning (Hussain et al., 2023). Managing flood risks in urban areas, for example, often involves balancing the priorities of residents, businesses and government agencies, each of which may perceive risks and preferred solutions differently (Rezvani et al., 2023; Kosova et al., 2022). Effective and lawful governance frameworks are essential for mediating such conflicts and ensuring that risk management approaches are implemented equitably and transparently (Rezvani et al., 2023).

The real-time integration of cloud-based systems and AI-enhanced decision support further strengthens the timeliness and effectiveness of collaborative disaster management strategies (Han & Liu, 2025). Ultimately, the success of resilient ecological planning hinges on the ability of stakeholders to collaborate constructively, resolve conflicts effectively and adapt to evolving conditions.

5.2 Community Engagement and Participatory Approaches

Community engagement and participatory approaches are widely acknowledged as critical elements of resilient ecological planning, particularly within the scope of DRR. These strategies facilitate the meaningful integration of local knowledge, values and priorities into planning processes, thereby enhancing the contextual relevance and long-term sustainability of interventions. Empowering local authorities and communities through shared decision-making and equitable resource allocation fosters a sense of ownership and increases the likelihood of successful implementation (UNISDR, 2015; UNEP, 2022b). Effective participation must extend beyond superficial consultation to include community actors in the design, implementation and monitoring phases of resilience strategies. Aguirre and Nyerges (2014) emphasize that overly simplistic participatory approaches risk omitting crucial components such as recruitment, knowledge exchange, deliberation and reflective learning. They advocate for a holistic and transdisciplinary framework that offers reasoning scaffolds and facilitates inclusive dialogue on complex issues.

Tools like participatory mapping and citizen science provide practical avenues for incorporating grassroots knowledge into formal planning efforts. These methods uncover localized vulnerabilities and community assets often overlooked by top-down assessments. For instance, citizen science initiatives contribute valuable environmental data, while participatory mapping identifies micro-level risks and informs context-specific interventions. Critically, these approaches cultivate a sense of agency and stewardship among residents, which is essential for sustaining resilience initiatives over time (UNEP, 2022b).

Educational and capacity-building programs represent equally vital components of community resilience. Programs such as Climate Change Knowledge for Schools (CLICKS), which combine interactive learning with practical fieldwork, have demonstrated effectiveness in enhancing climate literacy and fostering problem-solving skills even among young participants (Bano et al., 2025). These initiatives strengthen both technical competencies and soft skills such as communication, collaboration and adaptive thinking, all of which are indispensable in disaster-prone environments. Moreover, bottom-up awareness campaigns directed at communities living near vulnerable ecosystems, such as wetlands and forests, further reinforce ecosystem stewardship by clarifying legal responsibilities and promoting sustainable resource use practices (UNEP, 2022a).

International frameworks consistently stress that resilience building must include all social sectors, with particular attention to vulnerable and marginalized groups. The “Build Back Better” principle, endorsed by UNISDR (2015), underscores the importance of participatory reconstruction processes that actively involve affected communities in shaping safer and more resilient environments following disasters. Integrating such inclusive processes into micro-catchment and local development plans ensures that disaster risk management is locally anchored and equitable.

Ultimately, embedding participatory approaches within ecological planning fulfills both ethical and strategic imperatives. It guarantees procedural justice while simultaneously enhancing the effectiveness of DRR measures. As Choi and Song (2022) assert, robust methodologies for disaster-resilient planning must prioritize community involvement at their core. This perspective aligns with UNEP's (2022a) call for inclusive Eco-DRR strategies that build local capacity while addressing climate and ecological risks.

5.3 Leadership and Decision-Making in Crisis

Effective leadership and decision-making represent core soft skills in resilient ecological planning, particularly under crisis conditions. Disaster contexts compel leaders to integrate scientific knowledge, stakeholder perspectives and real-time data to navigate uncertainty and manage risk effectively. This process requires not only technical expertise but also interpersonal competencies such as empathy, adaptability and clear communication, especially when addressing the diverse needs of affected populations (Rezvani et al., 2023). Consequently, leadership in crisis situations is increasingly characterized by its capacity to foster adaptive, collaborative and context-sensitive responses.

Tosan et al. (2025) emphasize that leaders must be able to translate complex scientific insights into strategies that are both accessible and actionable. This capacity is especially critical in domains such as water resource management and climate adaptation, where decision-making has direct implications for both livelihoods and ecosystem integrity. Leadership during crises also involves overcoming institutional barriers. Organizational learning, the standardization of practices and the development of transparent, auditable procedures are vital for maintaining consistency and reinforcing legitimacy. This is particularly significant in DRR contexts, where the mandates of emergency response and sustainable development objectives converge (Rezvani et al., 2023). Accordingly, leaders need to cultivate systems thinking approaches that align local actions with broader governance frameworks.

Furthermore, effective leadership often emerges organically from within communities themselves. Case studies presented by Hussain et al. (2023) illustrate how self-organized initiatives in flood-affected regions successfully restored critical infrastructure and provided support to vulnerable populations, underscoring that crisis leadership extends beyond formal authorities. It is instead grounded in collective action, shared responsibility and the empowerment of local stakeholders. Davis (2020) further reinforces this perspective by highlighting the necessity of building trust and enabling stakeholder collaboration to strengthen planning capacity and improve resilience outcomes.

In addition, disaster management requires operation within a multi-scalar ecological governance model. Coordinated action across local, regional and national levels is essential, as preparedness, response and recovery processes are inherently interdependent and cannot be effectively addressed through isolated institutional frameworks (Beaton et al., 2008).

5.4 Transboundary and Regional Cooperation

Transboundary and regional cooperation are increasingly recognized as fundamental components in advancing ecological planning and disaster resilience, especially considering the interconnectedness of ecosystems and the cross-border nature of many environmental hazards. As highlighted by UNISDR (2015), coordination at international, regional, sub-regional and transboundary levels is indispensable for supporting both state and non-state actors in reducing disaster risk. However, current frameworks often remain underdeveloped, indicating significant gaps in operationalization and implementation that merit further academic inquiry and policy refinement.

Practical examples demonstrate the potential of such cooperation to bridge ecological and administrative divides. The Rösjö green wedge initiative in northern Stockholm, for instance, showcased the benefits of municipal and civic collaboration by conceptualizing the green wedge as an ecological unit rather than as fragmented jurisdictions (Frantzeskaki et al., 2017). These collaborative models promote integrated, place-based planning approaches that align with natural systems rather than artificial political boundaries. Similarly, global programs such as the National Adaptation Programmes of Action (NAPA) and the Climate Change Adaptation through Integrated Risk Reduction (CCAIRR) provide structured pathways for harmonizing national policies with climate adaptation and disaster resilience objectives, particularly in developing countries (Nahyan, 2017). Initiatives like Rebuild by Design, developed in response to Hurricane Sandy, illustrate how cross-professional and cross-sector partnerships can generate innovative and context-responsive solutions (Furuta & Shimatani, 2018).

Despite their promise, efforts in transboundary cooperation frequently face obstacles related to institutional fragmentation and capacity limitations. As noted by Shi (2020) and Rezvani et al. (2023), regional institutions, especially in governance contexts as complex as that of the United States, often lack the authority or mechanisms required to synchronize cross-sectoral and inter-jurisdictional climate responses effectively. Additionally, institutional weaknesses and financial constraints compound these challenges, underscoring the necessity for stronger regulatory frameworks and more robust funding mechanisms (UNISDR, 2015). A recurring concern in the literature is the prevalent prioritization of grey infrastructure solutions over systems thinking approaches, which can lead to the neglect of essential cross-sectoral interdependencies, an oversight particularly detrimental in transboundary contexts (Rezvani et al., 2023).

International organizations such as UNEP have documented successful case studies that illustrate the value of multisectoral partnerships in enhancing resilience across borders (UNEP, 2022b). These cases include collaborations among humanitarian, environmental and civil society actors working together to restore ecosystems and reduce disaster vulnerability. Nevertheless, as emphasized by UNISDR (2015) and Rezvani et al. (2023), the governance structures and forums required to sustain and scale such cooperation often remain inadequate. Future research should therefore focus on identifying and designing inclusive, adaptive and operational governance

models capable of reconciling diverse stakeholder interests. This focus is particularly critical in transboundary regions where environmental risks intersect with socio-political dynamics and economic disparities.

5.5 Policy Integration and Governance

The alignment of governance structures with ecological and hydrological principles is essential for managing complex urban systems, particularly in the context of escalating climate-related risks. Despite this necessity, persistent disconnects continue to exist between scientific research and practical implementation. Fragmented governance frameworks and prevailing economic imperatives can further hinder the effective integration of GBI and NbS within urban planning processes. Addressing these challenges requires governance models that reconcile ecological, social, and financial objectives while facilitating coordination across spatial and institutional scales (Tosan et al., 2025; UNEP, 2022b).

Multi-level governance emerges as a fundamental prerequisite for integrating disaster risk management with sustainable urban development. Effective policy responses rely on cross-sectoral alignment, robust intergovernmental coordination, and inclusive stakeholder engagement (IPBES, 2019). The prominence of terms such as “Management,” “Governance,” and “Policy” in the academic literature underscores the deeply institutional nature of resilience challenges (Tosan et al., 2025; UNISDR, 2015). Inclusive engagement that involves women, youth, marginalized groups, and the private sector enhances both the legitimacy and contextual relevance of policy decisions (UNISDR, 2015). Empowering local authorities is also critical, as strengthening local governance builds capacity to address complex challenges such as drought and climate-induced migration (Tosan et al., 2025). Participatory approaches, including citizen science and participatory GIS, play an important role by filling data gaps, promoting transparency, and linking local knowledge with governance mechanisms (Davis, 2020).

Cultural considerations, such as the preservation of heritage during reconstruction efforts, further necessitate governance models that are attuned to local values and priorities (UNISDR, 2015). Lessons from initiatives like the Rösjö green wedge in Stockholm and the Odisha case in India demonstrate the effectiveness of collaborative, multi-stakeholder approaches in fostering policy innovation and institutional learning (Frantzeskaki et al., 2017; CDRI & G20 Working Group on DRI, 2024).

The urgency for adaptive governance and integrated policymaking is amplified by the growing frequency and intensity of climate-induced disasters. Scholars advocate for the use of scenario planning, spatial modeling, and publicly accessible datasets as tools to guide adaptive decision-making processes (Mitrovic et al., 2023; Choi & Song, 2022). Tools such as system innovation catalogues and resilience assessments provide visual and data-driven support for the implementation and evaluation of policy measures. Nevertheless, significant research gaps remain, particularly in developing empirical frameworks that enable effective cross-sectoral

governance and in equipping professionals with the necessary skills to navigate complex interdependencies. Future efforts should prioritize scalable and inclusive governance models capable of addressing emerging risks through sustained collaboration among governments, civil society, academia, and the private sector (Rezvani et al., 2023; UNEP, 2022b).

6. EDUCATION AND CAPACITY BUILDING FOR DISASTER-RESILIENT ECOLOGICAL PLANNING

Education and capacity building are widely recognized as foundational pillars for enhancing disaster resilience, especially within the contexts of ecological planning and climate-responsive urban development. As climate change intensifies the complexity and frequency of disasters, it has become increasingly imperative to equip professionals, policymakers, and community stakeholders with the skills and knowledge necessary for adaptive and evidence-based responses.

A significant trend in contemporary education is the emergence of interdisciplinary programs that integrate sustainability science, geospatial information systems (GIS), and disaster risk management. Graduate-level programs such as the Professional Master's Program in GIS for Sustainability Management (PMPGIS) at the University of Washington exemplify how curricula are evolving to encompass both theoretical foundations and applied tools for resilience and sustainability planning (Aguirre & Nyerges, 2014). These programs incorporate spatial analysis, ecological assessment, and policy frameworks, addressing the multifaceted challenges of disaster risk and urban transformation.

Technological innovation plays a central role in transforming educational content. The integration of AI, GIS, digital twin systems, and urban informatics into instructional strategies has enhanced analytical capacity and promoted data-driven decision-making among learners. Scenario-based modeling tools and dynamic geospatial mapping platforms, such as WebGIS, allow students to simulate and visualize risk conditions in real time, strengthening their ability to plan evacuation routes, identify safe zones, and design resilient infrastructure (Villani et al., 2023; Han & Liu, 2025).

Digital transformation in education is further supported by European policy initiatives such as the Digital Education Action Plan, which advocates for the development of high-performing digital ecosystems and the cultivation of digital competencies aligned with evolving societal needs (European Commission, 2020b). Tools developed for AI-enhanced learning, including curriculum guides and simulation platforms, are increasingly deployed to support both technical and soft skill development in disaster management contexts (Perini & Wubbels, 2024).

Practice-based learning remains a critical component of effective disaster resilience education. Experiential methods, including participatory risk assessments and simulation exercises, enable students to apply theoretical knowledge to real-world scenarios. These methods are especially effective for training in ecological planning strategies such as NbS and geodesign, which require the practical translation of abstract models into actionable design interventions (Li et al., 2022). For example, participatory mapping in flood-prone communities or buffer analysis in tsunami-

affected zones fosters context-sensitive engagement and encourages collaboration between students, local authorities, and community members (Han & Liu, 2025).

Despite these advancements, notable gaps persist in curriculum design. Many existing programs fail to sufficiently integrate disaster resilience topics or treat climate change merely as a peripheral issue, thereby limiting their ability to develop professionals equipped with systemic thinking and cross-sectoral expertise (Bano et al., 2025). A persistent challenge lies in the lack of interdisciplinary collaboration in course design, which hampers the development of shared frameworks across urban planning, ecology, engineering, and the social sciences. Interdisciplinary teams enhance disaster management education by providing students with practical, real-world experiences in a collaborative learning environment (Becker, 2000). The successful integration of disaster resilience requires intentional efforts to harmonize methodologies, terminologies, and priorities across these domains (Campomanes et al., 2025).

Furthermore, while technical competencies such as hydrological modeling and GIS are increasingly acknowledged as critical, soft skills including stakeholder engagement, communication, and adaptive problem-solving are often underemphasized. This imbalance can result in professionals who are technically proficient but lack the interpersonal capabilities required for participatory planning and community resilience building.

The development and dissemination of open educational resources offer a potential solution by enabling the creation of flexible, modular, and accessible content that supports both initial education and ongoing professional development. Similarly, collaborative initiatives with NGOs, municipalities, and civil society actors enrich the learning environment and ensure that educational programs reflect local needs and risks. Partnerships with industry can further enhance disaster management education by facilitating continuous knowledge exchange, practical training, and exposure to real-world challenges (Thayaparan et al., 2014).

The imperative of lifelong learning must also be embedded within disaster resilience education. As technological, climatic, and institutional contexts continue to evolve, professionals require continuous upskilling and access to peer learning mechanisms. Educational institutions should cultivate learning ecosystems that extend beyond formal education to include workshops, mentoring, and experiential learning opportunities, thereby fostering a culture of resilience through adaptive and inclusive educational strategies (Gyang et al., 2025; Kosova et al., 2022). Moreover, the formal and rigid structures of higher education institutions often act as barriers to the adoption of flexible, non-formal, and informal learning modalities such as online and distance education, which are crucial for supporting lifelong learning in this field (Thayaparan et al., 2014).

During the literature review process, additional research was carried out to identify postgraduate programs that align with the project's thematic focus on ecological planning, DRR, and climate-resilient urban development. Over 80 graduate programs from Europe, Asia, North America and Ocenia have been examined. Some of these programs and their information is shown in Table 3. An examination of the objectives and course contents of the analyzed programs reveals that

certain themes are more prominent. While disaster management, climate adaptation, ecological planning, and sustainability stand out, humanitarian and migration themes appear to have the least representation.

Table 3. General information of the some Masters degree programs on ecological planning and resilience.

Country	University	Program Name	Language	Access Link
USA	Harvard University	Master in Design Studies: Risk and Resilience	English	https://www.gsd.harvard.edu/master-in-design-studies-mdes-pre-fall-2021/risk-and-resilience/
USA	Georgetown University	Master's in Emergency & Disaster Management	English	https://scs.georgetown.edu/programs/419/master-of-professional-studies-in-emergency-disaster-management/
USA	Georgetown University	Executive Master's in Humanitarian Crisis & Emergency Management	English	https://scs.georgetown.edu/programs/546/executive-master-of-professional-studies-in-humanitarian-crisis-emergency-management/
USA	University of North Texas	Emergency Management and Disaster Science Master's Master of Science (M.S.)	English	https://catalog.unt.edu/preview_program.php?catoid=34&poid=15692&returnto=3818
USA	Northeastern University	Urban Informatics, MS	English	https://catalog.northeastern.edu/graduate/social-sciences-humanities/public-policy-urban-affairs/urban-informatics-ms/#programrequirementstext
CANADA	York University	Master in Disaster & Emergency Management	English	https://www.yorku.ca/gradstudies/dem/
UNITED KINGDOM	University Collage London (UCL)	Department of Risk and Disaster Reduction Risk, Disaster and Resilience MSc	English	https://www.ucl.ac.uk/prospective-students/graduate/taught-degrees/risk-disaster-and-resilience-msc
UNITED KINGDOM	University of Manchester	MSc in Disaster Management and Resilience	English	https://www.manchester.ac.uk/study/masters/courses/list/09910/msc-international-disaster-management/#course-profile
UNITED KINGDOM	University of Huddersfield	Risk, Disaster and Environmental Management MSc	English	https://www.hud.ac.uk/
EU Spain	Universitat de Girona	Master in Smart Cities	English	https://www.udg.edu
EU Spain	UAB (Universitat Autònoma de Barcelona)	Master in Territorial Planning and Environmental Management	Spanish (some English)	https://www.uab.cat
EU Spain	Universitat Internacional de Catalunya	Master of International Cooperation Sustainable Emergency Architecture (The program forms part of	English	https://masteremergencyarchitecture.uic.es/program/

Country	University	Program Name	Language	Access Link
		the Erasmus Mundus European Cooperation Program)		
EU Spain	Polytechnic University of Madrid (Universidad Politecnica de Madrid)	Urban and Territorial Planning - Speciality in Urban Studies	Spanish	https://blogs.upm.es/muput-duyot/
EU Netherlands	TU Delft	Master of Science Architecture, Urbanism and Building Sciences	English	https://www.tudelft.nl/en/education/programmes/masters/architecture-urbanism-and-building-sciences/msc-architecture-urbanism-and-building-sciences
EU Netherlands	University of Twente	Master Geo-information Science and Earth Observation	English	https://www.itc.nl/education/study-finder/geo-information-science-earth-observation/
EU Netherlands	University of Groningen	MSc in Society, Sustainability and Planning	English	https://www.rug.nl/masters/society-sustainability-and-planning/
EU Netherlands	Radboud University and Nijmegen School of Management	MSc in Spatial Planning – Specialization in Cities, Water and Climate Change	English	https://www.ru.nl/en/education/masters/cities-water-and-climate-change
EU Netherlands	Utrecht University	MSc in Sustainable Development – Earth System Governance Track	English	https://www.uu.nl/en/masters/sustainable-development
EU Netherlands	Radboud University	MSc in Environment and Society Studies – Sustainable Cities Track	English	https://www.ru.nl/masters/environment-and-society-studies/
EU Denmark	University of Cophenhagen	Master of Disaster Management	English	https://continuing-education.ku.dk/master-of-disaster-management/#courses
EU Denmark	VIA University College – Aarhus	Master of Disaster Risk Management and Climate Change Adaptation	English	https://en.via.dk/programmes/master/disaster-risk-management-and-climate-change
EU Belgium	Ghent University	MSc in Urbanism and Spatial Planning	Dutch (some English)	https://studiekiezer.ugent.be/master-of-science-in-de-stedenbouw-en-de-ruimtelijke-planning-en
EU Belgium	University of Antwerp	MSc in Environmental Science – Urban Environment Focus	English	https://www.uantwerpen.be/en/education/education-and-training/environmental-science/
EU Portugal	University of Porto – Faculty of Engineering (FEUP)	MSc in Spatial Planning and Urban Project	Portuguese	https://sigarra.up.pt/feup/en/cur_geral.cur_view?pv_curso_id=742
EU Portugal	ISCTE – University Institute of Lisbon	MSc in Planning and Policies of Territory	Portuguese	https://www.iscte-iul.pt/course/29/msc-planning-and-territorial-policies
EU Italy	Polytechnic University of Milan (Politecnico di Milano)	Urban Planning and Policy Design - Resilient Cities Path	English	https://www.polimi.it/en/education/laurea-magistrale-programmes/programme-detail/urban-planning-and-policy-design

Country	University	Program Name	Language	Access Link
EU Germany	TU Berlin	MSc in Urban Design – Habitat Unit Focus	English	https://habitat-unit.de/teaching/msc-urban-design/
EU Germany	HafenCity University Hamburg	MSc in Resource Efficiency in Architecture and Planning (REAP)	English	https://www.hcu-hamburg.de/en/research/master-programmes/reap/
EU Sweden	KTH Royal Institute of Technology	MSc in Sustainable Urban Planning and Design	English	https://www.kth.se/en/studies/master/sustainable-urban-planning-and-design/msc-sustainable-urban-planning-and-design-1.48350
EU Sweden	Lund University	Disaster Risk Management and Climate Change Adaptation - Master's Programme	English	https://www.lunduniversity.lu.se/lubas/i-uoh-lu-TAKAK#overview
EU France	Sciences Po – Paris School of International Affairs	Master in Environmental Policy – Cities and Territories Track	English	https://www.sciencespo.fr/psia/
EU France	ENSAPLV (École Nationale Supérieure d'Architecture de Paris-La Villette)	Master Architecture – Parcours Architecture, Environnement et Résilience	French	https://www.paris-lavillette.archi.fr/
EU Norway	Norwegian University of Life Sciences (NMBU)	MSc in International Environmental Studies	English	https://www.nmbu.no/en/studies/master-international-environmental-studies
EU Czech Republic	Czech Technical University in Prague (CTU)	MSc in Spatial Planning	English	https://www.fa.cvut.cz/en/education/master-study/spatial-planning/
EU Czech Republic	Masaryk University – Faculty of Social Studies	MSc in Environmental Studies and Sustainability	English	https://www.muni.cz/en/education/faculties/fss
EU Czech Republic	Charles University – Faculty of Science	MSc in Environmental Geosciences	English	https://www.natur.cuni.cz/eng/education/degree-programmes/environmental-geosciences
EU Switzerland	ETH Zurich	MSc in Architecture – Urban Design & Sustainable Architecture Focus	German & English	https://arch.ethz.ch/
EU Switzerland	University of Geneva	MSc in Environmental Sciences – Urban Ecology & Risk Management Track	English & French	https://www.unige.ch/enviro/en/
EU Switzerland	ZHAW – Zurich University of Applied Sciences	MSc in Environment and Natural Resources – Major in Urban Ecosystems	English	https://www.zhaw.ch/en/lsfm/study/master/environment-and-natural-resources/
Australia	RMIT University	Master of Disaster, Design and Development	English	https://www.rmit.edu.au/study-with-us/levels-of-study/postgraduate-study/masters-by-coursework/master-of-disaster-design-and-development-mc251

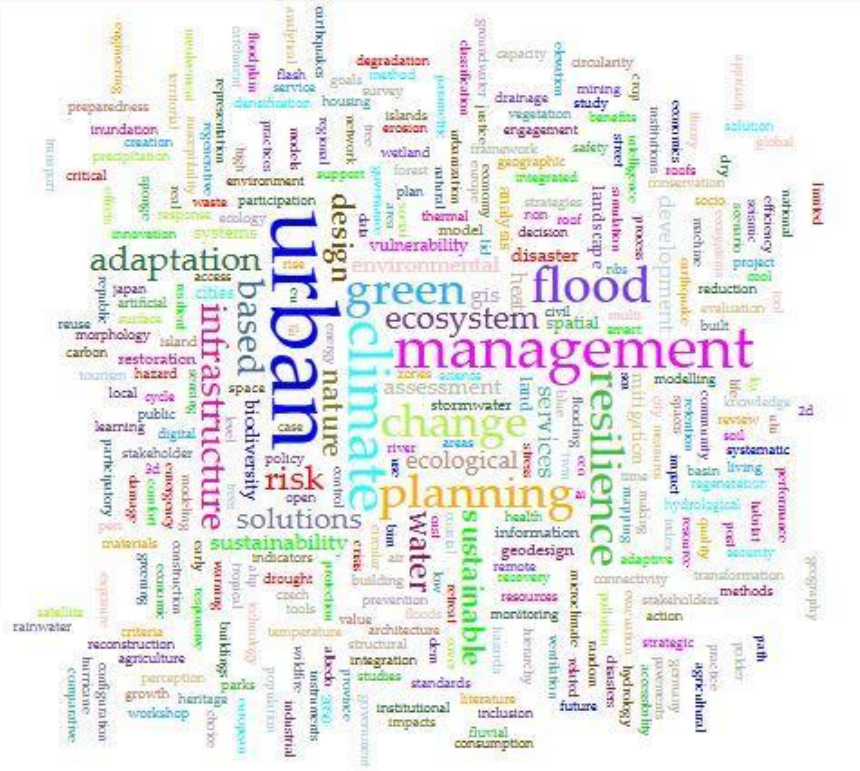
Country	University	Program Name	Language	Access Link
NEW ZEALAND	University of Canterbury	Master of Urban Resilience and Renewal	English	https://www.canterbury.ac.nz/study/academic-study/qualifications/master-of-urban-resilience-and-renewal#accordion-8af598ab40-item-e4405ea4ab-button
Japan	University of Tokyo	Master of Environmental Studies – Urban Environmental Resilience Track	English	https://www.k.u-tokyo.ac.jp/en/gsfs/
Japan	Kobe University	MSc in Maritime and Urban Disaster Risk Management	English	https://www.kobe-u.ac.jp/en/
Japan	Waseda University	MSc in Architecture – Sustainability and Resilience Focus	English	https://www.waseda.jp/fsci/gscs
SINGAPORE	National University of Singapore	MSc in Integrated Sustainable Design – Resilience and Adaptation Studio	English	https://www.sde.nus.edu.sg/
HONG KONG	CUHK (Chinese University of HK)	MSc in Urban Design – Urban Resilience and Sustainability Pathway	English	https://www.arch.cuhk.edu.hk/
CHINA	Tsinghua University	Master of Landscape Architecture – Ecological Infrastructure Focus	English	https://www.arch.tsinghua.edu.cn/
CHINA	Tongji University	MSc in Urban and Rural Planning – Resilient City and Regional Planning Track	English	https://caup.tongji.edu.cn
TURKEY	İstanbul Technical University	Housing and Earthquake Non-Thesis Master's Program	English / Turkish	https://kaem.itu.edu.tr/egitim/konut-ve-deprem-tezsiz-yuksek-lisans-programi

Disaster management appears as the most prevalent theme, with widespread representation in Europe, North America, and parts of Asia. The UK is especially strong in this area, with institutions like University College London, University of Manchester, and Coventry University offering MSc degrees focused on DRR, crisis leadership, and resilience. In the USA, programs at Georgetown University, Harvard, and the University of North Texas reflect a more applied and emergency response-oriented approach. In Canada, York University offers a blend of theory and field application in disaster studies. Climate adaptation is a globally relevant theme, but it is especially embedded in programs from Northern and Western Europe. The integration of technology and geospatial data (e.g., GIS, RS, urban informatics) is a growing theme across Master's programs, particularly in North America and Western Europe. Notable examples include Northeastern University's MS in Urban Informatics, and the University of Twente's MSc in Geo-Information Science. Ecological planning is most commonly embedded within broader urban or environmental programs. Humanitarianism and migration is a niche but important thematic area, mostly concentrated in a few specialized programs such as Georgetown University's Executive

Master's in Humanitarian Crisis and Emergency Management and UIC Barcelona's Master in Sustainable Emergency Architecture.

7. CONCLUSION

This literature review underscores the growing imperative to integrate ecological planning and design into all stages of disaster management; mitigation, preparedness, response, and recovery. It provides a multidimensional analysis that bridges academic curricula, best practices, policy frameworks, and emerging technologies to inform the development of a smart training module within the EPD-NET project. The word cloud created to visualize the most frequent keywords from the reviewed publication is shown in Figure 11.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From a technical perspective, the review showcases the growing relevance of deep-tech tools; notably GIS, AI, and RS; in enabling evidence-based planning, early warning systems, and post-disaster assessments. These technologies enhance both spatial accuracy and operational speed in disaster-prone areas, providing planners with the capacity to model risk, prioritize interventions, and engage communities through interactive platforms.

Moreover, the review affirms the importance of capacity building and transnational cooperation. Institutions must not only train individuals but also foster collaborative cultures between academia, NGOs, professional bodies, and the private sector. The project's ambition to build a learning network is grounded in this need to share methods, data, and pedagogies across borders. Such exchange will be crucial in operationalizing ecological planning and design practices and embedding them within mainstream disaster policy frameworks.

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ANNEX 1. Scientific publications

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
1	Reassessing the projections of the World Water Development Report	Boretti, A; Rosa, L	2019	http://dx.doi.org/10.1038/s41545-019-0039-9	water demand by 2050, water sources by 2050, water quality by 2050, water pollution, statistics	The aim of this paper is simply to highlight the connection between population and economic growth and water demand, resources and pollution, that ultimately drive water scarcity, and the relevance of these aspects in local, more than global perspective, to stimulate an urgent and comprehensive debate	The paper has discussed the correlation between the exponential growth in global population and GDP and water scarcity, that is the result of the competing water demand, water resources, and water pollution	Population and economic growth to 2050 will be very likely strong, and unequal across the globe, with the largest growth rates expected in third world countries. Water demand to 2050 will grow even more than the population and the economy, same of the reduction of water quality and resources. Local patterns will be more critical than global patterns, making the problem more difficult to be solved
2	Nature-based solutions to climate change mitigation and adaptation in urban areas: perspectives on indicators, knowledge gaps, barriers, and opportunities for action	Kabisch, N; Frantzeskaki, N; Pauleit, S; Naumann, S; Davis, M; Artmann, M; Haase, D; Knapp, S; Korn, H; Stadler, J; Zaunberger, K; Bonn, A	2016	http://dx.doi.org/10.5751/ES-08373-210239	NBSs, inter- and transdisciplinary expert workshop, governance challenges in implementing NbS, socio-environmental justice and social cohesion	The workshop aimed to showcase and explore examples of good practices of NbS to climate change mitigation and adaptation in Europe's urban areas and their surrounding landscapes, and to identify indicators of success for NbS, challenges of implementation, and other knowledge gaps. n explicit goal was to assess how the concept of NbS can help conservation to work across sectors in collaboration with different disciplines such as urban planning, architecture, ecology, and public health.	All participants convened and participated in a facilitated discussion and dialogue about NbS. The workshop was organized into two full days with different sessions, including keynote presentations, panel discussions, and group activities and discussions.	Indicators for measuring the effectiveness of NbS for climate change mitigation and adaptation and associated cobenefits Knowledge gaps relating to the effectiveness of NbS in cities Potential barriers to NbS Opportunities facilitating action for NbS

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
3	Of resilient places: planning for urban resilience	Mehmood, A	2016	http://dx.doi.org/10.1080/09654313.2015.1082980	resilience discussion, urban renaissance of UK, Transitiontowns, the Transition movement in the UK,a bottom-up initiative, resilience thinking,	This paper set out to look at how resilience thinking can help plan and shape resilientplaces in a situation of finite means, and how these change mechanisms can be mediated	A place-based perspectivehelps in locating the territorial dimension that mediates this change by identifying thecities as complex adaptive systems. The Transition movement as discussed above reflectsthe place-based response to the issues of global impact	the Transition movement became successful in the post-urbanrenaissance UK due to its encompassing stance towards social, economic and environ-mental well-being. This exemplifies the ways that resilience thinking can help with plan-ning and shaping cities. The complex adaptive systems view within resilience thinking alsohelps in looking at communities and places as subsystems that can intertwine to formulate,adapt or even mitigate and mediate the change mechanisms.
4	Challenges and strategies for urban green-space planning in cities undergoing densification: A review	Christine Haaland, Cecil Konijnendijk van den Bosch	2015	https://doi.org/10.1016/j.ufug.2015.07.009	Compact cityGreen infrastructure Green space changeInfill developmentPublic participationSustainable urban development,	reen space planning and management can be very challenging, especially in city areas under densification, since important ecosystem services are supposed to be delivered by limited green spaces. Therefore existing studies need to be reviewed that have looked at urban green space planning in cities undergoing densification. Questions to be answered by this review are: (1) how do the compact city approach and densification processes affect urban green space planning? (2) Which particular challenges and problems arise from this? And (3) which strategies and solutions are offered for dealing with these challenges and problems?	Literature was identified by structured and semi-structured searches in selected major scientific databases (Scopus, Web of Knowledge and Google Scholar), with additional cross-referencing.	Despite different contexts in different regions regarding urban density, population growth, societal conditions and preconditions for urban green space planning, several recurring challenges and problems resulting from the impact of the compact city approach and densification processes are evident

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
5	The business of accelerating sustainable urban development: A systematic review and synthesis	Daina Mazutis , Lauren Sweet	2022	https://doi.org/10.1016/j.jclepro.2022.131871		Further empirical research is needed to focus on the role of the private sector in designing, planning and building SUDs, with evidence not just from local administrators, but also from key actors, managers and institutions from the private sector (Alkhani, 2020; D'Auria et al., 2018; Loorbach and Wijsman, 2013). A systematic literature review is therefore warranted to take stock of what is known to date and what knowledge gaps remain.	to provide an unbiased and critical review of the literature, a comprehensive analysis of the empirical research on sustainable urban built environments from a business management perspective was conducted using a combination of both systematic and narrative review processes. The combination of systematic and narrative review methods ensures the review criteria to be explicit and replicable, while also allowing for the capture of studies referenced in key articles that may be elusive to systematic coding	this paper provides a systematic review and synthesis of the extant empirical research on the role of the business sector in driving SUDs. We derive an evidence-based multi-level, multi-stage model that provides a framework to situate built environment businesses as both affected by top-down, macro-level factors such as governmental legislation, incentives, power and control, as well as influencing more bottom-up, meso-level dimensions such as cross-sector partnerships, experimentation and community engagement.
6	Understanding Private-Sector Engagement in Sustainable Urban Development and Delivering the Climate Agenda in Northwestern Europe; A Case Study of London and Copenhagen	Alkhani, R.	2020	https://doi.org/10.3390/su12208431	climate gaps; climate policy; climate governance; private sector contribution; climate data; sustainable development; city leadership; ecological place-making	The focus of the paper is on clarifying local private sector involvement and private sector contributions with regards to the delivery of sustainability and climate goals in European cities. The aim is also to consider the potential effectiveness of the policy, governance, and planning and regulative frameworks relevant to new urban development and existing urban areas. The paper also seeks to clarify practical choices around sustainability-related knowledge and the potential relevance of shared information bases using agreed methods and approaches to allow bottom-up local and national action, monitoring, and assessments. A final aim is to identify options for improving engagement, including possibilities to incentivise the private sector.	The main methodology for the paper consists of a literature review followed by a qualitative case-study analysis.	In conclusion the article emphasises the importance of strong 'city leadership' for promoting sustainable growth, ensuring synergies and suitable frameworks for private-sector engagement through its various forms, and monitoring sustainability impacts

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7	Assessing data quality in citizen science	Margaret Kosmala1 *, Andrea Wiggins2 , Alexandra Swanson3 , and Brooke Simmons	2016	https://doi.org/10.1002/fee.1436	Iterative development of task and tool design, Volunteer training and testing, Use of standardized and calibrated equipment, Expert validation, Replication and calibration across volunteers, Skill-based statistical weighting of volunteer classifications, Accounting for random error and systematic bias,	Here we examine data quality practices across a wide range of ecological and environmental citizen-science projects and describe the most effective methods used to acquire high-quality data. We discuss current challenges and future directions in ensuring high-quality data	We focus on two objective taskindependent measures of data quality that prompt the most skepticism among professional ecologists and environmental managers: accuracy and bias	High-quality data can be produced using a suite of techniques, and investment in additional research and technology has the potential to augment these techniques and make them more broadly accessible. We suggest that Panel 1 be used as a guide by citizen-science evaluators, project creators, and data users as a standard to gauge data quality. As we face grand challenges related to global environmental change, citizen science emerges as a general tool to collect otherwise unobtainable high-quality data in support of policy and resource management, conservation monitoring, and basic science.
8	Mapping urban resilience to disasters – A review	Jean-Marie Cariolet , Marc Vuillet , Youssef Diab	2019	https://doi.org/10.1016/j.scs.2019.101746	Urban resilienceMap GISResilience indicators	This paper aims to understand how urban resilience to disasters is mapped by researchers. The usefulness and reliability of the identified cartographic output will also be examined. Although Renschler et al. (2010) assumed that GIS play a major role in assessing system resilience, there is still a need to understand exactly how. We have analysed scientific articles and reports whose results included resilience maps to disasters of urban territories, urban infrastructures or urban communities.	This study follows qualitative systematic review principles. Studies were searched using the Scopus and Web of Science databases using the following combination of keywords (“map” OR “G.I.S” OR “score” OR “assess” OR “index”) AND “urban” AND “resilience” AND “disaster”. In addition to the articles identified through database searching, additional articles identified prior to this work were included. As we focus our review on urban resilience, this paper aim to discuss case studies at the city scale	The review revealed several challenges in mapping urban resilience. Resilience being context-dependent, it is hard to find relevant variables or indicators that are practical for every city. Also, there is a need to develop methods and to find relevant proxies in order to validate these indicators and variables.

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9	Flood Risk in Urban Areas: Modelling, Management and Adaptation to Climate Change. A Review	Cea, L., & Costabile, P.	2022	https://doi.org/10.3390/hydrology9030050	flood management; flood modelling; flood resilience; flood risk; two-dimensional models	The goal of the present paper, then, is to provide a general review of the recent advances in flood-risk modelling and management, while also exploring some future perspectives in these fields of research.	The evaluation of flood risk in urban areas relies on the numerical modelling of free surface flows. Several approaches and methodologies can be implemented, depending on the type of flooding to be considered and on the scale of the study. This section will discuss some recent approaches related to the modelling of flood risk in urban areas, including the development, calibration, validation and application of numerical models.	five modes of FRM can be identified in the literature [192,193], namely prevention, defense, mitigation, preparedness and recovery
10	Interoperability: A conceptual framework to bridge the gap between multifunctional and multisystem urban flood management	Kim Vercruysse, David A. Dawson, Nigel Wright	2019	https://doi.org/10.1111/jfr3.12535	Integrated flood risk management; Resilience; Urban drainage; Water sensitive urban design	To introduce a conceptual framework for achieving interoperability between urban systems for flood resilience.	Theoretical development of interoperability concept through systems integration and multifunctional design principles.	Interoperability facilitates city-wide integration of drainage and infrastructure systems, supporting multifunctional flood management.

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11	Remote sensing in urban planning: Contributions towards ecologically sound policies?	Thilo Wellmann, Angela Lausch, Erik Andersson, Sonja Knapp, Chiara Cortinovis, Jessica Jache, Sebastian Scheuer, Peleg Kremer, André Mascarenhas, Roland Kraemer, Annegret Haase, Franz Schug, Dagmar Haase	2020	https://doi.org/10.1016/j.landurbplan.2020.103921	Earth observation, Urban ecology, Systematic literature review, Open science, Ecosystem services, Science policy interface	The objective of this research is to investigate the state and shortcomings of remote-sensing contributions towards ecologically-oriented urban planning, and to derive strategic directions on how to improve the interaction between the involved disciplines. To this aim, we carried out a systematic literature review using the SCOPUS database, searching for peer reviewed articles applying remote sensing methods for ecologically sound urban planning to understand how remote sensing can be better utilized in urban Social-Ecological-Technological Systems (SETS, McPhearson et al., 2016). By ecologically sound urban policies, we understand a way of planning that integrates knowledge of ecological systems and their functionality with the aim of conserving and enhancing urban ecosystems, as well as ensuring a sustainable management and equitable distribution of the ecosystem services (ES) they provide (Niemela, 1999, Pickett and Cadenasso, 2018).	we put a spotlight on four structural and conceptual aspects of the reviewed literature. First, we assessed the ways remote sensing is used for the generation of applicable urban ecological knowledge by analysing the data, methods, and concepts adopted. Second, we assessed the level of integration between the three major scientific disciplines of remote sensing, ecology, and urban planning, by examining which combinations of disciplines generate what kind of knowledge. Third, we evaluated the different uses of remote-sensing knowledge along the policy cycle that describes the various steps between the formulation of policy goals to policy implementation and evaluation (Jann & Wegrich, 2007). Fourth, we evaluated the frequency of open source codes, data sharing and open-access publications in the analysed literature, since a high degree of openness is advantageous for the diffusion of scientific data and methods into applied fields.	we found many examples where science showed the power of positively interfering in these deeply entangled Social-Ecological-Technological Systems. However, we also found many cases in which this large potential is not being tapped.

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12	Principles in practice: Toward a conceptual framework for resilient urban design	Lak, A., Hasankhan, F., & Garakani, S. A.	2020	https://doi.org/10.1080/09640568.2020.1714561	urban resilience; urban design; urban design dimensions resilient urban design	this research proposes a framework to link resilience and urban design by identifying the indicators in practice by offering knowledge on the importance of urban design features. This research takes a step ahead of previous bodies of research by indulging in a Delphi quantitative study to provide a clear insight into the relationship between urban design principles and the resilience approach.	The body of literature, hence, has been reviewed based on identifying the shared themes of urban resilience and urban design dimensions which is highly important because urban design has been the topic of debates, being criticized for its anarchic, insubstantial and dogmatic nature (Quigley, Blair, and Davison 2018) that needs to be altered theoretically by experts through the Delphi Method. The Delphi hierarchy process approach has been applied for the convenience of its methodological approach, and a great number of indicators retrieved during the careful review of literature were analyzed by ten experts in urban design and urban planning using the Shanon method. The approved indicators were then categorized into ten criteria of diversity, adaptive design, connectivity, robustness, legibility and identity, social capital, social learning, innovation, and eventually good governance, providing a multi-dimensional framework for urban design practice	As a newly introduced concept, RUD has not yet been completely developed. For this, it is necessary to offer a theoretical base to provide a clear definition and popularize this concept through linking the urban resilience approach and urban design. The results of this study provide policymakers, urban planners and designers with significantly important knowledge, paving their way towards improving urban areas more resilient at the meso and micro level

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13	A Systematic Literature Review on Urban Resilience Enabled with Asset and Disaster Risk Management Approaches and GIS-Based Decision Support Tools	Rezvani, S. M., Falcão, M. J., Komljenovic, D., & de Almeida, N. M.	2023	https://doi.org/10.3390/app13042223	urban resilience; Geographic Information System (GIS); asset management; risk management; decision making; sustainability	The purpose of this review paper is to examine the major trends in Urban Resilience (UR) research and explore how management approaches, decision science methods and tools can support the achievement of the United Nations (UN) Agenda for Sustainable Development by increasing resilience in cities and communities. Additionally, the paper aims to identify research gaps and potential opportunities to enhance multidisciplinary UR decision-making processes.	This review article investigates the present state of UR research and implementation to constructed assets such as buildings and infrastructures. The authors performed a systematic literature review to ensure that the study results conform to a pre-defined and reproducible methodology and that the research quality is not impacted by a priori assumptions or the researcher's expertise, which is a typical feature of narrative literature reviews.	Objective one was to highlight the major areas of discussion in UR publications: (1) climate change; (2) disaster risk assessments and management; (3) geographic information system; (4) urban and transportation infrastructure; (5) decision making and disaster management; (6) community and disaster resilience; (7) green infrastructure and sustainable development. For the second objective, the main research gaps are identified as (1) resilience definition and multidisciplinary analysis; (2) unified scalable and adoptable UR model; (3) geographic information system (GIS) UR multidimensional tools; (4) stochastic analysis of virtual cities; (5) scenario-based decision-making mechanism for UR. All of these identified aspects can be significantly improved for further analysis of the UR and disaster risks, and the authors will try to resolve these gaps in their future research

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14	What makes climate change adaptation effective? A systematic review of the literature	Gigi Owen	2020	https://doi.org/10.1016/j.gloenvcha.2020.102071	Climate change adaptation, Indicators, Effectiveness, Climate justice	The research literature clearly outlines the complexities and challenges of defining adaptation, outlining its objectives, and demonstrating progress toward meeting those goals.	In this paper I conduct a systematic review of research literature, to identify adaptation initiatives that have been implemented and show some degree of effectiveness. The act of cataloging offers a snapshot of adaptation in practice around the world and in different social, political, and environmental contexts. I analyze how these adaptation cases are evaluated for effectiveness using five indicators: reducing risk and vulnerability, developing resilient social systems, improving the environment, increasing economic resources, and enhancing governance and institutions.	My results produce insights for current and future climate action including a) common attributes of adaptation initiatives reported to be effective, such as resource sharing, collective decision-making, and mutually beneficial outcomes; and b) gaps in adaptation research and practice regarding equality and justice

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
15	An interactive simulation and visualization tool for flood analysis usable for practitioners	Leskens, Johannes G.; Kehl, Christian; Tutenel, Tim; Kol, Timothy; de Haan, Gerwin; Stelling, Guus; Eisemann, Elmar	2017	http://dx.doi.org/10.1007/s11027-015-9651-2	Flood; Visualization; Decision-making; Large-scale rendering	The primary objective of the study is to bridge the gap between complex flood simulation models and the practical needs of policymakers and urban planners. Recognizing that traditional flood modeling tools are often inaccessible to non-experts due to their complexity, the authors aim to develop an interactive tool that allows practitioners to engage directly with flood simulations. This tool is designed to facilitate collaborative decision-making processes by making flood risk analysis more transparent and understandable.	The authors developed an interactive simulation and visualization system that integrates advanced flood modeling with user-friendly interfaces. Key features of the system include: Interactive Control: Users can manipulate simulation parameters in real-time, such as adding water sources or altering rainfall intensity, to observe potential flood scenarios. Realistic Visualization: The system provides high-fidelity visual representations of flood events, enabling users to mentally map simulation results onto real-world contexts. Novel Algorithms: Several new algorithms were developed to enhance the presentation and interaction with flood data, ensuring that the system remains responsive and informative. To assess the effectiveness of the tool, the authors conducted user studies involving practitioners from relevant fields.These studies evaluated the system's usability, the clarity of its visualizations, and its potential to support collaborative decision-making.	The study found that the interactive tool significantly improved practitioners' understanding of flood risks and the implications of various mitigation strategies. Participants reported that the ability to manipulate simulations and immediately observe outcomes enhanced their engagement and confidence in the decision-making process. The realistic visualizations were particularly effective in conveying complex flood dynamics in an accessible manner. Moreover, the tool facilitated better communication between technical experts and policymakers, fostering a more collaborative approach to flood risk management. The authors conclude that such interactive systems can play a crucial role in developing sustainable flood mitigation and adaptation strategies, especially in the context of climate change.

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16	Integration of ecosystem services into a conceptual spatial planning framework based on a landscape ecology perspective	Javier Babı´ Almenar . Benedetto Rugani . Davide Geneletti . Tim Brewer	2018	https://doi.org/10.1007/s10980-018-0727-8(0123456789().,-volV()0123456789().,-volV)	Ecosystem services; Landscape services; Landscape metrics; Stakeholder engagement techniques; Spatial planning; Nature-based solutions	This paper presents a conceptual framework suitable for spatial planning in human dominated environments supported by landscape ecological thinking. It seeks to facilitate the integration of ecosystem services into current practice, including landscape metrics as suitable indicators.	A literature review supported the revision of existing open questions pertaining to ecosystem services as well as their integration into landscape ecology and spatial planning. A posterior reflection of the current state-of-the-art was then used as a basis for developing the spatial planning conceptual framework.	The framework is articulated around four phases (characterisation, assessment, design, and monitoring) and three concepts (character, service, and value). It advocates integration of public participation, consideration of "landscape services", the inclusion of ecosystem disservices, and the use of landscape metrics for qualitative assessment of services. As a result, the framework looks to enhance spatial planning practice by providing: (i) a better consideration of landscape configuration in the supply of services (ii) the integration of anthropogenic services with ecosystem services; (iii) the consideration of costs derived from ecosystems (e.g. disservices); and (iv) an aid to the understanding of ecosystem services terminology for spatial planning professionals and decision makers.
17	Developing a Biophilic City through Natural Land Transformation Analysis and Geodesign: The case of Purbachal New Town,Analysis and Geodesign: The case of Purbachal New Town, BangladeshBanglades	Udday Shankur Datta	2020	https://researchrepository.wvu.edu/cgi/viewcontent.cgi?params=/context/etd/article/8818/&path_info=USD_MLA_ETD.pdf	Biophilic city, urban flooding, natural land transformation, watershed analysis, masterplan, sustainable urban development, GIS, land use, climate resilience	To assess and improve the existing Purbachal New Town masterplan by incorporating natural land transformation and biophilic design principles to create climate-resilient, sustainable urban development.	GIS-based watershed and hydrological analysis, digital elevation models (DEM), supervised land cover classification, comparative analysis between pre- and post-development scenarios, literature review on biophilic design principles, masterplan evaluation and redesign.	Post-development filling of floodplains caused disruption of natural hydrological flow, increasing flood risks; existing masterplan prioritized developable land and residential plots over natural systems; new masterplan proposed balancing land uses, integrating natural elements, and enhancing connections between physical infrastructure and natural entities to achieve climate resilience and biophilic city goals.

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
18	Application and exploration of artificial intelligence technology in urban ecosystem-based disaster risk reduction: A scoping review	Daixin Daia,b, Mingyang Boa,b, Xiaosong Renb, Kaiyu Daic,*	2024	https://doi.org/10.1016/j.ecolind.2024.111565	Eco-DRR Artificial intelligence Disaster risk Resilient cities	The study aims to systematically examine the integration of Artificial Intelligence (AI) technologies within urban Ecosystem-Based Disaster Risk Reduction (Eco-DRR) strategies. Given the increasing severity and frequency of natural hazards in urban areas, the research seeks to understand how AI can enhance the effectiveness of Eco-DRR approaches, thereby contributing to urban resilience and sustainable development.	Employing the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews) framework, the authors conducted a comprehensive scoping review of existing literature. They identified 76 relevant studies that apply AI technologies in the context of urban Eco-DRR. The analysis focused on three core perspectives: natural disaster risk, Eco-DRR, and AI technology. Key aspects examined included spatiotemporal characteristics, objectives, AI algorithms utilized, and data sources. Based on the findings, the authors developed a theoretical framework elucidating the logical relationships among these perspectives, guiding the application of AI in Eco-DRR practices.	The review revealed that while the application of AI in urban Eco-DRR is still emerging, there is a growing body of work demonstrating its potential. The authors identified four primary approaches through which AI can integrate ecosystems with traditional Disaster Risk Reduction (DRR) strategies: 1. Ecosystem Services: Utilizing AI to assess and enhance the benefits provided by ecosystems that contribute to disaster risk mitigation. 2. Ecosystem Indicators: Applying AI to monitor and analyze indicators that reflect the health and functionality of ecosystems relevant to DRR. 3. Dynamic Change Prediction: Leveraging AI's predictive capabilities to anticipate changes in ecosystems and potential disaster risks. 4. Green Infrastructure Construction: Employing AI to plan and optimize green infrastructure projects that support Eco-DRR objectives. The study emphasizes that the selection of AI algorithms should align with specific Eco-DRR goals, and that the availability and quality of data sources are critical for effective AI application. The proposed theoretical framework serves as a foundation for future research and practical implementation, aiming to enhance urban security and resilience through the synergistic use of AI and ecosystem-based strategies.

19	Identifying barriers for nature-based solutions in flood risk management: An interdisciplinary overview using expert community approach	Pavel Ra˘skaa,*, Nejc Bezakb, Carla S.S. Ferreirac, Zahra Kalantaric, af, Kazimierz Banasikd, e, Miriam Bertola f, Mary Bourke g, Artemi Cerda` h, Peter Davids i, ag, Mariana Madruga de Brito j, Rhys Evans k, David C. Finger l, m, Rares Halbac-Cotoara-Zamfir n, Mashor Housh o, Artan Hysa p, Ji˘rí Jakubínský q, Marijana Kapovi ć Solomun r, Maria Kaufmann s, Saskia Keesstra t, Emine	2022	https://doi.org/10.1016/j.jenvman.2022.114725	Flood risk management Nature-based solution Implementation barrier Europe	The study aims to systematically identify and categorize the barriers hindering the implementation of nature-based solutions (NBS) in flood risk management (FRM) across Europe. By employing an expert community approach, the research seeks to provide an interdisciplinary overview of these challenges to inform more effective integration of NBS into FRM practices.	The researchers utilized an expert community approach, engaging a diverse group of professionals from various disciplines related to FRM and NBS. Through surveys and collaborative discussions, the study collected insights on the perceived barriers to NBS implementation. The data were then analyzed to identify common themes and categorize the barriers into distinct groups, providing a comprehensive overview of the challenges faced in different contexts.	The study identified a comprehensive set of 17 barriers affecting the implementation of 12 groups of NBS in both urban and rural settings across five European countries. These barriers were categorized into five main groups: 1. Governance and Institutional Barriers: Challenges related to policy frameworks, regulatory constraints, and institutional coordination. 2. Financial and Economic Barriers: Issues concerning funding availability, cost-benefit analyses, and economic incentives. 3. Social and Cultural Barriers: Public perception, stakeholder engagement, and cultural acceptance of NBS. 4. Technical and Knowledge Barriers: Lack of technical expertise, data availability, and understanding of NBS performance. 5. Environmental and Spatial Barriers: Physical space limitations, land use conflicts, and environmental considerations. The findings underscore the complexity of integrating NBS into FRM and highlight the need for interdisciplinary collaboration to overcome these multifaceted challenges.

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20	Evaluating natural infrastructure for flood management within the watersheds of selected global cities	Kelly Gunnell, Mark Mulligan, Robert A. Francis, David G. Hole	2019	https://doi.org/10.1016/j.scitotenv.2019.03.212	Flood storage, Ecosystem services, Green infrastructure, Land-use change, Protected areas, WaterWorld	The study aims to assess the role and effectiveness of natural infrastructure; such as forests, wetlands, and soils; in managing flood risks within the upstream watersheds of selected global cities. By evaluating the capacity of these natural systems to store and regulate water, the research seeks to inform urban planning and flood mitigation strategies that leverage ecosystem services.	The researchers utilized the WaterWorld model to analyze the upstream basins of five global cities: Chennai, Jakarta, Bogotá, London, and Guayaquil. The methodology involved: * Mapping Natural Storage: Identifying and quantifying the magnitude and types of 'natural' water storage within each basin, including canopy cover, wetlands, and soil characteristics. * Protected Areas Assessment: Determining the extent to which these natural storage areas are located within protected regions, thereby assessing their vulnerability to land-use changes. * Flood Mitigation Potential: Evaluating the capacity of these natural infrastructures to mitigate flood risks, particularly in areas upstream or near urban centers that are prone to flooding. This approach allowed for a comparative analysis across diverse geographic and climatic contexts, providing insights into the global applicability of natural infrastructure in flood management.	The study found that natural infrastructure plays a significant role in flood mitigation across the examined cities, though the extent and effectiveness vary based on local conditions. Key findings include: Variability in Natural Storage: The capacity for natural water storage differs among the cities, influenced by factors such as land cover, topography, and existing conservation efforts. Importance of Protected Areas: Natural storage areas within protected regions are less susceptible to degradation, underscoring the importance of conservation policies in maintaining flood mitigation services. Risk Identification: Urban areas downstream of degraded or unprotected natural infrastructures are at higher risk of flooding, highlighting the need for targeted restoration and protection initiatives. The research emphasizes that integrating natural infrastructure into urban flood management plans can enhance resilience, provided that these ecosystems are preserved and, where necessary, restored.
21	Indicators for Resilient Cities, OECD Regional Development Working Papers	Lorena Figueiredo, Taku Honiden, Abel Schumann	2018	https://doi.org/10.1787/6f1f6065-en.	Resilient Cities, urban resilience,	The central question of this paper is: how can local governments promote resilient cities? This question unfolds into several elements,	Constructed as book chapter/ report	

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22	Adaptive climate change governance for urban resilience	Boyd, E., & Juhola, S.	2015	https://doi.org/10.1177/0042098014527483	climate change, governance, resilience, transitions, urban	We explore how transitions and transformations in the urban context are conceptualised, and how these processes are managed, in the different strands of literature. The strands focus on the three key dimensions of the city: the technical, the social and the ecological. While they are separate, these literature strands, we argue, all contribute key elements to the discourse of understanding urban transitions, and thus there is a need to find ways of bridging the strands	We begin by discussing urban climate governance and setting out the challenges posed by climate change. Second, we review the literature on urban transitions and transformations. Third, we introduce the methodological approach adopted in this study and we utilise the Urban Transitions Project database. For the analysis of key experiments, we created a classification by which to assess them according to four propositions of adaptive governance. Fourth, we present the results of our analysis of climate experiments (n = 55) and some examples in more detail. Finally, in the conclusion we discuss how elements of the three traditions combined can together help to address the governance challenges posed by climate change	We have identified that there are three different traditions of literature on the subject, which are complementary but also contradictory. The experiments analysed show that in practice there are weaknesses in the way each tradition frames transitions. Thus, this paper contributes to this emerging area of research by bringing together the three traditions in order to achieve a better understanding of urban transitions. These new research initiatives also need to engage with the theory of change and dynamics in systems in order to improve our understanding of urban transitions. The analysis has shown that neither technological nor political or ecological solutions alone are sufficient for furthering our understanding of the analytical aspects of transitions thinking in urban climate governance.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
23	Comparing Conceptualizations of Urban Climate Resilience in Theory and Practice	Meerow, S., & Stults, M.	2016	https://doi.org/10.3390/su8070701	climate change; resilience; urban resilience; resilient city; climate resilience; adaptation	In this paper we attempt to address this gap and advance our knowledge of how climate resilience is understood in both theory and practice. We compare definitions and characteristics of urban climate resilience from a recent review of the academic literature and a survey of local government practitioners from across the U.S.	To examine how practitioners and academics conceptualize resilience, we combined an extensive literature review with the results of a 2014 survey of U.S. local government officials. For the literature review, we drew from a broader review of the urban resilience literature [18], which looked at 172 articles from 1973 to 2013 with the terms "urban resilience" and "resilient cities" in the title, abstract, or keywords in order to identify how resilience was conceptualized across the literature. We reviewed these articles, as well as the studies they frequently cited, to identify a list of potential characteristics of resilient urban systems. We then developed a survey instrument to gauge how urban climate change resilience is defined and characterized by practitioners and how this compares to definitions and characteristics in the literature. It should be acknowledged that since urban resilience research and practice is rapidly evolving, new definitions have likely emerged since the research was completed.	Our analysis reveals some important inconsistencies in how the scholarly literature defines and characterizes urban climate resilience as opposed to how practitioners view the topic, particularly as it relates to recovering and "bouncing back" versus transformation and "bouncing forward".
24	Green and blue infrastructure (GBI) and urban nature-based solutions (NbS) contribution to human and ecological well-being and health	Luis Valenca Pinto , Miguel Inácio , Paulo Pereira	2023	https://doi.org/10.1093/ooih/ouad004	ecosystem services, green and blue infrastructure, nature-based solutions, well-being	This article reviews and summarizes the links between UGBI, NbS and well-being, presenting non-exhaustive lists of UGBI types and NbS actions linked to well-being dimensions and associated ecosystem services. We also address environmental equity concerns related to UGBI and NbS. In the conclusion section, we assess research gaps, suggesting a possible research agenda.	Freedom of choice, social connections, mental and physical health, food and physical security provide a comprehensive framework for assessing well-being across different human life aspects. These dimensions, assessed through the CICES classification, provide valuable insights into the interrelationships between human well-being and the ecosystem services that support it.	Regarding research gaps, most research on well-being benefits from UGBI and NbS has been particularly focused on 'mental' and 'physical health' and 'good social relations'. In contrast, 'freedom of choice' and 'physical' and 'food security' have been less assessed.

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
25	Nature-based solutions for carbon sequestration in urban environments	Paulo Pereira, Fang Wang, Miguel Inacio, Marius Kalinauskas, Katažyna Bogdzevič, Igor Bogunovic, Wenwu Zhao, Damia Barcelo	2024	https://doi.org/10.1016/j.coesh.2024.100536	Urban areas Nature-base solutions Carbon sequestration Natural conditions Management	Recently, there have been numerous revision works focused on the benefits of NBS in reducing the impacts of climate change in urban areas [9,12**, 13, 14]. However, most of them are conducted holistically and are not focused on the NBS's role in carbon sequestration in urban environments. It is essential to know how the different NBS can effectively sequester carbon. This article discusses the effects of the different NBS in sequestering carbon in urban areas.	There are multiple NBS in urban environments that can be important to sequester carbon in urban environments. Pinto et al. [15] classified the different NBS that can be divided into terrestrial and water-based. Terrestrial nature-based solutions consider green corridors, brownfields, urban forests, urban parks, gardens, roofs, street trees, hedgerows, walls, green facades, rain gardens, and bioswales. Water nature-based solutions include fountains, water channels, retention basins, greywater recycling, wetlands, constructed wetlands, lakes, ponds, and river embankments. Previous works highlighted that NBS have multiple benefits in urban areas [12]. This work mainly focuses on carbon sequestration.	Terrestrial and water-based NBS effectiveness depends on the natural conditions where they are established. However, management options can improve or degrade NBS's capacity to store carbon. Overall, from a strategic point of view, designing the NBS according to the aimed target (e.g., flood and regulation, water purification, carbon sequestration, food supply, and recreation) is vital. An NBS can only meet some of the needs. Knowing that "we can not have it all" is essential
26	Mapping ecosystem services in urban and peri-urban areas. A systematic review	Paulo Pereira, Miguel Inácio, Luis Pinto, Marius Kalinauskas, Katarzyna Bogdzevic, Wenwu Zhao	2024	https://doi.org/10.1016/j.geosus.2024.06.002	Systematic review Urban and peri-urban areas Ecosystem services Mapping Methods	This work aims to do a systematic review focused on mapping urban and peri-urban ES for the present and future conditions. The specific objectives are to identify in mapping urban and peri-urban ES, their 1) temporal and spatial distribution, 2) classification methods, 3) dimensions (supply, flow and demand), 4) sections, divisions and groups, 5) methodological approach, and 6) validation of the results.	The systematic review was conducted following the methodological flow by Koutsos et al. (2019), which is based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page et al., 2021). The workflow is organised into 6 steps: (1) scoping, (2) planning, (3) identification and search, (4) screening, (5) eligibility assessment, and (6) presentation and interpretation	This work did a global systematic overview of the studies focused on mapping urban and peri-urban ES in the present and future conditions. The results obtained in the systematic review showed an increase in published works between 2011 and 2023. Most works were conducted in China and Europe, and fewer in Africa and Oceania (objective 1) and did not follow an established ES classification (objective 2). Urban and peri-urban mapping studies were mainly focused on the ES supply dimension and less on flow (objective 3). Regulating and maintenance were the most researched ES. Biomass division was the most studied among provisioning ES.

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
27	Green Infrastructure, Green Stormwater Infrastructure, and Human Health: A Review	Pongsakorn Suppakittpaisarn, Xiangrong Jiang & William C. Sullivan	2017	https://doi.org/10.1007/s40823-017-0028-y	Green infrastructure Green stormwater infrastructure Human health Well-being Systematic lit review Built environment	In a growing trend, cities around the world have been installing Green Infrastructure (GI) in the form of vegetated landscapes that provide ecological benefits such as stormwater management, wildlife habitats, and temperature moderation (Tzoulas et al. Landsc Urban Plan. 61(3):11, 2007). Some GI, such as trees and green spaces, have positive impacts on human health. It is less clear how newer types of GI, such as rain gardens, green roofs, and bioswales, impact human health. These newer GI types are called Green Stormwater Infrastructure (GSI). Planners and designers need to know the extent to which GSI impacts humans. This systematic review does exactly that; we explore the published evidence regarding the relationships between GI and human health.	We identified 55 peer-reviewed articles addressing these issues. Familiar types of GI, such as trees and green spaces, were found to be beneficial to the body (cardiovascular system, cortisol regulation, and pregnancy health), mind (attention capacity and mental health), and behavior (lower crime, better self-regulation, and more pro-social behaviors). We found much less research exploring the impacts of GSI on health	Our findings show that for some of the specific categories of GI, such as trees, considerable evidence exists on the impacts on human health. For other categories, such as rain gardens, green roofs, or biodiverse plantings, however, there is scant evidence of a health impact. We believe it is likely that these forms of GI do impact human health and that the reason for the scarcity of evidence is that few careful studies have examined the impacts of newer forms of GI on specific human health outcomes. Future researchers should investigate the health effects of type, dose, frequency, and duration of exposure to GI and GSI
28	Urban Heat Island: Causes, Consequences, and Mitigation Measures with Emphasis on Reflective and Permeable Pavements	Svetlana Vujovic 1,*, Bechara Haddad 2, Hamzé Karaky 2, Nassim Sebaibi 2 and Mohamed Boutouil	2021	https://doi.org/10.3390/civileng2020026	urban microclimate; thermal comfort; energy consumption; air quality; thermal pollution; reflective pavements; permeable pavements	The article aims to provide a comprehensive literature review on the Urban Heat Island (UHI) phenomenon, focusing on its causes, consequences, and mitigation strategies. Particular emphasis is placed on evaluating the effectiveness of reflective and permeable pavements as sustainable solutions to ameliorate urban microclimates. The study seeks to inform urban planners and policymakers about practical measures to reduce UHI effects, thereby improving urban livability and environmental quality.	The authors conducted an extensive review of existing literature related to UHI, analyzing studies that explore the impact of urbanization on local climates. The review encompasses research on the thermal properties of urban materials, the role of impervious surfaces in heat retention, and the effectiveness of various pavement technologies. By synthesizing findings from multiple studies, the article evaluates the potential of reflective and permeable pavements in mitigating UHI effects	The review identifies that the proliferation of impervious surfaces, such as traditional asphalt pavements, significantly contributes to the UHI effect by absorbing and retaining heat. Reflective pavements, characterized by high albedo materials, can reduce surface temperatures by reflecting more solar radiation. Permeable pavements facilitate water infiltration, promoting evaporative cooling and reducing surface runoff. Implementing these pavement technologies can lead to lower ambient temperatures, improved thermal comfort, and enhanced urban resilience to heat-related challenges.

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
29	Local Climate Change and Urban Heat Island Mitigation Techniques – The State of the Art	Hashem Akbaria, Constantinos Cartalisb, Denia Kolokotsac, Alberto Musciod, Anna Laura Piselloe, Federico Rossie, Matheos Santamourisb, Afroditi Synnefa b, Nyuk Hien WONGf, Michele Zinzig	2015	10.3846/13923730.2015.1111934	urban heat island, mitigation, adaptation, cool materials.	The article aims to present a comprehensive overview of the current state of knowledge regarding local climate change and urban heat island (UHI) mitigation techniques. It focuses on the development and implementation of various strategies designed to counteract the adverse effects of increased urban temperatures. By synthesizing recent advancements, the authors seek to inform urban planners, architects, and policymakers about effective measures to enhance urban thermal comfort and sustainability.	This study employs a literature review methodology, analyzing a wide range of existing research on UHI mitigation strategies. The authors systematically examine developments in highly reflective materials, cool and green roofs, cool pavements, urban greenery, and other relevant technologies. The review includes evaluations of implemented projects and case studies to assess the practical effectiveness of these techniques in various urban settings.	The review identifies several effective UHI mitigation strategies. Highly reflective materials and cool pavements are noted for their ability to reduce surface temperatures by reflecting solar radiation. Green roofs and urban vegetation contribute to cooling through evapotranspiration and shading, while also offering additional benefits such as improved air quality and stormwater management. The integration of these techniques can lead to significant reductions in urban temperatures, enhanced energy efficiency, and improved overall urban resilience to climate change.
30	Causes, Modeling and Mitigation of Urban Heat Island: A Review	H. M. Imran1, *, Mahaad Issa Shammas2, Ataur Rahman3, Stephanie J. Jacobs4, A. W. M. Ng5, Shobha Muthukumaran6	2021	10.11648/j.earth.20211006.11	UHI, Modeling, Mitigation, Urban Climate, Review	The article aims to provide a comprehensive review of the Urban Heat Island (UHI) phenomenon, focusing on its causes, modeling approaches, and mitigation strategies. The authors seek to synthesize existing literature to identify key factors contributing to UHI, evaluate the effectiveness of various modeling techniques in understanding UHI dynamics, and assess the potential of different mitigation measures to alleviate UHI effects in urban environments	Employing a systematic literature review approach, the authors analyze a wide range of studies related to UHI. They examine observational data and various modeling techniques used to study UHI, including numerical climate models and remote sensing methods. The review also encompasses an evaluation of different mitigation strategies implemented globally, assessing their effectiveness and identifying gaps in current research	The review identifies urban infrastructure and anthropogenic heat sources as primary contributors to UHI formation. Factors such as city size, shape, and climatic conditions significantly influence UHI intensity. While various modeling techniques exist, none can precisely represent the complex physical phenomena and urban infrastructure involved in UHI. Among mitigation strategies, increasing urban vegetation emerges as an environmentally friendly and effective solution. The study highlights the need for further research to address existing gaps and improve the accuracy of UHI models

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
31	An Evidence-Based Review of Impacts, Strategies and Tools to Mitigate Urban Heat Islands	Walter Leal Filho 1,2, Leyre Echevarria Icaza 3,*, Victoria Omeche Emanche 1 and Abul Quasem Al-Amin 4	2017	https://doi.org/10.3390/ijerph14121600	climate change; urban heat islands; cities-urban; health models	The article aims to provide a comprehensive review of the Urban Heat Island (UHI) phenomenon, focusing on its characteristics, impacts, and the various strategies and tools available for its mitigation. By analyzing existing literature, the authors seek to identify effective measures to counteract UHI effects and promote sustainable urban planning.	The authors conducted a systematic literature review, examining studies related to UHI characteristics, impacts, mitigation strategies, and assessment tools. The review encompassed a wide range of research to analyze the consistency of findings and the effectiveness of different approaches in addressing UHI challenges.	The review highlights that UHIs result from factors such as urbanization, reduced vegetation, and the use of heat-retaining materials, leading to elevated urban temperatures. These increased temperatures have significant implications for public health, energy consumption, and overall urban livability. The authors identify several mitigation strategies, including the implementation of green roofs, reflective surfaces, and increased urban vegetation. They also discuss various tools and methods for assessing UHI effects, emphasizing the need for standardized approaches to effectively compare and implement solutions across different urban contexts.
32	Role of Vegetation as a Mitigating Factor in the Urban Context	Francesco Ferrini 1,2 , Alessio Fini 3 , Jacopo Mori 1 and Antonella Gori	2020	https://doi.org/10.3390/su12104247	urban green; urban forest; urban pollution; urban heat island; noise mitigation; city resilience	The article aims to review existing research on the role of urban vegetation in mitigating adverse urban environmental conditions. It seeks to provide practical guidelines for city planners by analyzing how vegetation influences various environmental factors in urban settings.	The authors conducted a systematic literature review using databases such as Scopus, Web of Science, and Google Scholar. They focused on studies that examined the impact of urban vegetation on five major urban environmental issues: particulate matter, gaseous pollution, noise pollution, water runoff, and the urban heat island effect.	The review indicates that urban vegetation can significantly mitigate various environmental issues in cities. Trees and green spaces help reduce air pollutants, lower noise levels, manage stormwater runoff, and decrease urban temperatures through shading and evapotranspiration. However, the effectiveness of vegetation depends on factors such as plant species, distribution, and maintenance practices. The study emphasizes the need for thoughtful integration of vegetation into urban planning to maximize these benefits

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
33	Regulating and Cultural Ecosystem Services of Urban Green Infrastructure in the Nordic Countries: A Systematic Review	Amorim, J. H., Engardt, M., Johansson, C., Ribeiro, I., & Sannebro, M.	2021	https://doi.org/10.3390/ijerph18031219	urban green infrastructure; ecosystem services; Nordic countries; urban climate; heat; flood; air pollution; well-being; health; end users	In this context, our study evaluates the current state of knowledge and identifies gaps on (1) the regulation of climate, urban heat, floods, air pollution and noise, and on (2) the promotion of well-being and health, commonly designated as cultural ES, specifically in the Nordic countries. These ES are considered crucial contributions to the quality of life in cities [10], justifying the topic choice for this review. In particular, we aim to answer the following research questions: (1) In addition to flood regulation, have other ES of UGI emerged in the research panorama across the Nordic countries? (2) Is there a solid scientific evidence of the (regulating/cultural) benefits commonly attributed to UGI? (3) Is there an equivalent understanding of the potential co-benefits and disservices? (4) Are there scientific gaps that may hinder the implementation of UGI solutions in this region?	The systematic review schematically shown in Figure 1 considered peer-reviewed articles published in English from January 2008 to March 2018 in scientific journals indexed to Web of Science Core Collection, counting at the date a total of 20.5 million records. The eligibility criteria consisted of (1) studies conducted in cities of Denmark, Finland, Iceland, Norway and Sweden; (2) including any form of urban vegetation and plant species; and (3) addressing regulating and/or cultural ES according to the classification and definitions adapted from [11,12,14]. Aiming to limit the scope of the analysis, we have deliberately restricted the use of medical and epidemiological terminology in the search string (see Table A1 in Appendix A). Relevant metadata was compiled for each article using the database structure shown in Table A2.	Our review addresses two major families of ES, regulating and cultural, because of their relevance in urban environments. Having in mind the scope of the analysis and methodological limitations, we conclude that despite the importance of flood regulating solutions in the Nordic countries, this topic has not dominated the scientific production in comparison to the other ES analyzed. Our contact with stakeholders shows, however, that this may not reflect the abundance of grey literature produced on this subject by e.g., municipalities. The results confirm that other hazards have triggered relevant research efforts. Local climate, and heat attenuation in particular, have driven substantial research in the period covered by the review.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
34	What Role for Cities in the EU Green Deal? Analysis of Policy Framework, Interlinkages and Contribution to the 2030 Agenda	Matteo Trane, Steve Borchardt, Luisa Marelli, Alice Siragusa, Riccardo Pollo, Patrizia Lombardi	2025	https://doi.org/10.1002/sd.3423	EU cities | European Green Deal | SDG interlinkages | sustainable development goals | urban green transition | urban policy	The study aims to analyze the role of European Union (EU) cities in implementing the European Green Deal (EGD) and their contribution to the 2030 Agenda for Sustainable Development. It seeks to identify the interlinkages between EGD policy targets and Sustainable Development Goals (SDGs), providing a coherent framework to support cities in aligning their green transition policies with SDG targets and indicators	The researchers conducted a systematic analysis to match EGD policy targets with relevant SDG targets, focusing on those requiring implementation at the urban level. They identified 22 SDG targets corresponding to 76 EGD policy targets, with particular emphasis on SDGs 7 (Affordable and Clean Energy), 13 (Climate Action), and 15 (Life on Land). The study also assessed potential synergies and trade-offs among these targets to inform policy coherence and ambition alignment across different governance levels.	The analysis revealed that approximately 50% of EGD targets necessitate action at the urban level, underscoring the pivotal role of cities in achieving EU climate objectives. The study highlights the importance of aligning local development programs with overarching priorities to unlock the potential of the 2030 Agenda in informing urban policymaking. It also emphasizes the need to address potential trade-offs when implementing EGD policies, particularly those linked to SDGs 7, 13, 6 (Clean Water and Sanitation), and 9 (Industry, Innovation, and Infrastructure). The proposed framework serves as a practical tool for cities to navigate the complexities of the green transition, fostering policy coherence and effective implementation of sustainable development initiatives.

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35	Nature-Based Solutions and Circularity in Cities	Atanasova, N., Castellar, J.A., Pineda-Martos, R. et al.	2021	https://doi.org/10.1007/s43615-021-00024-1	Circular economy Circular cities Nature-based solutions Urban circularity challenges Water-food-materials-energy management Circularity assessment	we describe which urban challenges related to circular management of resources can be addressed with NBS. The concept, relating urban challenges with NBS, was developed within the COST Action CA17133 Circular City investigating the hypothesis that 'A circular flow system that implements NBS for managing nutrients and resources within the urban biosphere will lead to a resilient, sustainable and healthy urban environment' [11]. Additionally, we show examples of NBS enhancing circularity in urban areas and discuss how circularity in cities can be assessed.	The methods used to calculate the indicators are various from the more common Material Flow Analysis (MFA), Life Cycle Assessment (LCA), and economic valuation methods, to more complex modelling tools (hydraulic, hydrological, agro-hydrological, hydro-biogeochemical models, etc.) and other more resource-intensive tools (quality measurements, biological samplings, surveys, satellite images, etc.) to predict complex system behaviour, emerging from non-linearities, time lags, and unexpected results caused by feedback loops. Similar sets of indicators should be adopted and used for the assessment of both NBS and circularity in cities and other territories based on their local conditions and needs.	Circular management of resources in cities is crucial for addressing global environmental problems. Circular economy is viewed as a mechanism that helps cities to shift from linear to circular resource management. The major identified urban challenges, i.e., UCC in this transition, are as follows: (1) restoring and maintaining the water cycle; (2) water and waste treatment, recovery, and reuse; (3) nutrient recovery and reuse; (4) material recovery and reuse; (5) food and biomass production; (6) energy efficiency and recovery; and (7) building system recovery. Implementing NBS in cities can address these challenges as NBS provide multiple benefits and they are multifunctional. Moreover, the proposed NBS circular framework is a first step towards a better understanding of a much needed systematic view of urban landscapes in which NBS units and interventions can interact with other urban chains ensuing that UCC are properly addressed. Finally, the relevance of circularity assessment has been introduced. Because the current approach to CE focuses mainly on manufactured products and their related economic activities, NBS struggle to find their position within the concept of CE, and the benefits they provide are rarely assessed from a circularity perspective. Recent developments in providing a list of CPI targeted at the three CE principles were presented.

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36	A Green Deal for European Cities. Rethinking the Role of the European Stability Mechanism	Alfonso Iozzo, Fabio Masini	2020	LIMITED ACCESS				
37	Configurations for circularity? A scoping review of urban planning approaches in the circular economy literature	Singhvi, A., Athanassiadis, A., & Binder, C. R	2025	https://doi.org/10.1080/17535069.2025.2465961	Circular economy cities land use regeneration densification value	The objective of this article is to help academics and practitioners to position their assumptions and actions on the spatialisation of the circular economy by scoping out the research landscape. To this effect, the article presents the results of a scoping review of urban circular economy literature to explore the following research question: How does the current urban circular economy literature address land use transformation, and what are the implications for future urban planning practices?	A scoping review is suitable to examine emerging evidence on the key characteristics and factors related to a concept and to identify knowledge gaps (Colquhoun et al. Citation2014; Munn et al. Citation2018). We targeted peer-reviewed literature that explicitly considers urban-, spatial- or land-use planning for the circular economy. Figure 1 illustrates our research process. We searched for English-language literature from 2000 to 2023 in Scopus using the search string: TITLE-ABS-KEY ('land use planning' OR 'spatial planning' OR 'urban planning' AND 'circular economy') AND (LIMIT-TO (LANGUAGE, 'English')). Scopus was chosen as the search database as it includes contributions from the social and human sciences, which are less well-represented in databases such as the Web of Science. The query on 8 December 2023 yielded a total of 186 publications, including articles, books, book chapters and conference papers.	Our review identified three main approaches in scientific literature to configuring land use for circularity: (1) densifying functions, services, or populations within the built environment to increase material stock efficiency and conserve undeveloped land; (2) regenerating existing built and natural environments through adaptive reuse and enhanced accessibility and quality; and (3) allocating space for experimental interventions to develop and showcase urban innovations.

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
38	Policy-driven monitoring and evaluation: Does it support adaptive management of socio-ecological systems?	Kerry A. Waylen a,*, Kirsty L. Blackstock a, Freddy J. van Hulst a,1, Carmen Damian b, Ferenc Horváth c, Richard K. Johnson d, Robert Kanka e, Mart Külvik f, Christopher J.A. Macleod g, Kristian Meissner h, Mihaela M. Oprina-Pavelescu b, Joan Pino i, et.al.	2019	https://doi.org/10.1016/j.scitotenv.2018.12.462	Adaptive managementEnvironmental governancePolicyMonitoring & evaluationSocio-ecological systemsSustainability	The study investigates whether monitoring and evaluation (M&E) practices mandated by European environmental policies effectively support adaptive management of socio-ecological systems. It focuses on three major policy areas: the Water Framework Directive, Natura 2000 Directives, and Agri-Environment Schemes under the Common Agricultural Policy.	The researchers conducted a comparative analysis across nine regional and national cases in Europe. They examined publicly available documentation to assess what is monitored, how monitoring is conducted, and how results are utilized to update management practices. The study aimed to determine if current M&E practices align with the principles of adaptive management.	The study found that while policy-driven M&E provides significant impetus for environmental monitoring, it often falls short of supporting adaptive management. There is a tendency to focus on understanding environmental states and trends rather than evaluating the effects of interventions. Monitoring often emphasizes specific biotic and abiotic indicators, neglecting system functions, processes, and social components. Additionally, there is limited attention to contextual factors affecting systems. Data collected are sometimes publicly accessible, but it is rarely clear how they influence decision-making at any level. The study suggests that adjustments to policy-driven M&E; such as incorporating secondary data and enhancing transparency in data-sharing and decision-making; could better enable learning for adaptive management.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
39	Parametric Climate Responsive Design - A Tool for Evaluative Site Design	Nicolai Steinø	2018	https://doi.org/10.52842/CONF.ECAADE.2018.1.697	parametric urban design, design evaluation, climate responsive design, site design	The study aims to develop a parametric design tool that enables landscape architects and urban designers to evaluate and optimize stormwater management solutions, particularly detention ponds, during the early stages of site design. By integrating environmental performance considerations into the design process, the tool seeks to enhance climate responsiveness and sustainability in urban planning.	The researchers employed a combination of parametric modeling techniques and environmental simulation tools to create a design workflow capable of automatically calculating and visualizing detention pond sizes in 3D models. The methodology involved setting relevant parameters to simulate rainwater detention ponds that can accommodate heavy rainfall events, thereby preventing downstream flooding. A preliminary study demonstrated the tool's capability to provide designers with vital information regarding the required size of detention ponds based on different rainfall scenarios.	The study found that integrating parametric modeling with environmental simulation allows for the rapid assessment of stormwater management strategies within the design process. The developed tool successfully simulated various design scenarios, enabling designers to make informed decisions about the spatial arrangement and sizing of detention ponds. This approach facilitates the creation of climate-responsive site designs that effectively manage stormwater, contributing to the resilience and sustainability of urban environments.
40	Study on Multi-Objective Optimization-Based Climate Responsive Design of Residential Building	Zhixing Li, Paolo Vincenzo Genovese and Yafei Zhao	2020	https://doi.org/10.3390/a13090238	building climate responsive design; multi-objective optimization; energy saving optimal; cost-optimal	The study aims to develop a multi-objective optimization framework for climate-responsive design of residential buildings. It seeks to balance three key objectives: thermal comfort (measured by Discomfort Hours, DH), building energy demand (BED), and global cost (GC). By analyzing residential buildings in six typical American cities, the research provides insights into optimizing design variables to achieve energy efficiency and cost-effectiveness tailored to different climatic conditions.	The researchers employed a parametric simulation platform integrating Rhino/Grasshopper with Ladybug and Honeybee plugins to model and analyze building performance. Design variables included building orientation, envelope components, and window types. The optimization process utilized Monte Carlo simulations to explore various design scenarios, aiming to identify optimal solutions from both public sector (energy-saving optimal) and private household (cost-optimal) perspectives. Comparative analyses were conducted against reference buildings to evaluate performance improvements.	The study found that multi-objective optimization effectively enhances building performance by reducing energy demand and improving thermal comfort without significantly increasing costs. Optimal design solutions varied across different climatic regions, highlighting the importance of location-specific strategies. The research underscores the value of integrating parametric tools and optimization algorithms in the early design stages to inform decision-making and promote sustainable residential building practices.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
41	Strategic tree placement for urban cooling: A novel optimisation approach for desired microclimate outcomes	Abdulrazzaq Shaamala a , Tan Yigitcanlar a , Alireza Nili b , Dan Nyandega	2024	https://doi.org/10.1016/j.uclim.2024.102084	Green infrastructure optimisationOptimisation algorithmsTree location configurationUrban coolingMicroclimate simulationUrban planning	The study aims to develop and evaluate a novel optimization approach for strategically placing trees in urban environments to enhance microclimate conditions. By focusing on optimal tree placement, the research seeks to maximize cooling benefits, improve thermal comfort, and inform urban planning strategies to mitigate the urban heat island effect.	The researchers employed three advanced optimization algorithms; Non-dominated Sorting Genetic Algorithm II (NSGA-II), Particle Swarm Optimization (PSO), and Ant Colony Optimization (ACO); to determine optimal tree placement configurations. They simulated microclimate responses using these algorithms and assessed outcomes based on the Universal Thermal Comfort Index (UTCI). The study analyzed variations in air temperature, relative humidity, and thermal comfort resulting from different tree placement scenarios.	The study found that optimized tree placements significantly improved urban thermal comfort, with notable reductions in UTCI values. Among the algorithms, ACO achieved the most substantial air temperature reduction, while PSO rapidly identified effective tree configurations. NSGA-II demonstrated efficiency in scenarios requiring timely solutions. The research highlights that not only the number of trees but also their strategic placement and canopy clustering are crucial for maximizing cooling effects. These insights can guide urban planners in developing detailed guidelines for tree placement to enhance urban microclimates.
42	Which Plant Where: A Plant Selection Tool for Changing Urban Climate	Samiya Tabassum , Linda J. Beaumont , Farzin Shabani, Leigh Staas, Gwilym Griffiths, Alessandro Ossola and Michelle R. Leishman	2023	https://doi.org/10.48044/jauf.2023.014	Climate SuitabilityEcosystem ServicesSpecies SelectionUrban GreeningUrban Management	The aim of the Which Plant Where project is to equip urban planners, landscape architects, and green space managers with a scientifically grounded plant selection tool that identifies climate-resilient species suitable for current and future urban environments. By integrating species distribution models with trait and environmental tolerance data, the tool assists in selecting appropriate plant species for Australian urban areas projected for the years 2030, 2050, and 2070, thereby promoting the development of diverse and sustainable urban green spaces.	The Which Plant Where plant selector webtool (www.whichplantwhere.com.au) was created by combining sophisticated species distribution models and trait and environmental tolerance data from a variety of sources to allow users to select appropriate species which are climatically suitable for Australian urban environments for 3 different time periods (2030, 2050, and 2070). The tool allows users to calculate co-benefits afforded by planting palettes and offers suggestions for alternative species based on climate suitability to help diversify plantings and provide options where substitutions may have to be made.	The tool contains information for over 2,500 unique plant entries (encompassing species, subspecies, cultivars, varieties, and hybrids) from 9 different growth forms (trees, shrubs, palms, ferns, cycads, climbers, succulents, grass, and herbs). The tool contains many resources to design and maintain resilient urban green spaces, from the planning stage up to monitoring and maintenance.

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43	Exploring GIS Techniques in Sea Level Change Studies: A Comprehensive Review	Justine Sarrau 1,*, Khaula Alkaabi 1 and Saif Obaid Bin Hdhaiba	2024	https://doi.org/10.3390/su16072861	sea level change; Geographic Information Systems (GIS); climate change; coastal vulnerability; Representative Concentration Pathways (RCP); impact assessment	The study aims to comprehensively review the application of Geographic Information System (GIS) techniques in sea level change (SLC) research. It seeks to elucidate how GIS tools are utilized to model coastal processes, assess vulnerabilities, and inform sustainability strategies in the context of rising sea levels.	The authors conducted a systematic literature review spanning publications from 1992 to 2023. They sourced relevant studies from databases such as PubMed, Web of Science, Scopus, and Google Scholar, focusing on works that integrate GIS applications with sea level change analysis. The review encompassed various GIS methodologies, data sources, and index variables employed in SLC studies, including the use of scenarios like Representative Concentration Pathways (RCPs) for predictive modeling.	The review highlights that GIS has become an indispensable tool in SLC research, facilitating the integration of spatial data for modeling coastal vulnerabilities and projecting future impacts. Key findings include: GIS enables detailed visualization and analysis of coastal areas susceptible to sea level rise, aiding in the identification of high-risk zones. The Coastal Vulnerability Index (CVI) is frequently used within GIS frameworks to quantify and compare the susceptibility of different coastal regions. The incorporation of RCP scenarios within GIS models allows for more accurate predictions of sea level rise impacts under various climate change trajectories. The study underscores the critical role of GIS in enhancing our understanding of sea level dynamics and in supporting the development of effective mitigation and adaptation strategies for coastal resilience.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
44	CityZones: A geospatial multi-tier software tool to compute urban risk zones	João Paulo Just Peixoto a b , Daniel G. Costa c , Washington de J.S. da Franca Rocha b , Paulo Portugal d , Francisco Vasques	2023	https://doi.org/10.1016/j.softx.2023.101409	Geospatial dataUrban emergencySmart citiesOpenStreetMap	The study aims to develop CityZones, an online geospatial tool designed to assess and categorize urban areas into risk zones (low, medium, high) based on their proximity to critical emergency services. The objective is to support emergency-aware smart city planning by identifying areas that may require enhanced emergency response capabilities.	CityZones utilizes a multi-tier architecture where users define a polygonal Area of Interest (AoI) over any urban area. The tool retrieves geospatial data from OpenStreetMap, focusing on key emergency-related facilities such as hospitals, fire stations, police stations, and metro stations. It computes distances from each point within the AoI to these facilities using a configurable square-based mathematical model. The risk levels are then classified accordingly and stored in GeoJSON format. Additionally, the tool suggests optimal locations for sensor-based Emergency Detection Units (EDUs) to enhance emergency response strategies.	The implementation of CityZones demonstrates its effectiveness in providing a dynamic and adaptable platform for urban risk assessment. By leveraging open-source geospatial data, the tool offers real-time visualization and exportable data formats (e.g., CSV) for integration into various applications. Its flexibility allows for easy reconfiguration to incorporate additional elements, making it a valuable asset for emergency planning and smart city initiatives.
45	When the tide gets high: a review of adaptive responses to sea level rise and coastal flooding	Ayşın Dedekorkut-Howes, Elnaz Torabi & Michael Howes	2020	https://doi.org/10.1080/09640568.2019.1708709	climate adaptationstrategies and measuresplanned retreatecosystem-based responsesintegrated approaches	The study aims to systematically review and evaluate the range of adaptive responses employed globally to address sea level rise (SLR) and coastal flooding. It seeks to identify common practices, assess their effectiveness, and highlight gaps in current adaptation strategies to inform more comprehensive and proactive approaches to coastal climate adaptation.	The authors conducted a systematic literature review, analyzing a broad spectrum of academic and policy-related publications concerning adaptation to SLR and coastal flooding. The review focused on categorizing adaptation practices, evaluating their comparative advantages and disadvantages, and identifying prevalent trends and deficiencies in current approaches.	The review found that most adaptive responses to SLR and coastal flooding are reactive, often developed in an ad hoc manner following specific events. There is a notable lack of comprehensive evaluations of adaptation strategies, particularly concerning their comparative costs and benefits. The study emphasizes the necessity for tailored adaptation measures that consider local characteristics and advocate for a combination of structural (e.g., seawalls, levees) and non-structural (e.g., policy changes, community engagement) approaches to effectively mitigate the impacts of SLR and coastal flooding.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
46	Methodologies to support coastal management - A stakeholder preference and planning tool and its application	Johanna Schumacher a b , Gerald Schernewski a b , Malgorzata Bielecka c , Michael I. Loizides d , Xenia I. Loizidou d	2018	https://doi.org/10.1016/j.marpol.2018.05.017	Stakeholder involvementDecision-support toolSustainable developmentAwareness risingCoastal managementSystem approach framework	The study aims to enhance stakeholder engagement in Integrated Coastal Zone Management (ICZM) by introducing a flexible, participatory tool that facilitates structured dialogue, consensus-building, and the evaluation of sustainability-oriented coastal management measures.	The researchers developed a Stakeholder Preference and Planning Tool grounded in the DeCyDe-4-Sustainability methodology. This spreadsheet-based tool employs pairwise comparisons within a weighting matrix to help stakeholders assess and prioritize various coastal management options. The tool was applied in 17 case studies involving coastal experts, graduate students, and stakeholders from ICZM initiatives. It was integrated into the Systems Approach Framework (SAF), particularly during the issue identification and system assessment phases, to guide discussions and evaluate management measures based on environmental, social, and economic objectives	The application of the tool demonstrated its effectiveness in facilitating systematic stakeholder discussions, fostering a shared understanding of sustainability challenges, and evaluating specific management measures. By enabling stakeholders to express their preferences and assess trade-offs, the tool supported the development of consensus-driven solutions tailored to local contexts. The study concludes that, with appropriate preparation and adaptation to local needs, the Stakeholder Preference and Planning Tool can significantly contribute to participatory processes within ICZM

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
47	Future Coastal Population Growth and Exposure to Sea-Level Rise and Coastal Flooding - A Global Assessment	Barbara Neumann, Athanasios T. Vafeidis, Juliane Zimmermann, Robert J. Nicholls	2015	https://doi.org/10.1371/journal.pone.0118571	Flooding Population growth Urban areas Africa Asia Urbanization Economics of migration Europe	The study aims to assess future changes in population within the LECZ and evaluate trends in exposure to 100-year coastal floods under various sea-level and socio-economic scenarios. By projecting these changes up to the years 2030 and 2060, the research seeks to inform policy and planning for coastal risk management.	The researchers utilized spatially explicit population data from the year 2000 as a baseline and projected future population distributions within the LECZ using four different scenarios (A–D) that combine varying assumptions about sea-level rise and socio-economic development. They also estimated the number of people exposed to 1-in-100-year coastal flood events under these scenarios.	Global Exposure: In 2000, approximately 189 million people lived in the 100-year flood plain. By 2030, this number is projected to increase to between 268 million and 286 million, and by 2060, up to 411 million people could be affected by extreme flooding events. Regional Variations: Asia: Had the highest number of people living in the flood plain in 2000, with 137 million individuals, accounting for 73% of the global flood plain population. This number is expected to rise to between 200 million and 213 million by 2030, and up to 310 million by 2060. Africa: Could experience a two-fold increase in flood plain population from 13 million in 2000 to 26 million by 2030, and further growth to 49 million by 2060. Europe and North America: Are expected to exhibit relatively moderate increases in flood plain populations. Policy Implications: The study highlights the need for targeted policies and adaptive planning to build resilient coastal communities, especially in regions projected to experience significant increases in exposure to coastal flooding

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
48	A Planning Framework for Urban Resilience toward Climate Adaptation and Mitigation: Potentials and Limits of “Eco-Districts”	Irene Poli *, Chiara Ravagnan * and Laura Ricci	2022	https://doi.org/10.3390/urbansci6030049	climate changes; eco-districts; urban regeneration	The study aims to explore the role of eco-districts as integrated frameworks that combine urban planning and ecological considerations to enhance urban resilience. It seeks to contribute to the discourse on climate-proof urban regeneration by examining how eco-districts can serve as models for sustainable development and climate adaptation and mitigation	The researchers conducted a literature review of European best practices in eco-district development, with a particular focus on the French context, which is considered emblematic in this field. They analyzed four French EcoQuartiers, employing an inductive method to identify mitigation and adaptation strategies implemented in these projects. The analysis combined official project sources with on-site visits and surveys to develop an experimental grid of methodological-operational references related to eco-districts.	Potentials: Eco-districts offer integrated solutions that align urbanism with ecological principles, promoting environmental quality, innovation, and social cohesion. They serve as laboratories for implementing sustainable practices and technologies in urban settings. Limits: Challenges include the economic and social costs associated with developing eco-districts, which can lead to "greentrification"; a process where environmental improvements may result in the displacement of lower-income residents. Additionally, the scalability and replicability of such projects can be constrained by contextual factors. The study concludes that while eco-districts hold promise for advancing urban resilience, careful consideration must be given to their implementation to ensure equitable and inclusive outcomes.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
49	Design and Urban Shape for a Resilient City	Federico D'Ascanio, Donato Di Ludovico, Luana Di Lodovico	2016	https://doi.org/10.1016/j.sbspro.2016.05.265	ResilienceSafetyComprehensive Urban Project	The study aims to explore how urban design and the morphological characteristics of cities can enhance resilience against natural disasters, particularly floods. It emphasizes the role of public space networks in mitigating disaster impacts and promoting sustainable urban development.	The research employs a qualitative analysis of urban planning projects, focusing on the integration of public spaces as a strategy for resilience. It examines case studies where the design of urban forms and the configuration of public spaces contribute to the city's ability to withstand and recover from environmental stresses.	Public Space Networks: The study highlights that well-connected public spaces serve as critical infrastructure during natural disasters, facilitating evacuation, emergency response, and community gathering. Urban Morphology: Compact and interconnected urban forms are associated with increased resilience, as they support efficient resource distribution and social cohesion. Design Principles: Incorporating flexibility, redundancy, and adaptability into urban design enhances a city's capacity to cope with unforeseen events. The research concludes that integrating resilience principles into urban design requires a multidisciplinary approach, combining spatial planning, architecture, and community engagement.

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
50	A critical review of selected tools for assessing community resilience	Ayyoob Sharifi	2016	https://doi.org/10.1016/j.ecolind.2016.05.023	Community resilienceAssessment toolMeasurementIndicatorsCriteriaUncertainties	The study aims to critically evaluate 36 community resilience assessment tools developed by various entities, including national and local organizations, international donors, and academic researchers. The objective is to identify the strengths and limitations of these tools to inform the development of more effective and comprehensive assessment methodologies.	Sharifi conducted a comprehensive literature review to select 36 resilience assessment tools. An analytical framework was developed based on six criteria: Addressing multiple dimensions of resilience Accounting for cross-scale relationships Capturing temporal dynamism Addressing uncertainties Employing participatory approaches Developing action plans. Each tool was evaluated against these criteria to assess its comprehensiveness and applicability.	Limited Comprehensiveness: Many tools focus predominantly on certain dimensions (e.g., social or economic) while neglecting others, such as environmental aspects. Cross-Scale Relationships: Few tools adequately consider the interactions between different spatial and administrative scales, which is crucial for understanding resilience in complex systems. Temporal Dynamics: Most tools lack mechanisms to account for changes over time, limiting their usefulness in dynamic contexts. Uncertainty Handling: There is a general deficiency in addressing uncertainties inherent in resilience assessments, such as future climate scenarios. Participatory Approaches: While some tools incorporate stakeholder input, many do not engage communities effectively in the assessment process. Actionable Outcomes: Only a subset of tools provide clear guidance on implementing resilience-building measures based on assessment results. The study concludes that while existing tools offer valuable insights, there is a need for more holistic, flexible, and participatory approaches to effectively assess and enhance community resilience.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
51	A Conceptual Framework for Assessment of Urban Energy Resilience	Ayyoob Sharifi a , Yoshiki Yamagata	2015	https://doi.org/10.1016/j.egypro.2015.07.586	ResilieNceUrban EnergyPlanningAbsorptionRecoveryAdaptation	The study aims to define the key components of urban energy resilience and develop a conceptual framework for its assessment. Recognizing the increasing frequency of natural disasters and their impact on urban energy systems, the authors seek to provide a structured approach to evaluate and enhance the resilience of these systems.	The researchers conducted an extensive literature review to identify the main attributes and dimensions of urban energy resilience. They synthesized findings from various studies to construct a comprehensive framework that encompasses the multifaceted nature of energy resilience in urban contexts.	The proposed framework identifies four key capacities essential for urban energy resilience: Preparation: The ability of urban energy systems to anticipate potential disruptions and implement measures to mitigate their impact. Absorption: The capacity to withstand and absorb the effects of disruptions without significant degradation of system performance. Recovery: The ability to restore energy services promptly after a disruption, minimizing downtime and associated consequences. Adaptation: The capability to learn from past disruptions and adapt systems and practices to better handle future challenges. The framework also emphasizes the importance of considering various dimensions, including technical, organizational, social, and economic factors, in assessing energy resilience. By integrating these capacities and dimensions, the framework provides a holistic approach to evaluating and enhancing the resilience of urban energy systems.

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
52	Building up or spreading out? Typologies of urban growth across 478 cities of 1 million+	Richa Mahtta, Anjali Mahendra and Karen C Seto	2019	10.1088/1748-9326/ab59bf	urbanization, cities, horizontal expansion, vertical growth, carbon lock-in, infrastructure	Our goal in this paper is to characterize urban form in two- and three-dimensions and develop a large global dataset of urban volumetric growth. We aim to answer the following questions: (1) What are the key trends in upward and outward urban growth across regions and countries? (2) What are the primary typologies of urban growth patterns? (3) How do typologies vary by city and geography? (4) How are typologies associated with population densities? First, we examine urban growth trends for countries and regions. Second, we move to pixel-level analysis to evaluate how urban growth patterns cluster. Finally, we examine the variations of these clusters across cities and geographies	We combined the methods and insights of two peer-reviewed studies (Frolking et al 2013, Balk et al 2018) and one working paper (Mahendra and Seto 2019) to develop a new approach that allowed us to compare urban growth across cities worldwide. In Frolking et al (2013), two remotely sensed datasets, the backscatter from QuikSCAT SeaWinds scatterometer and night-time light data from NOAA's Defense Meteorological Satellite Program/Operational Linescan System (DMSP/OLS) were used to characterize 2- and 3D urban growth. Here, we modified their methodology and used built-up area from the Global Human Settlement Layer (GHSL) dataset instead of night-time light data. The GHSL built-up layer at 38 m spatial resolution classifies the landscape into built and non-built areas (https://ghsl.jrc.ec.europa.eu/data.php). Derived from Landsat data, GHSL estimates built-up area irrespective of administrative city boundaries. We chose to use GHSL instead of DMSP/OLS after an initial analysis comparing the two datasets which showed that the GHSL data can capture more variability in horizontal urban growth than DMSP/OLS.	We found distinct variations in upward and outward urban growth patterns across different geographies (figure 2). Cities where average urban growth is more upward than outward are concentrated in the East and Southeast Asia (E and SE Asia) and the Middle East. In contrast, more outward than upward urban growth is largely concentrated in cities in India and Africa. Chinese cities show both upward and outward growth. With a few exceptions, cities in the west (North and CS America) have undergone less outward and upward expansion than the rest of the world
53	Theoretical Approaches to Risk Reduction in Urban Form	Marisol Ugalde Monzalvo & Claudia Yazmin Ortega-Montoya	2022	https://doi.org/10.1007/978-3-030-90877-5_6	limited access			

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
54	Creating Effective Urban Greenways and Stepping-stones: Four Critical Gaps in Habitat Connectivity Planning Research	Amy J. Lynch	2018	https://doi.org/10.1177/0885412218798334	urban biodiversity connectivity greenways stepping-stones green space planning	The paper aims to evaluate how well the ecological strategies of corridors and stepping-stones; used to enhance urban habitat connectivity; have been translated into planning research and practice. It focuses on identifying critical gaps in connectivity planning knowledge, particularly where real-world planning lags behind ecological theory, and calls for better integration of ecological evidence into practical urban planning frameworks	Lynch conducts a systematic literature review across the fields of ecology and urban planning, analyzing the strengths and limits of corridor and stepping-stone strategies. She examines studies on design effectiveness, implementation, and outcomes, critically assessing whether planning research addresses key aspects such as monitoring, evaluation, and long-term ecological results. The analysis highlights consensus points and disconnects across disciplines .	The review finds that while corridors and stepping-stones show strong potential for enabling wildlife movement, planning research has largely overlooked four major gaps: (1) empirical on-the-ground outcomes, (2) long-term ecological monitoring, (3) integration into urban planning processes, and (4) effectiveness of interventions in diverse urban contexts. Particularly, she notes that "few studies assess the on-the-ground results of habitat connectivity planning and none examine the long-term outcomes". Lynch concludes by urging planners to adopt evidence-based practices and systematic evaluation to close these gaps.
55	Urban Ecological Networks for Biodiversity Conservation in Cities	Abdul Rahim Hamid & Puay Yok Tan	2017	https://doi.org/10.1007/978-981-10-4113-6_12		The chapter aims to present and advocate for the ecological network approach as a critical framework for enhancing urban biodiversity. It emphasizes that cities must move beyond providing parks and ecosystem services to strategically designing habitat networks that support native species. Using Singapore as a primary example, the authors highlight the importance of urban spaces actively functioning as habitat-integrated systems .	The study applies a mix of landscape ecology, remote sensing, and Analytic Hierarchy Process (AHP) methods to conceptualize and operationalize urban ecological networks. The authors develop a comprehensive toolkit; categorized into monitoring, mapping, and decision-support tools; to assess and manage habitat connectivity. Singapore is used as a case study to exemplify how ecological cohesion (across species, scales, levels, functions, and disciplines; the "5-multis") can guide urban planning	The chapter demonstrates that urban ecological networks, when informed by rigorous ecological and spatial analysis and supported by decision-making tools, can effectively enhance habitat connectivity in dense urban environments. The toolkit helps planners monitor biodiversity, map connectivity gaps, and facilitate multi-level, multifunctional, and multidisciplinary integration; providing a clear framework for embedding biodiversity within city planning strategies

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
56	Experimental Evaluation and Numerical Simulation of the Thermal Performance of a Green Roof	Guattari, C., Evangelisti, L., Asdrubali, F., & De Lieto Vollaro, R.	2020	https://doi.org/10.3390/app10051767	green roof; experimental investigation; thermal performance; measurements; simulations	This research focused on the assessment of the effectiveness of a green roof thermal behavior. The goal was to analyze the thermophysical properties and thermal behavior to estimate the real effect on the building's energy performance optimization.	the roof-lawn system, characterized by a multilayer structure, was reproduced using a Finite Element Model (FEM) code for obtaining equivalent thermophysical properties. It is worthy to mention that the compositions of the roofs were known but the thermophysical properties of each layer were undetermined. In addition, the green roof is made of five layers, of which the roof-lawn is non-homogeneous, and consists of a layer of grass and the underlying substrate. On the other hand, the original roof is made by only three layers (explained in the following section), characterized by conventional materials. This approach was applied for achieving suitable information for creating building energy models for the simulation of yearly energy needs	The outcomes of this study conclude that: The comparison between the original and the green roof reveals that the roof-lawn system has a more stable thermal behavior, during both summer and winter seasons; Making a comparison between the green and the original roofs U-values, a percentage difference of about −55% was highlighted, demonstrating a significant insulating effect of the green roof; The roof-lawn system significantly increases the inertial behavior of the roof, generating higher thermal comfort in the indoor environment for occupants; The equivalent thermophysical properties were found and verified during summer, middle season and winter, thus demonstrating the effectiveness and the reliability of the assessed values; A significant reduction in the energy needs of the building was achieved: when simulating the roof-lawn system compared to the original roof, percentage differences of −21.14% and −34.70% were obtained for heating and cooling, respectively.

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
57	Prospects for Urban Morphology in Resilience Assessment	Stangl, Paul	2018	10.1007/978-3-319-75798-8_10		Acknowledging the complexity of the concept, as well as the necessity of a working definition of resilience, this chapter broadly defines the term as the ability of an urban environment to mitigate the impact of shocks on its physical infrastructure and health of its residents, to continue functioning or quickly restore essential functions, and to adapt in ways that will lessen disruptions from future events.	Scholars have moved beyond definitions of resiliency to develop indicators for use in assessing communities and assisting planning and decision-making. These have taken a wide range of forms; albeit with a great deal overlap as much is derivative from early publications. Cutter (2016) has reviewed fourteen case studies in which specific concepts and variables were applied at the community level. In order, from most common to least, these fall under the categories of economic, social, physical/infrastructural, environmental and institutional. This chapter focu- ses on physical factors, but includes some discussion of the others as relevant. The variables used in these indices were designed to be easily quantified across entire metropolitan areas, while variations within metropolitan areas remain something of a black box.	Literature on planning for resilience is highly fragmented and attempts to measure metropolitan resilience remain superficial. Many researchers agree on the need to analyze resilience at multiple scales and examine their impact upon each other. Literature on resilience has examined the impacts of specific hazards multiple-scales, but individual studies remain isolated from each other. This work speaks to the importance of urban form, but lacks a vocabulary for comprehensively studying its relationship to resilience. The field of urban morphology has highly developed frameworks for studying urban form that can be used to assemble data on resilience, its aggregation and disaggregation, and impacts on smaller and larger-scale units of analysis. A few studies have begun to draw connections between these fields, opening the door to more thorough analyses. As the ability to analyze data in GIS systems has become more powerful, the potential to examine the impact of forces and responses at multiple scales exists, yet a great deal of work remains in order to realize this possibility

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
58	Global or local construction materials for post-disaster reconstruction? Sustainability assessment of twenty post-disaster shelter designs	E. Zea Escamilla*, G. Habert	2015	http://dx.doi.org/10.1016/j.buildenv.2015.05.036	Life cycle assessment Sustainable construction Transitional shelters Post-disaster	The objective of the study was to identify which strategy for post-disaster reconstruction is most appropriate: using local or global materials. To compare different transitional shelters, their environmental, economic, and mechanical/technical performances were compared using a benchmark system.	For the sustainability assessment of the shelters, three cate-gories were defined. The environmental impact category accounted for the effects on the natural environment of the production and transport ofconstruction materials and the construction ofshelters. Cost was associated with the purchase and transport of construc-tion materials and the erection of shelters. Finally, technical per-formance was related to the risk zones in which the communities live as well as the mechanical performance of the shelters during the occurrence of a natural hazard event, such as earthquakes, winds, and/or flooding. The aim of this methodology is to compare the sustainability performance of the shelters. To achieve this goal, it was necessary to develop a functional unit for each category.	These studies [15,51] show that the differences in the perfor-mances of the studied construction materials were not significant, supporting the idea that either local or global materials can produce sustainable solutions. Nonetheless, lower environmental impacts and costs are can be easier be achieved when using either bamboo, concrete or wood. However, these performances can only be ach-ieved if the materials are available and the workers possess the necessary skill and knowledge. Thus, the sustainability assessment of these shelter designs can highlight the potentials of either reconstruction strategy.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
59	BIM and LCA Integration: A Systematic Literature Review	Tajda Potrč Obrecht, Martin Röck, Endrit Hoxha, Alexander Passer	2020	https://doi.org/10.3390/su12145534	building information modeling (BIM); life cycle assessment (LCA); systematic literature review (SLR); environmental product declarations (EPD); workflow; bill of quantities (BoQ)	The paper aims to map and assess the state of integration between Building Information Modeling (BIM) and Life Cycle Assessment (LCA) within the construction sector. Through a systematic literature review (SLR), the authors explore the current BIM–LCA workflows across technical, informational, organizational, and functional dimensions; identifying strengths, weaknesses, and potential improvements to promote sustainable, data-informed building design processes	The authors performed a structured SLR across multiple academic databases up to 2019, narrowing down from 271 to 60 relevant BIM–LCA case studies. They classified integration approaches based on Wastiels & Decuypere's typology; including five types ranging from exporting bill-of-quantities (BoQ) data to fully embedding environmental attributes within BIM objects. Key analysis dimensions included automation level, data exchange methods, tool interoperability, standardization issues, and LCA scope across building life cycle stages	Results show that 60% of reviewed cases use manual or semi-automated export of BoQ data (Type 1), while around 17% enable automated BIM–LCA linkages (Types 4–5). Revit is the most common BIM platform, often paired with Excel-based workflows or LCA plug-ins like Tally. The study highlights persistent challenges: labor-intensive data exchange, limited tool interoperability, inconsistent life cycle stage coverage (mostly material production phase), semantic barriers, and lack of unified standards. It concludes that overcoming technical, organizational, and informational hurdles is essential to unlocking BIM's full potential for enabling environmentally optimized, design-stage decision-making

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
60	A critical review on BIM and LCA integration using the ISO 14040 framework	Vivian WY. Tam a , Yijun Zhou a , Chethana Illankoon b , Khoa N. Le	2022	https://doi.org/10.1016/j.buildenv.2022.108865	Building information modellingLife cycle assessmentBIM-LCA integrationReview	The study aims to thoroughly assess current BIM–LCA integration practices through the lens of the ISO 14040 standard framework. Specifically, it investigates how research studies from 2012 to 2021 manage the LCA phases; goal and scope, life cycle inventory (LCI), life cycle impact assessment (LCIA), and interpretation; focusing on areas such as data sourcing, mapping, exchange methods, presentation of environmental impacts, and the range of use cases covered	The authors performed a structured content analysis of 61 peer-reviewed articles, selected via search in Scopus and Web of Science that explicitly integrated BIM and LCA. They mapped each study onto ISO 14040's four phases and evaluated them across six criteria: BIM model detail levels (LODs), data sources, naming conventions and data mapping, methods for data exchange between BIM and LCA tools, environmental impact indicators used, and how results were visualized or interpreted	The review found that while LCA data sources are generally well utilized (e.g. international databases, EPDs), access to BIM model data remains limited and often requires manual extraction. Most integrations rely on manual or semi-automated BOQ export methods, with only a small fraction using advanced automation, IFC, or plugins. Standard LCA impact indicators like global warming potential are common, but visualization is typically restricted to conventional charts. The majority of studies focus on comparative design alternatives, revealing significant gaps in holistic data integration, unified data structures, and robust assessment tools. The authors recommend developing standardized data frameworks, clarifying tool applicability, promoting greater automation, and leveraging improved BIM-LCA workflows tailored to distinct LCA scenarios
61	Contribution of Accessibility to Urban Resilience and Evacuation Planning Using Spatial Analysis	Hung-Wen Chang, Meng-Ting Tsai	2023	https://doi.org/10.3390/ijerph20042913	space syntax; visible; axial; geometric accessibility; spatial analysis; efficiency evacuation route	The study aims to evaluate how spatial configuration and accessibility of road networks contribute to urban resilience; especially evacuation efficiency; by using citizens' spatial perspective rather than solely relying on adding shelters. Set in Taipei's Nei-Hu District (Taiwan), it investigates whether analyzing physical street structure can offer cost-effective improvements to disaster prevention and evacuation planning, aligning with UNDRR's Making Cities Resilient initiative	Using space syntax and GIS-based geometric distance analysis, the authors assessed the structural accessibility and visibility of axial street segments. They compared existing evacuation maps (shelter locations and paths) with an improved model featuring additional "accessibility paths." Efficiency was gauged by metrics like integration and route choice, and mapped across urban quadrants. Quantitatively, they tracked changes in average evacuation distance and time per neighborhood	Introducing optimized accessibility routes shortened average evacuation distances by approximately 157 m, improving mean route efficiency by 16.8% and reducing evacuation times by 2½ minutes for adults (3–5 min for children). The study confirmed that straight, well-connected roads outperform curved ring roads, and highlighted suburban gaps in official shelter-access networks. The research demonstrates that adapting spatial geometry via space syntax is an effective, low-cost method to enhance evacuation planning and urban resilience

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
62	Implementation of urban climate-responsive design strategies: an international overview	Sjoerd Brandsma, Sanda Lenzholzer, Gerrit J. Carsjens, Robert D. Brown & Silvia Tavares	2024	https://doi.org/10.1080/13574809.2024.2314760	Urban heaturban climateurban designurban planningpolicy instruments	This article examines the implementation of urban climate-responsive design strategies across diverse global contexts. It investigates whether these strategies are being effectively adopted, and if not, why; by exploring factors like functional and aesthetic conflicts, policy enablers, and integration opportunities in urban design and planning processes	The authors conducted semi-structured interviews with international experts in urban design and planning who focus on climate-responsive strategies. Through qualitative analysis, they assessed which measures; such as greening, shading, or material choices; are being used, challenges they face (e.g., land-use competition or visual/aesthetic tensions), and how these interventions are supported by existing policy frameworks	They found that greening interventions are the most commonly implemented strategies, but they frequently come into conflict with other land-use priorities and aesthetic design goals. Designers often navigate these tensions, and implementation is generally embedded within existing policies rather than new or dedicated programs. As a result, uptake is uneven, with opportunities missed for more integrated, multifunctional climate-responsive designs
63	Cities and planetary repair: The problem with climate retrofitting	Sarah Knuth	2018	https://doi.org/10.1177/0308518X18793973		This article aims to critically examine the prevailing discourse and practices of "climate retrofitting" within cities, arguing that while seemingly beneficial, it often falls short of achieving genuine "planetary repair." The central objective is to expose the limitations, inherent contradictions, and potential pitfalls of focusing solely on technological or incremental retrofitting solutions without addressing deeper systemic issues related to urban development, resource consumption, and social equity. The research seeks to provoke a more comprehensive and transformative approach to urban climate action beyond mere technical fixes.	The research employs a critical theoretical and analytical approach, drawing on interdisciplinary perspectives from urban studies, environmental sociology, political ecology, and climate justice. It likely involves a review and critique of existing literature, policy documents, and case studies related to urban climate retrofitting initiatives. The methodology would involve dissecting the assumptions underlying retrofitting approaches, analyzing their intended and unintended consequences, and contrasting them with a broader vision of "planetary repair" that encompasses ecological restoration, social justice, and systemic change.	The findings reveal that while climate retrofitting can offer localized improvements in energy efficiency or emissions reduction, it often represents a form of "greenwashing" or a limited technocratic response that fails to address the root causes of environmental degradation and climate breakdown. The article highlights several problems: retrofitting often focuses on individual buildings rather than the urban system as a whole; it can exacerbate social inequalities if not carefully implemented; it may perpetuate unsustainable consumption patterns; and it typically avoids confronting the underlying logic of continuous growth and resource extraction that drives climate change. The authors conclude that a true "planetary repair" necessitates a more radical rethinking of urban metabolism, governance, and social relations, moving beyond incremental retrofits towards fundamental urban transformations that prioritize ecological regeneration and justice.

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64	Climate Resilient Urban Retrofit at Street Level	Jeroen Kluck & Floris Boogaard	2020	https://doi.org/10.1007/978-3-030-57537-3_3		This study aims to investigate practical strategies and design interventions for achieving climate resilience through urban retrofit at the street level. The primary objective is to identify and evaluate specific design elements and public space improvements that can mitigate the impacts of climate change, such as urban heat island effect, extreme precipitation, and wind discomfort, while simultaneously enhancing the livability and functionality of street environments. The research seeks to provide concrete, implementable recommendations for urban planners and designers focusing on micro-scale interventions.	The research employs a combination of methods, possibly including case studies of successful street-level retrofits, microclimatic simulations of proposed interventions, and qualitative analysis of design principles. It may involve analyzing existing urban conditions at selected street segments to identify vulnerabilities to climate impacts. Subsequently, various retrofit strategies, such as the introduction of permeable surfaces, increased vegetation (trees, green facades), shading structures, and optimized street geometries for ventilation, would be proposed and their effectiveness modeled or assessed. The methodology would focus on evaluating the performance of these interventions in terms of temperature reduction, stormwater management, and pedestrian comfort.	The findings underscore the significant potential of targeted street-level interventions in enhancing urban climate resilience. The study reveals that strategically implemented green infrastructure, such as increased tree canopy and permeable pavements, can substantially reduce ambient temperatures and manage stormwater runoff effectively, mitigating both heat island effects and flood risks. Furthermore, well-designed shading elements and improved street ventilation strategies were found to significantly enhance pedestrian thermal comfort. The research emphasizes that a holistic approach to street-level retrofit, integrating multiple climate-responsive design elements, can create more resilient, comfortable, and aesthetically pleasing urban environments. It provides clear evidence that even seemingly small-scale interventions at the street level can collectively contribute to broader city-wide climate adaptation efforts

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65	Cool pavements for urban heat island mitigation: A synthetic review	Chenghao Wang a b , Zhi-Hua Wang a , Kamil E. Kaloush a , Joseph Shacat	2021	https://doi.org/10.1016/j.rser.2021.111171	Urban heat island, Heat mitigation strategies Reflective pavements, Permeable pavements, Life-cycle assessments, Building codes, Green rating systems, Implementation projects, Knowledge gaps	The review aims to synthesize existing literature on cool pavements as a climate adaptation strategy by evaluating both conventional (reflective, evaporative) and emerging technologies (e.g., retro-reflective, PCM-integrated, water-retentive pavements). Its goal is to assess their potential for mitigating the urban heat island (UHI) effect and to bridge knowledge gaps across research, standards, and practical implementation	The authors conducted a structured literature review, surveying over 400 peer-reviewed sources indexed in Scopus, Web of Science, and Google Scholar. They categorized pavement technologies by cooling mechanism (reflective, evaporative, energy-storing), analyzed data on performance metrics (surface and air temperature reductions), assessed measurement and modeling approaches, and reviewed building codes, green certifications, and real-world case studies	Surface temperature reductions vary widely: reflective pavements cool by up to ~5–20 °C, evaporative types by ~5–35 °C, and energy-storing/PCM pavements by ~3–5 °C. At the pedestrian/air level, cooling is more modest; typically 0.2–1 °C; though behavioral and comfort impacts can still be meaningful. Challenges include coating durability, glare, cost, and misalignment with existing codes or urban guidelines; many advanced technologies remain at pilot or prototype phases . Recommendations: tailor pavement type to local climate and rainfall, combine strategies (e.g. reflectivity plus shading), integrate with standards and incentives, and scale from pilots to broader urban policies.
66	A digital twin uses classification system for urban planning & city infrastructure management	Ramy Al-Sehrawy, Bimal Kumar, Richard Watson	2021	https://doi.org/10.36680/j.itcon.2021.045	urban digital twin knowledge transfer standards	To address a key gap in urban digital twin (DT) practice: the inadequate capture, documentation, and reuse of "know-how" from DT pilot projects in city planning and infrastructure. The goal is to develop a standardized DT Uses Classification System (DTUCS) that enables practitioners to systematically standardize, detail, and classify use cases for knowledge sharing and cross-project learning	The authors applied a meta-methodological approach, combining: A systematic literature review of urban DT use cases. Ontology development (simplified per Noy & McGuinness) to create a taxonomic UML-based library of use cases. Classification framework development to populate DTUCS's three prongs: A: Standardize-to-Publish (shared terminology), B: Detail-to-Prove (use-case diagrams), C: Classify-to-Reach (searchable retrieval)	Identified three primary limitations in existing DT practice: (a) inconsistent terminology, (b) lack of structured documentation, (c) missing classification systems for DT use cases. Developed the DTUCS framework with the three prongs to remedy these gaps. Demonstrated that DTUCS supports consistent language, machine-readable UML documentation, and efficient case retrieval, providing a foundation for scalable DT adoption. Recommended further validation through real-world DT initiatives to improve and standardize urban DT knowledge transfer

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67	Digital Twin for Urban Planning in the Green Deal Era: A State of the Art and Future Perspectives	Giorgio Caprari 1,*, Giordana Castelli 2, Marco Montuori 3, Marialucia Camardelli 1 and Roberto Malvezzi	2022	https://doi.org/10.3390/su14106263	digital twin; urban planning; urban governance; tools and techniques; geospatial technologies; climate action	The article presents a comprehensive review of contemporary digital twin (DT) initiatives in urban planning worldwide, positioning the concept within the broader context of the European Green Deal and global sustainability frameworks. It analyzes how DT tools are evolving to support climate action, citizen engagement, and evidence-based decision-making in the urban realm	Researchers conducted a structured comparative analysis of six illustrative case studies of urban DT implementations. They examined each project in terms of technology infrastructure, data integration (semantic + sensor data), purpose (evaluative vs prefigurative), and geographic scale. The study also critically assessed how each initiative aligns with policy needs, leverages open standards, and addresses environmental and socio-health challenges.	The review found that urban DTs are technologically mature; capable of supporting real-time data integration, simulations of energy and climatic scenarios, and participatory tools; but remain largely experimental in planning practice. Case studies (e.g., Helsinki, Zurich, Dublin) demonstrate DTs' value in simulating microclimate, visualizing urban change, and facilitating public feedback. However, widespread deployment is impeded by data silos, lack of interoperability, limited scalability, and uneven stakeholder involvement. The authors advocate advancing DT realism, standardization, and integration into governance workflows to harness their potential during the Green Deal transition.

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68	Managing urban stormwater for urban sustainability: Barriers and policy solutions for green infrastructure application	Krishna P. Dhakal , Lizette R. Chevalier	2017	https://doi.org/10.1016/j.jenvman.2017.07.065	Barrier Green infrastructure Policy Sustainability Stormwater Urban	We analyzed policies of 10 US cities, relevant state and federal policies, and other available literature to diagnose the obstacles and explore policies that can both overcome the barriers and expedite the adoption of GI. We identified 29 barriers and grouped them into 5 categories. The findings show that most of the barriers stem from cognitive limitations and socio-institutional arrangements. Accordingly, we suggest a set of 33 policies, also grouped into 5 policy types, which span from conducting education and awareness programs to changing existing policies and governance structures	The research consisted of two phases. In the first phase, we explored the existing barriers through a critical analysis of literature available. The materials that were extensively analyzed included peer-reviewed journal articles, books, the US Constitution, US laws and regulations, court decisions, municipal codes and manuals, and the US EPA case study reports. Literature on ecosystem services was also reviewed. In the second phase, we synthesized normative policy recommendations to address the barriers identified in the first phase. For this, policy tools and strategies adopted by four US cities (Seattle, Washington; Portland, Oregon; Chicago, Illinois; and Philadelphia, Pennsylvania) were analyzed against the barriers identified in the first phase. These cities have been using GI relatively widely (Chen et al., 2013). The documents examined included ordinances, codes, manuals, and standards that influence the adoption of GI and the maintenance of ecosystem services.	his paper explores 29 barriers under 5 categories that cause the delay and suggests 33 policy strategies under 5 categories that can both overcome these barriers and expedite implementation. The study suggests that the most critical barriers are cognitive barriers and socio-institutional path dependence

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69	Challenges in the vulnerability and risk analysis of critical infrastructures	Enrico Zio	2016	https://doi.org/10.1016/j.ress.2016.02.009	Critical infrastructures Complex systems Systems of systems Electric power grids Smart grids Vulnerability Risk Resilience Uncertainty	In this paper, the complexity of CI is presented as a challenging characteristic, which calls for an integrated framework of different types of analyses and methods of vulnerability and risk assessment, for application to CI protection and resilience. The concepts of vulnerability, risk and resilience are discussed in details and analyzed with respect to their characterization in CI, and the challenges therein. Recent new perspectives on these concepts and their applications are also discussed in relation to their applicability for analyzing CI vulnerability and risk in view of decision making for protection and resilience.	In Section 2, we introduce the concept of critical infrastructures and specify them as engineered complex systems; • In Section 3, vulnerability and risk concepts are introduced and discussed with reference to critical infrastructures design and operation. Three statements are proposed to advocate the need for extended modeling as a way to understanding system behavior and capturing the related risk and vulnerability factors; • In Section 4, some perspectives are offered on approaches for looking into the complexity characteristics of CI, for analyzing their vulnerability and risk.	The findings of these NRAs and other studies confirm that high degree of inter- and intra-connectedness that critical infrastructures have, can make them vulnerable to global disruption, when exposed to hazards of various nature, from random mechanical/physical/material failures to natural events, software failures, intentional malevolent attacks, human and organization errors. It is widely recognized that this broader spectrum of hazards and threats, calls for an all-hazards approach for the understanding of the failure behavior of such systems, for their effective protection and for ensuring resilience

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
70	Contributions and Risks of Artificial Intelligence (AI) in Building Smarter Cities: Insights from a Systematic Review of the Literature	Yigitcanlar, T., Desouza, K. C., Butler, L., & Roozkhosh, F.	2020	https://doi.org/10.3390/en13061473	artificial intelligence (AI); AI technologies; AI algorithms; disruptive technology; smart city; smart urban technology; urban informatics; sustainable urban development; climate change	The prospective benefits of AI for cities continue to be discussed in the literature in the context of smart cities; that are enabled by community, technology, and policy to deliver productivity, innovation, livability, wellbeing, sustainability, accessibility, as well as good governance and planning [15,21,22]. Despite the growing number of articles on the topic, there is no scholarly work that provides a comprehensive review of the growing literature. This paper organizes the literature to examine how AI can contribute to the development of smarter cities. As the methodologic approach, the study adopts a systematic literature review on the topic of 'AI and the smart city'.	We undertook a systematic review of the literature to answer the following research question: How can AI contribute to the development of smarter cities? We adopted a three-phase methodologic approach (Figure 2) following the study steps of Yigitcanlar et al. The first phase is planning, which involves developing the research aim, research question, a list of keywords, and criteria for the inclusion and exclusion of articles. The research aim was framed to generate insights into forming a greater understanding on how AI can contribute to the development of smarter cities. The inclusion criteria were intended to be peer-reviewed journal articles, that were available online, in English, and had relevance with respect to the research aimThe second phase involved carrying out the review of relevant articles. The third and final phase is reporting and dissemination.	The study reported in this paper offers a novel contribution to the literature by mapping out the scientific landscape of the understudied 'AI and the smart city' area. This study helps not only in identifying the current and potential contributions of AI to the development of smarter cities; to aid urban policymakers, planners and researchers; , but also in determining the gaps in the literature to bridge them in prospective studies. The study also gives a heads up for urban policymakers, planners and scholars for them to prepare for the disruptions that AI will cause in our cites, societies and businesses [200].

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
71	Integrating Artificial Intelligence and Environmental Science for Sustainable Urban Planning	Anwar, M. R., & Sakti, L. D.	2024	https://doi.org/10.34306/itsdi.v5i2.666	Artificial Intelligence, Geographic Information Systems (GIS), Sustainable Urban Planning, Environmental Science, Urbanization	This study aims to demonstrate the practical applications of integrating AI with environmental science for urban planning. Through a series of case studies involving several metropolitan areas, the research will evaluate the effectiveness of AI-enhanced GIS tools in crafting sustainable urban development strategies. The focus will be on assessing the utility of these tools in predicting urban growth and its environmental impacts, thereby providing a scientifically robust basis for sustainable urban planningdecisions	his research using Spatial Analysis with GIS is designed to utilize advanced technology and data integration to optimize urban planning decisions. This methodology offers a structured way to utilize cutting-edge technology to address complex urban planning challenges, ensuring that development strategies are both sustainable and grounded in robust scientific analysis	The research on integrating Artificial Intelligence (AI) and Environmental Science for Sustainable Urban Planning has highlighted significant insights into the dynamic interplay between urban growth and environmental sustainability. By leveraging AI techniques within a GIS framework, the study successfully predicted areas of urban expansion and assessed their potential environmental impacts. The predictive models, especially decision trees and neural networks, provided a robust tool for forecasting land usechanges and their consequences, enabling urban planners to visualize future scenarios and make informed decisions. The results from overlay and buffer analyses within GIS have proven invaluable in identifying high-risk areas where urban development could severely impact environmental quality

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72	The Role of Urban Design in Facilitating a Circular Economy: From Linear to Regenerative Cities	Williams Chibueze Munonye & George Oche Ajonye	2024	https://doi.org/10.20849/jess.v7i2.1479	circular economy; urban design; adaptive reuse; green architecture; nature-based solutions; regenerative cities; urban planning; resource loops; sustainable development	The aim of this study is to explore the pivotal role of urban design and planning in facilitating the transition from linear to regenerative, circular cities. It seeks to analyze how strategies such as adaptive reuse of buildings, green architecture, and the integration of nature-based solutions can contribute to establishing sustainable, resilient urban environments. By examining case studies and theoretical frameworks, the study aims to provide insights into how these design approaches can effectively close material and resource loops, promote ecological restoration, and support the development of cities that prioritize resource efficiency and environmental regeneration. Ultimately, the research endeavors to offer practical recommendations for policymakers, urban planners, and stakeholders committed to fostering sustainable urban development within the principles of a circular economy.	The methodology of this study involves a comprehensive review and analysis of existing literature, case studies, and theoretical frameworks related to urban design strategies that support the circular economy. By examining examples of adaptive reuse, green architecture, and nature-based solutions implemented in various cities worldwide, the study assesses their effectiveness in promoting sustainability and resilience. Additionally, the research employs qualitative analysis to synthesize insights from diverse sources, identifying best practices, challenges, and opportunities for integrating circular principles into urban planning.	The results of this study highlight that urban design strategies such as adaptive reuse, green architecture, and nature-based solutions significantly contribute to advancing the circular economy within cities. Case studies from cities like Rotterdam, Freiburg, and Singapore demonstrate successful implementations where these approaches have extended building lifespans, reduced resource consumption, and enhanced ecological resilience. Adaptive reuse projects have effectively minimized construction waste and preserved embodied energy, while green architecture and NBS have improved environmental quality, urban temperature regulation, and water management. Moreover, integrating these strategies fosters community engagement, supports biodiversity, and enhances overall urban livability. Despite challenges like financial constraints and institutional barriers, the evidence underscores the potential for these regenerative design practices to transform cities into more sustainable, resilient habitats aligned with circular economy principles.

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73	A methodological framework for the implementation of urban living lab on circular economy co-design activities	Carolina Innella, Giuliana Ansanelli, Grazia Barberio, Claudia Brunori, Francesca Cappellaro, Rocco Civita, Gabriella Fiorentino, Erika Mancuso, Rocco Pentassuglia, Luigi Sciubba & Amalia Zucaro	2024	10.3389/frsc.2024.1400914	Circular economy, Urban Living Lab (ULL), co-design	There is no reference methodology in the literature for implementing ULLs focused on co-design of CE actions and activities, based on the specificities and needs of the involved urban community. To fill this gap, this paper presents an ad hoc methodological framework for a correct co-design process of CE at the urban level. This framework is based on a comprehensive literature review of LLs and ULLs and the lessons learned from various national and European research projects. The framework is described step-by-step.		
74	Geodesign Approaches to City Resilience Planning: A Systematic Review	Ripan Debnath,Christopher Pettit andSimone Zarpelon Leao	2022	https://doi.org/10.3390/su14020938	collaborative planning; computation; geodesign; city resilience; sustainability; climate change	The increased frequency of extreme events facing society is placing mounting pressure on cities and regions that need more robust resilience planning against growing uncertainty. Data augmented participatory methods, such as geodesign, offer much promise in supporting strategic planning to make our cities and regions more resilient. In that context, this study aims to contribute to a deeper understanding of geodesign practices in resilience planning, through a systematic review of the selected 487 studies available from various bibliographic databases.	The implementation of this research involved two major tasks using secondary literature, both peer-reviewed and grey materials available through web searches. It started by selecting appropriate geodesign studies to review, followed by framing in the overarching resilience thinking into an analysis framework to explore the contribution of those studies to city resilience planning.	The results indicate that a total of 75 studies were connected to resilience thinking, with a focus on climate change, floods, and sea level rise risks. A significant cluster of those resilience-related studies worked, especially, on improving sustainability. A detailed analysis of 59 relevant geodesign case studies revealed a strong underlying emphasis on disaster risk reduction and management activities. This study also noticed two prominent approaches among the analysed case studies to future city scenario planning: computational (41 studies), and collaborative (18 studies).

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75	A BIM-Based Framework for Life Cycle, Cost, and Circularity Data Integration in Environmental Impact Assessment	Sophia Silvia Pibal, Rene Bittner & Iva Kovacic	2025	https://doi.org/10.3390/su17062656	BIM; LCA; circular economy; BIM object library; sustainable construction; environmental impact assessment	The AEC's resource consumption and environmental impact necessitate a shift towards sustainable, circular practices. Building information modeling, powered by information technology, serves as a key enabler in this transition, offering life cycle data management capabilities from design to deconstruction. However, current BIM models lack embedded life cycle and circularity data, limiting their effectiveness for sustainability integration. This study addresses this gap by proposing a BIM object library framework that embeds life cycle, cost, and circularity data into objects and aims at enabling informed, sustainability-driven decision making.	Through a proof of concept, this research demonstrates how embedding LCA and CE metrics into BIM objects enhances environmental and circular impact assessments. The framework aligns with standards such as ISO 14040 and EN 15804, EU Level(s), and United Nations' 2030 Agenda for Sustainable Development. Limitations such as manual data integration and the need for specialized expertise occurred. However, this framework provides a scalable foundation for future research, including automating data integration, enhancing metric calculations, and developing interactive circularity dashboards to improve as a decision-support tool.	This study advances circular BIM adoption, integrating sustainability principles into digital design workflows from the object level, while serving as a centralized repository for sustainability-driven decision making.

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76	A comparison of energy and thermal performance of rooftop greenhouses and green roofs in Mediterranean climate: A hygrothermal assessment in WuFi	Mansoureh Gholami, Alberto Barbaresi , Patrizia Tassinari, Marco Bovo and Daniele Torreggiani	2020	10.3390/en13082030	rooftop greenhouse; green roof; two-dimensional hygrothermal simulation; urban local microclimate modelling; green systems	Although the local climate has a direct impact on the energy loads of a building, few studies have examined roofing scenarios in the context of the building. Most studies have been limited to macroscale climate modelling. However, there are many local parameters, such as the urban heat island effect in every urban area that can impact both cooling and heating loads and actual local temperatures. Further attempts are needed to bring energy simulation results closer to reality. Notably, simulation in one-dimensional models neglects some important parts of energy simulation and simplifies the heat transfer in different layers and shapes to remarkably reduce the simulation time. To overcome these limitations and achieve more realistic results, a two-dimensional hygrothermal simulation has been developed in the software WUFI (Wärme Und Feuchte Instationär in German) by which water surface exposure, absorption, and intrusion are examined to model rainfall, irrigation, and moisture in the roof materials. In addition, an accurate localized weather model has been developed to take into consideration the impact of urban context on microclimate conditions.	This paper aims at evaluating the performance of three different roofing technologies through a two-dimensional hygrothermal simulation in software WUFI. To accomplish this, a precise localized microclimate model of a complex urban context on the scale of a neighborhood was employed to evaluate the cooling and heating loads of the buildings, the impact of the water content in the green roof on the thermal behavior of the roof surface, and the feasibility of designing a building with nearly zero cooling needs. A two-story building in the city center of Bologna, Italy is modelled.	Simulation results have shown that during the cooling period, the performance of the designed rooftop greenhouse is the most effective by 50% reduction in cooling loads. Besides, the impact of moisture in green roofs has been detected as a negative factor for thermal and energy performance of the building in the Mediterranean climate. The results ultimately highlighted the capability of passively-designed rooftop greenhouses to create a building with nearly zero cooling needs.

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77	Combining circular and LCA indicators for the early design of urban projects	Saadé, M.; Erradhouani, B.; Pawlak, S.; Appendino, F.; Peuportier, B.; Roux, C.	2022	https://doi.org/10.1007/s11367-021-02007-8	Life Cycle Assessment, Circularity indicator, Building, Urban Project, Circular Practices, Eco-Design	The built environment is a key sector for the transition towards a so-called circular economy, contributing to solve the global environmental challenges humanity is facing. As buildings interact with other sectors like transport and energy, a systemic approach is needed to assess the environmental relevance of circular economy practices. The purpose of this study is to develop and test an approach for the evaluation of overall environmental performance of urban projects.	Combining Material Flow Analysis (MFA), the Material Circularity Indicator (MCI), and Life Cycle Assessment (LCA) indicators allows for relating means (material recovery) and performance (protection of human health, biodiversity, and resources).	This study shows the ability of LCA to evaluate circular economy practices at the scale of an urban project. It also highlights LCA's limitations and shows that research is needed to improve resource depletion evaluation and biogenic carbon accounting in eco-design LCA tools. Results show that at the project scale, the MCI, one of the major circular indicators in use today, and MFA provide interesting information complementary to LCA but do not successfully evaluate the environmental performance of circular practices.
78	A SYSTEMATIC REVIEW OF THE URBAN HEAT ISLAND EFFECT: URBAN FORM, LANDSCAPE AND PLANNING STRATEGIES	Dilara Yılmaz, Sevgi Öztürk	2023	https://dergipark.org.tr/en/download/article-file/3167309	Climate Change, Urbanization, Sustainable Urban Development, Green Infrastructure, Albedo.	The aim of the article is to systematically review the urban heat island (UHI) effect by examining the relationship between urban form, landscape, and planning strategies. It aims to identify and analyze various approaches and parameters used in the mitigation and management of UHI, highlighting the significance of sustainable urban development and planning measures to reduce the impact of UHI on urban environments, especially in the context of climate change and urbanization	the study presents a systematic review of studies that deal with planning strategies within the scope of green infrastructure, architectural design, and albedo parameters, focusing on urban heat island effects, urban form, and landscape relationship in urban heat island formation.	The study provides a theoretical basis for the urban heat island effect, the relationship between urban heat island and urban form and landscape. The study also determined the spatial factors that are effective in reducing the urban heat island effect within this theoretical framework.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
79	What Nature-Based Flood Protection Solutions Are Best Perceived by People? Lessons from Field Research in Czechia	Jan Macháč, Jan Brabec, Marek Hekrle & Alena Vacková	2021	https://doi.org/10.1007/698_2021_763	Aesthetic preferences, Choice experiment, Floods, Nature-based solutions,Public perception, Willingness to pay	The paper aims to fill the existing knowledge gap regarding public preferences and awareness of the implementation of nature-based solutions (NBS) and types of cultivated crops (TCC) that may be used to mitigate pluvial floods by exploring preferences of the residents in the Oleška river basin in Czechia.	Local residents' preferences regarding NBS and TCC used for flood mitigation were investigated using anonymized questionnaire-based interviews. Apart from questions covering information on the respondents' sociodemographic characteristics, the following topics were studied: respondents' opinions on the most important agricultural functions, evaluation of nature-based flood protection solutions from the aesthetic point of view using an image-assisted questionnaire survey, analysis of respondents' preferences using a choice experiment, and eliciting respondents' previous experience with floods..Data were collected through face-to-face surveys (n = 256) with residents of the Oleška river basin.	Afforestation and grassing along the stream were best perceived by residents from the purely aesthetical point of view and, together with dry polders, they were considered the most relevant solution for flood mitigation

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80	Ecological Planning: Retrospect and Prospect	Frederick Steiner, Gerald Young & Ervin Zube	1988	https://www.jstor.org/stable/43323188	Ecological planning	The aim of the article is to explore the historical development, major themes, issues, and future potential of ecological planning. It aims to understand how ecological principles have been integrated into planning practices, highlighting key contributions, influential thinkers like McHarg, and the evolution of ecological concepts in the field. The scope includes analyzing both the literature and practical applications of ecological planning, examining its foundational ideas, thematic trends, and the progress made over time, while also assessing challenges and directions for future development	The methodology of the article involves a comprehensive review and analysis of the historical development, major themes, and practical applications of ecological planning.	The article highlights significant progress in the integration of ecological concerns into planning over the past few decades. This growth is evident in the expanded literature, curriculum development, and practical applications, reflecting a rising recognition of ecology's importance in shaping sustainable land use. Ecological planning is characterized by its focus on land and environmental quality, adopting a holistic and interdisciplinary approach that emphasizes the interconnectedness of human activities and natural systems. Influential thinkers such as Geddes and McHarg have played pivotal roles in shaping these ideas, with McHarg's approach notably strengthening the modern movement toward applied human ecology. Land use advocates like Leopold underscored the importance of ecological reactions and conditions in guiding sustainable land management, arguing for careful planning that minimizes obstacles and promotes ecological harmony. The historical foundations of ecological planning are rooted in the works of giants like Marsh, Powell, and Geddes, who emphasized the need for rational, nature-based strategies to harmonize human action with environmental realities. Despite the abundant theoretical development, there remains a gap between ecological concepts in the literature and their practical application, as exemplified by successful projects like The Woodlands, which demonstrate effective interdisciplinary and ecological integration. Looking

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								ahead, the field holds considerable promise for further synthesis of ecological principles and planning practices, offering pathways toward more sustainable and holistic land management that better reconcile human development with ecological integrity.
81	Systems Approach to Eastern Baltic Coastal Zone Management	Eglė Baltranaitė, Ramūnas Povilanskas, Kestutis Ducinskas, Raimonds Ernsteins	2020	https://doi.org/10.3390/w12113102	Baltic states, integrated coastal management, systems approach framework, Stakeholder involvement, retrospective analysis	This study emphasizes the integration of ecological, social, and governance systems in managing coastal areas. It advocates for a systems-based approach that combines ecological planning with disaster resilience, particularly in the face of climate-induced hazards such as sea-level rise and erosion.	SAF methodology. The methodology of the BaltCoast case study re-analysis has been described in a detailed, stepwise way by Støttrup et al. As already mentioned above, the survey included a SWOT analysis on the overall quality of the ICM process (expert judgement) and on external and internal risks and opportunities that may further affect the process (expert judgement). After the review of the draft survey material by a panel of national ICM experts, these national experts conducted interviews in local languages with participants of the respective case study processes and consolidated them by summing them up in one completed questionnaire for each case study.	A truly dedicated involvement of a wide range of stakeholders throughout all process stages showed to be critical for further successful advance of ICM processes and principles based on the systems approach in the Baltic States
82	Innovative Urban Blue Space Design in a Changing Climate: Transition Models in the Baltic Sea Region	Izabela M. Burda, Lucyna Nyka	2023	https://doi.org/10.3390/w15152826	water; urban blue spaces; urban planning; coastal areas; sustainability; waterfronts	Focusing on urban coastal zones in the Baltic Sea Region, this research explores how ecological design can mitigate climate risks like flooding and heatwaves. It highlights the importance of multifunctional blue spaces in enhancing urban resilience.	The methodological and conceptual framework of this study is based on qualitative analysis of urban form with respect to coastal and riverine waters	Findings highlight the need to verify the existing planning regulations and make them more flexible and effective in guiding the sustainable waterfront design processes.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
83	Baltic Sea Ecosystem-Based Management under Climate Change: Synthesis and Future Challenges	Thorsten Blenckner, Henrik Österblom, Per Larsson, Agneta Andersson	2015	http://dx.doi.org/10.1007/s13280-015-0661-9	Eutrophication, Persistent organic pollutants, Overfishing, Ecosystem-based management, Climate change	This paper synthesizes the challenges and opportunities of implementing ecosystem-based management (EBM) in the Baltic Sea region under changing climatic conditions. It emphasizes the need for integrated approaches that consider ecological, social, and economic factors in disaster management.	In the paper is identified challenges for the future, and identify the next steps needed for successful implementation of EBM in general and specifically for the Baltic Sea.	Scientists synthesize the scientific findings into four components: pollution and legal frameworks, ecosystem processes, scale-dependent effects, and innovative tools and methods.
84	Determination of Erosion Statistics by Land Use Type at National Scale with the Dynamic Erosion Model and Monitoring System (DEMMS)	İskender Demirtaş, Günay Erpul	2024	https://dergipark.org.tr/tr/download/article-file/4254337	DEMMS, RUSLE, Soil Erosion, Land Use, GIS, Remote Sensing, Turkey, Erosion Statistics	To determine national scale erosion statistics according to land use types in Turkey using DEMMS software integrated with RUSLE and supported by remote sensing and GIS, providing spatial classifications of erosion severity and sediment transport estimates to assist policy and land management.	This study used the RUSLE erosion model combined with DEMMS software processing various datasets, including rainfall intensity (R factor), soil erodibility (K factor), vegetation cover (C factor), and slope length and steepness (LS factor), derived from high-resolution spatial data (10-25 m). Data sources included meteorological stations, soil samples, CORINE 2018 land cover data, forest stand maps, and digital elevation models. Model parameters were calibrated with literature and statistical methods. The model was applied to Turkey's 25 river basins at micro and macro catchment scales using GIS and remote sensing-supported spatial statistics. Outputs include erosion rate maps, sediment yield estimates, and erosion severity classes.	The estimated total soil loss in Turkey is about 642 million tons per year. Approximately 79.4% of the area experiences very low or low erosion severity, while 20.6% suffers moderate to very severe erosion. Severe erosion is most pronounced in agricultural and pasture areas. The LS factor explains 47.55% of erosion variance, followed by C (34.82%), R (14.26%), and K (3.36%). The highest sediment yield per area is in the Çoruh basin (26 t ha^{-1} y^{-1}), the lowest in the Sakarya basin (4.2 t ha^{-1} y^{-1}). At the basin scale, the highest sediment transport is in the Dicle-Fırat basin (160 million tons), and the lowest in the Burdur basin (3.6 million tons). Produced national erosion maps facilitate targeted management.
85	Adaptation to Floods in Riga, Latvia: Historical Experience and Change of Approaches	Laila Kūle, Agrita Briede, Maris Klavins, Guntis Eberhards, Andris Loĉmanis	2013	https://doi.org/10.1002/9781118548165.ch6	historical floods flood risk management urban planning stakeholders knowledge	This paper examines the historical and contemporary approaches to flood adaptation in Riga, emphasizing the integration of ecological planning in urban flood management.	This study examines the flood management process in Riga by using a qualitative, historical, and locally-informed, multi-stakeholder, and interdisciplinary approach.	Integrative use of gained knowledge for local flood protection needs has been identified as a prerequisite for adapting to the changing environment.

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86	Urban ecosystem services in strategic planning in Swedish municipalities	Åsa Ode Sang, Frederik Aagaard Hageman n, Nils Ekelund, Jessica Svännel	2021	https://doi.org/10.1007/s11252-021-01113-7	Urban ecosystem service, Practical implementatio n, Strategic planning and management, Municipality	This study examined the provision of urban ecosystem services in a Swedish municipality context, based on interviews with municipal stakeholders in strategic management and planning from six municipalities and a review of existing publications readily available to practitioners. The analysis focused on (1) the ecosystem services explicitly covered, (2) whether multifunctionality was covered and specific synergies and trade-offs identified and, (3) the spatial scale and context used for ecosystem services (valuation/mapping, planning, design or maintenance) in practical application.	This study uses a triangulation mixed method approach were semi-structured interviews are complemented with a review of guidelines for municipal planning in order to address the research questions.	The results showed that regulatory services are very much the focus in municipal operations as well as in publications available to practitioners. This is reflected in the implementation of the concept through problem solving often related to regulatory services, using multifunctionality and win-win situations in ecosystem service supply. These findings contribute to the growing body of work exploring how the concept of ecosystem services is adapted and utilised in practice.
87	Smart Nature-Based Solutions for Stormwater Management in Urban Areas; An Analysis of Pilot Cases	Kerta Kõiv, Ivar Annus, Nils Kändler, Murel Truu	2024	http://dx.doi.org/10.3390/engproc2024069018	NBS; stormwater management; multidimensio nal; co-benefits; smart urban water systems	Pilot projects in Estonia and Finland demonstrate the use of smart valves and nature-based solutions to manage stormwater, reducing flooding and improving water quality.	The method consists of two steps. 1. Determining the Primary and Secondary Benefits of NBSs. 2.Determining the Impact of Primary and Co-Benefits.	This study demonstrates, using 7 pilot areas near Baltic Sea region, that the transition from no- and low-tech to high-tech NBSs can have significant positive impacts on flood protection and water quality, as well co-benefits such as public health, highlighting NBSs' multifaceted advantages.

88	Developing a Framework for Smart Stormwater Management in Tallinn, Estonia	Kristjan Suits, Anatoli Vassiljev, Katrin Kaur, Kerta Kõiv, Nils Kändler, Ivar Annus	2024	http://dx.doi.org/10.3390/engproc2024069023	smart stormwater systems; water quality monitoring; urban stormwater management	A methodology was developed to evaluate stormwater managers' ability to implement continuous stormwater monitoring solutions. The proposed framework was developed based on a literature review, and it considers environmental, technical, financial, and human resource factors.	The Stormwater 3-Step Strategy. An extensive literature review was conducted, based on scientific literature, various technical reports, gray literature, and manufacturers' documentations. This review included 103 references, specifically selected for their relevance to the preidentified research questions, as presented below: What is the state-of-the-art for monitoring stormwater quality and quantity? What are the main stormwater pollutants and their pathways, effects, and real-time monitoring options? What is the status of existing best practices in Estonia's largest water company, compared to the state-of-the-art, and which benefits could the company reap from the digitalization of stormwater management? What are the requirements for setting up systems for stormwater quality monitoring? The findings from the review were generalized to evaluate the need and the capacity of stormwater managers to move towards continuous stormwater monitoring. The capacity to integrate stormwater quality and quantity monitoring into their workflow was evaluated according to criteria such as organization's size, environmental considerations, servicing area and income base, number of personnel, existing infrastructures, number of employed personnel, and their technological savviness. The strategy took inspiration from the RTC guidelines developed by the German Water Association (DWA M180). The paper concludes with a proposed step-by-	This proposed framework represents the first step towards putting data-driven urban stormwater management into practice.

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89	Integrating Sustainable Stormwater Management in Urban Planning: Ways Forward towards Institutional Change and Collaborative Action	Anna Bohman, Erik Glaas, Martin Karlson	2020	https://doi.org/10.3390/w12010203	sustainable stormwater management; urban planning; institutions; institutional change	The study discusses the shift towards collaborative action and institutional change in Sweden, emphasizing the role of multifunctional solutions and public participation in stormwater management.	step strategy for enhancing stormwater management through implementing continuous water quality and quantity monitoring. This study is based on data collected through a series of workshops, individual interviews, and a questionnaire targeting stakeholders in the Swedish stormwater sector. The data collection aimed at building an understanding of the current planning challenges and changes seen as necessary by practitioners in the field.	We argue that institutional changes in line with the points raised above will facilitate planning towards more sustainable stormwater management in Sweden and beyond.
90	Managing floodplains using nature-based solutions to support multiple ecosystem functions and services	Jiří Jakubínský, Marcela Prokopová, Pavel Raška, Luca Salvati, Nejc Bezak, Ondřej Cudlín, Pavel Cudlín, Jan Purkyt, Paolo Vezza, Carlo Camporeale, Jan Daněk, Michal Pástor, Tomáš Lepeška	2020	http://dx.doi.org/10.1002/wat2.1545	Floodplain Management Green-Blue Infrastructure	This article reviews the recent understanding of floodplain delineation, the most common causes of disturbance, the ecosystem functions being performed, discussing in turn the measures being considered to mitigate the frequency and magnitude of hydrologic extremes resulting from ongoing environmental changes.	Comparation of different approaches to floodplain delineation and outlined a conceptual nexus between floodplains and ecosystem functions, both illustrated with case studies.	This article provided comparative insight into different approaches to floodplain delineation and outlined a conceptual nexus between floodplains and ecosystem functions, both illustrated with case studies

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91	A dam or a polder? Stakeholders' dispute over the "right" flood-protection measure in the Czech Republic	Ivan Andráško, Barbora Duží, Stanislav Martinát	2024	http://dx.doi.org/10.1007/s13280-024-02022-7	Czech Republic, Dispute/conflict, Flood-protection measures, Interviews, Polder, Stakeholder involvement	This study focuses on the Skalicka Waterwork (SWW), a largely debated and media-covered water-related/ flood-protection project in the Czech Republic.	Following the methodical recommendations of Ras ˇ ka et al.(2023), we traced back, explored, and retrospectivelyreconstructed the evolution of the SWW project	The opposition succeeded not only in terms of a renewed assessment of the project, but finally, the side polder has been approved by the government to be realized.
92	Costs and benefits of landscape-based water retention measures as nature-based solutions to mitigating climate impacts in eastern Germany, Czech Republic, and Slovakia	Janez Sušnik, Sara Masia, Michal Kravčík, Jan Pokorný, Petra Hesslerová	2022	http://dx.doi.org/10.1002/ldr.4373	climate mitigation, Germany, Czech Republic, Slovakia, landcover, nature-based solutions, water-retention measureS	This work contributes to the growing body of literature assessing the costs and benefits of water-retention measures, including the potential for landscape cooling, lowering temperature gradients, and ecosystem restoration. As the world urbanises, and as more land is converted to homogeneous cropland, such measures may prove critical in mitigating climate change, landscape drying, flood runoff, and soil and nutrient loss.	This study assesses a number of metrics : 1) th e volume of wate r transported from the ground in the form of water vapour, representing an evaporative cooling potential; 2) investmets required for new water retention measures; 3) the volume of water from measures available for atmospheric cooling and; 4) the decrease in 'hot day' temperature over different l and covers. Surf ace and air te mperature are used to calculate the velocity of ascending air. Combined with absolute humidity, this is converted into the volume of water released to the atmosphere.	approved by the government to be realized.Results demonstrate how different land cover type s lose water through water vapour transport caused by an overheated landscape

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93	Flood protection in a municipality with the implementation of a nature-based solution	Lenka Brumarová, Jakub, Brumar, & Patricie, Gamonová	2024	https://doi.org/10.5593/sgem2024v/3.2/s11.07	nature-based solution, floods, dry polder	This study focuses on the implementation of dry polders; one of the nature-based solutions; at the scale of a municipality. The aim of the study is to evaluate the dry polder application in terms of the following aspects: -Reducing flood risk, -Providing sustainable adaptation to climate change, -Increasing the resilience of the settlement (village) to disasters, elivering social benefits (such as alternative uses like nature trails). In addition, the study aims to demonstrate how nature-based solutions can be planned based on a risk analysis and how they can offer multifunctional benefits.	This study examines the implementation of a nature-based solution (dry polders) based on risk analysis through an applied case study within a specific local context (a municipality). This approach aims to enhance sustainable adaptation to climate change and strengthen local resilience by considering both technical and social impacts.	The paper describes the implementation of nature-based solution (dry polders) as key to sustainable adaptation to climate change and increasing the resilience of the village to flooding.
94	This Is My Land! Privately Funded Natural Water Retention Measures in the Czech Republic	Lenka Slavíková, Pavel Raška	2019	http://dx.doi.org/10.1007/978-3-030-23842-1_6	Natural Water Retention Measures (NWRM) Private Land Conservation Farmer-Led Initiatives Ecosystem Services	The Czech case study presents the story of an individual farmer who decided to invest his private resources in water retention and biodiversity enhancement while continuing his farming practices.	Describing the background, motivation, performing conditions and effects of measures.	Initiatives by individual private owners using their own resources for water retention or biodiversity enhancement, for example, are described.

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95	Eastern European Perspective on the Environmental Aspects in Current Flood Risk Management: The Example of the Czech Republic	Blanka Loučková	2014	https://doi.org/10.1007/978-3-319-07548-8_13		The primary purpose of this paper is to analyze this trend in the Czech Republic, an eastern European country in which engineered approaches have been heavily employed in the recent past. The study discusses possible reasons for this gap between levels of governance and looks at the obstacles that hinder the promotion of natural measures in flood risk management.	To assess the environmental aspects of current flood management strategies, the degree of implementation of "green" measures in relevant documents was evaluated at two levels: national legislative level and the regional implementation level.	While the shift towards natural solutions in flood protection is well reflected at national level, traditional engineered approaches favouring "grey" infrastructure still prevail at regional level.
96	Nature-Based Flood Risk Management on Private Land	Thomas Hartmann, Lenka Slavíková, Simon McCarthy	2019	https://doi.org/10.1007/978-3-030-23842-1	Flood Risk Management Property Rights Land Policy Water Management Nature-based Solutions Open Access landscape/regional and urban planning climate change water policy	This open access book addresses the various disciplinary aspects of nature-based solutions in flood risk management on private land.	The study employs a multidisciplinary and qualitative approach based on case study analysis and critical academic reflections from various disciplinary perspectives.	The academic contributions from various disciplines presented in the book illustrate the diverse perceptions of NBS and shed light on the prominent challenges associated with their implementation.

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97	Participatory approaches for planning nature-based solutions in flood vulnerable landscapes	Eleni Ioanna Koutsovili, Ourania Tzoraki, Alitheia Aliki Kalli, Sotiris Provatas, Petros Gaganis	2023	http://dx.doi.org/10.1016/j.envsci.2022.11.012	Nature-based solutions (NBS) Flood risk mitigation Participatory planning Vulnerability and Capacity Assessment (VCA) Community-based adaptation	vulnerable areas, where floods are frequent, decision-making through participatory workshops has proved highly applicable and yielded positive results in integrated management issues. This paper examines Nature-Based Solutions (NBS) to provide flood risk mitigation and proactive adaptation options. The case study concerns the Kalloni river basin (Lesvos Island, Greece) which represents a highly flood-prone area. Participatory methods and community-based approaches according the methodology developed in "Vulnerability and Capacity Assessment (VCA)", are used to evaluate NBS options and determine their design and implementation framework.	"Participatory Process based on tools of the vulnerability and capacity assessment (VCA) Interviews, focus group discussion, "	"Vulnerability and Capacity Assessment (VCA) tools are applied. Nature-based solutions (NBS) are examined as effective flood control measures. Specific sustainability indicators are used for the evaluation of NBS alternatives"

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98	Shifting landscapes of risk: Quantifying pluvial flood vulnerability beyond the regulated floodplain	Narcisa G. Pricope, Christopher Hidalgo, J. Scott Pippin, Jason M. Evans	2022	https://doi.org/10.1016/j.jenvman.2021.114221	Inundation CubeSat imagery Managed floodplains Vulnerability	We propose a novel approach to estimate flood risk resulting from this singular event (termed an actualized risk index) when compared to a published empirical model of vulnerability. We show that 24.3% of detected floodwater was outside the 100-year floodplain, 43.4% of exposed residential structures are outside the 100-year floodplain, and communities of highest vulnerability are not only along the coast but also inland along the Cape Fear, Northeast Cape Fear, Trenton, and Neuse Rivers. This suggests that the SFHA may not adequately show the spatial distribution of pluvial flood risk in riverine areas, and that misunderstanding of this risk has led to a pattern of development in which houses have a higher than expected risk of flooding. Moreover, this additional flood risk may disproportionately affect lower-income residents of these largely rural areas.	Building inventory; FEMA flood zones; PlanetScope satellite imagery; USGS gage data	"Pluvial flood risk historically is not well-characterized in standard floodplain delineation. Post-analysis of pluvial flood events is crucial for more effective floodplain management. Losses from Hurricane Florence (North Carolina, USA) show floodplain assessment gaps. Uncharacterized flood risk disproportionately exposed socially vulnerable populations."
99	Modification of input datasets for the Ensemble Streamflow Prediction based on large-scale climatic indices and weather generator	Václav Šípek, Jan Daňhelka	2015	https://doi.org/10.1016/j.jhydrol.2015.07.008	Seasonal forecasting ESP Large-scale climate Weather generator	Ensemble Streamflow Prediction (ESP) provides an efficient tool for seasonal hydrological forecasts. In this study, we propose a new modification of input data series for the ESP system used for the runoff volume prediction with a lead of one month. These series are not represented by short historical weather datasets but by longer generated synthetic weather data series.	This study proposes and tests a modified Ensemble Streamflow Prediction (ESP) method using synthetic weather data generated by the LARS-WG model, constrained by observed meteorological variables and large-scale climate indices, applied to runoff volume forecasting in a Central European river basin over a four-year period.	New modification of the Ensemble Streamflow Prediction (ESP) system is proposed. In contrast to the ESP, it uses synthetic weather series as input datasets. The synthetic weather series used are restricted based on the climatic forecast. Hydrological forecasts have tighter forecasting interval compared to the ESP.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
100	Attributing the drivers of runoff decline in the Thaya river basin	Milan Fischer, Petr Pavlík, Adam Vizina, Jana Bernsteinová, Juraj Parajka, Martha Anderson, Jan Řehoř, Jana Ivančicová, Petr Štěpánek, Jan Balek, Christopher Hain, Pavel Tachecí, Martin Hanel, Petr Lukeš, Monika Bláhová, Jiří Dlabal, et.al.	2023	http://dx.doi.org/10.1016/j.ejrh.2023.101436	Climate change, Evapotranspiration, Precipitation, Remote sensing, Runoff, Trend analysis, Water balance	This study combined terrestrial and remote sensing data to provide new insights into the complex interplay of climate, vegetation, and the hydrological cycle of the Thaya river basin in Central Europe.	Data and Attribution analysis; Correlation analysis; Budyko framework; Albedo, leaf area index, and normalized difference vegetation index; Remote sensing data; Meteorological variables and snow depth	The results of this study suggest that complex adaptation to climate change will be needed to sustain the water dependent sectors operating in the Thaya river basin characterized by an increasing aridity. These measures must reflect the different hydroclimate relationships across the altitudinal gradient characterized by water and energy limits that are shifting over time, as well as several local, regional up to continental scale (self-)compensating mechanisms discussed in this study.

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101	The role of traditional agricultural landscape structures in changes to green infrastructure connectivity	Hana Skokanová, Patrik Netopil, Marek Havlíček, Bořivoj Šarapatka	2020	http://dx.doi.org/10.1016/j.agee.2020.107071	Agricultural small holdings Greenways Structural connectivity Central Europe Landscape homogenization Agricultural landscape	A reduction and disappearance of traditional agricultural landscape structures (TALSs) has been taking place throughout Europe. TALSs are a mixture of small arable fields with trees, vineyards with and without trees, orchards and field margins, and represent an important component of green infrastructure (GI). During this period and continuing until the present, TALSs and especially small vineyards, started to play a significant role in GI connectivity. Nowadays, GI connectivity has started to again increase also through the introduction of new types of GI. These are bio-centres and bio-corridors (patches of woods that are newly planted in order to create an ecological network) and elements connected with agri-environmental schemes (e.g. erosion control grassed belts).	Derivation of data on traditional agricultural landscape structure and green infrastructure	"Traditional agricultural landscape structures (TALS) are part of green infrastructure (GI). GI was removed by plowing large grasslands during the early 20th century. Further removal of small GI elements occurred during the second half of 20th century. TALSs play key roles in GI connectivity as cores and offer economic gain. Present GI connectivity increased due to new GI elements and some TALS types"

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102	Attributing the effects of climate change and forest disturbance on runoff using distributed modeling and indicators of hydrological alteration in Central European montane basins	Jakub Langhammer, Jana Bernsteinová	2024	http://dx.doi.org/10.1016/j.ejrh.2024.102101	Climate change, Forest disturbance, Hydrological modeling, MIKE-SHE, Hydrological alteration indicators	This study examines the impacts of climate warming and forest disturbances on hydrological alterations in montane headwater basins. Using the MIKE SHE distributed hydrological model, scenario-based simulations assessed changes in runoff seasonality, evapotranspiration, streamflow, and variability. Hydrological alteration indicators were applied to disentangle the contributions of these drivers and their interactions under varying environmental conditions. Climate warming is the primary driver of hydrological change, causing shifts in runoff seasonality, increased evapotranspiration, and reduced streamflow.	Hydrological modeling; Model setup and scenarios; Simulation scenarios (Forest disturbance scenarios); Indicators of hydrological alteration	MIKE SHE modeling and hydrologic change indicators to assess hydrologic change. Climate change driving major shifts in runoff seasonality and balance in mountain basins. Forest disturbance amplifies climate-driven changes, especially in dry conditions. Hydrological impacts of forest disturbance vary significantly between wet and dry conditions. Regional differences in hydrological responses reflect varied physiographic condition.

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103	Impact of landscape management and vegetation on water and nutrient runoff from small catchments for over 20 years	Václav Nedbal, Tereza Bernasová, Martina Kobesová, Blanka Tesařová, Aleš Vácha, Jakub Brom	2025	https://doi.org/10.1016/j.jenvman.2024.123748	Specific water runoff; Nitrates leaching; Phosphates leaching; Water retention; Flood protection; Surface water quality protection; Small catchment management	Land cover, vegetation, and landscape management have a large impact on surface water conditions. We analyzed the quantity and quality of surface waters draining from forest catchment with high vegetation and agricultural catchment with low or no vegetation. The following parameters were assessed: specific water runoff, precipitation totals, electrical conductivity in the surface waters, the content of suspended solids, nitrate nitrogen (N-NO3-), and phosphate phosphorus (P-PO43-) in the surface waters.The main findings of this research show that as vegetation increases, the landscape holds more water and other substances, reducing the risk of floods, droughts, and water pollution. Other research results show that even a small change in vegetation cover has a significant impact on the water runoff and quality of surface waters. The work emphasizes the importance of supporting vegetation in temperate zone landscapes in landscape planning and management.	Specific water runoff measurement Hydrochemical parameter measurement Statistical analysis.	Well-vegetated lands retain several times more rainwater than low or no vegetated. Landscapes with high vegetation reduce flood water runoffs during intense rainfalls. Low-vegetated landscapes dry out much faster than landscapes with high vegetation. Landscapes with high vegetation slow the runoff of substances from the soil. Landscapes with high vegetation contribute to the protection of surface water quality.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
104	On the right track of flood planning policy? Land uptake in Central-European floodplains (1990–2018)	Martin Dolejš, Pavel Raška, Silvia Kohnová, Reinhard Schinke, Weronika Warachowska, Thomas Thaler, Dušan Kočický	2022	https://doi.org/10.1016/j.landurbplan.2022.104560	Flood; Floodplain; Land use; Land uptake; Planning; Central Europe	Floods continue to remain among the costliest disasters worldwide and especially in Europe. Among the major causes of flooding are human impacts on water retention in catchments and extensive alterations to floodplains. While several policies and instruments have been coined internationally to mitigate land uptake in floodplains, their impact on recent land use and land cover (LULC) changes remains unclear. In this paper, we provide the first cross-country explorative analysis of LULC transitions in hydrologically delimited floodplains of the five Central-European countries (Germany, Austria, Czechia, Poland, and Slovakia) for the period of 1990–2018.	GIS processing, Dynamics of LULC transitions.	Land use and land cover change in floodplains in Central Europe is studied. Continuing land uptake in floodplains is documented between 1990 and 2018. Proximity to existing artificial surface is a locational factor for land uptake. The effects of flood land policies on land uptake in floodplains remains limited.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
105	Spatiotemporal variability of flash floods and their human impacts in the Czech Republic during the 2001–2023 period	Rudolf Brázdil, Dominika Faturová, Monika Šulc Michalková, Jan Řehoř, Martin Caletka, and Pavel Zahradníček	2024	http://dx.doi.org/10.5194/nhess-24-3663-2024		Flash floods, characterized by their sudden onset, extreme discharge, short duration, material damage, and human loss, represent a significant natural hazard. Not well covered by standard hydrological observations, flash flood data can primarily be derived from various types of documentary evidence. This evidence served as the main data source for creating a flash flood database for the Czech Republic from 2001 to 2023. This database enabled detailed analysis of different aspects of flash floods. The annual series of 233 flash flood events, 160 flash flood days, and 424 affected municipalities showed significant inter-annual variability but no linear trends. While flash floods can occur anywhere, they were more frequently recorded at the foots of mountain slopes, often coinciding with "critical points" where built-up areas meet concentrated surface runoff pathways.There were also 36 recorded fatalities. The understanding of flash floods in the Czech Republic aligns generally well with studies of flash floods in other European regions.	Database of flash floods Statistical analysis Critical point method assessment	FFEs, with their socioeconomic impacts manifested in human fatalities and material damage to private and public property and infrastructure, pose a significant natural hazard in the CR. This requires attention in flood risk management across various levels of state administration and local government.

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106	Disaster risk management, climate change adaptation and the role of spatial and urban planning: evidence from European case studies	Joaquín Farinós-Dasí, Pablo Pinazo-Dallenbach, Enrique Peiró Sánchez-Manjavacas & Diana Catalina Rodríguez-Bernal	2022	https://doi.org/10.1007/s11069-024-06448-w	Spatial planning, Natural hazards, Climate change, Adaptation, Economic impact, Disaster risk management	This paper advances knowledge and understanding of the relationships between risk management, climate change adaptation and spatial planning as good territorial governance practices. The aim is to present evidence on how risks and their management are progressively being integrated into national planning systems in order to reduce territorial vulnerability and costs related to natural events in the European context.	Documentary analysis, Online survey + interviews	The resulting governance is more "functional" than "territorial", leaving room for further advances and innovations such as territorial and multi-risk perspective, partnerships and civil society participation, and soft versus traditional hard or engineering solutions.
107	BIM-LCA Integration for the Environmental Impact Assessment of the Urbanization Process	Madelyn Marrero, Maciej Wojtasiewicz, Alejandro Martínez-Rocamora, Jaime Solís-Guzmán, M. Desirée Alba-Rodríguez	2020	https://doi.org/10.3390/su12104196	Life cycle assessment; building information modelling; environmental product declaration; ecolabels; environmental impact assessment; urbanization	To define a method integrating construction cost databases and LCA-enabled environmental impact assessments into BIM for urbanization projects, improving environmental awareness in early project stages.	The method combines BIM geometry with unit costs from construction cost databases and integrates environmental data from LCA databases (e.g., Ecoinvent) and ecolabels (e.g., EPD). Environmental indicators (EE, CF, WF) are calculated per construction work unit and embedded or linked via BIM plugins or external tools.	The approach allows detailed, reliable environmental impact assessment at the construction work breakdown unit level for scattered urbanization projects. Integration with BIM enables dynamic updates and project visualization with environmental data. The case study proved the feasibility of combining cost databases and environmental assessments, despite challenges in data complexity and multidisciplinary requirements.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
108	Chapter 10: The role of risk transfer and spatial planning for enhancing the flood resilience of cities	Paul Hudson, Lenka Slavíková	2022	http://dx.doi.org/10.4337/9781800379534.00019		The study, in the context of urban flood risk management, covers the following topics: -Risk transfer instruments (insurance, government compensation, insurance-linked securities [ILS], etc.) -Spatial planning mechanisms (development restrictions, reconstruction requirements, etc.) -The three pillars of resilience: -Recovery -Resistance -Adaptive capacity -Examples from various European implementations (e.g., France, the United Kingdom, Germany, the Czech Republic)	This is a theoretical and conceptual analysis; it does not rely on case studies, empirical data, or modeling. Instead, the authors develop a conceptual framework based on a review of existing literature and illustrative examples from practice. The interactions between risk transfer and spatial planning are examined through the lens of the three core pillars of resilience: recovery, resistance, and adaptive capacity.	Planning and risk transfer should not be considered in isolation, but rather as complementary instruments. When coordinated effectively, these two mechanisms can enhance each other's effectiveness. The resilience pillars framework recognizes that flood risk management should extend beyond mere risk reduction to include post-disaster recovery and long-term adaptation. Moreover, spatial planning can improve the affordability and accessibility of risk transfer mechanisms by lowering exposure and potential damages; for example, through water-sensitive urban design.
109	An opportunity missed is an opportunity lost. Flood maps and their (non-)utilization by local government bodies in the Czech Republic	Kamila Dolák Klemešová, Ivan Andráško, David Fledor, Lukáš Dolák "	2024	http://dx.doi.org/10.2478/mgr-2024-0011	Flood maps, flood risk management, local government bodies, questionnaire survey, Czech Republic	Flood maps are a crucial component of integrated flood risk management. While their key role is commonly acknowledged by experts and scholars, however, literature and findings on the practical utilization of flood maps (including the user' experiences) within the processes of governance are scarce. Our study aims to contribute to closing this gap; by focusing on the Czech local government bodies, data collected through a questionnaire survey allowed us to examine (a) how, or whether at all, the officials employ flood maps in their agendas; (b) how do they experience and assess working with the maps; and (c) which data would they supplement the extant flood maps by.	Computer Assisted Web Interviewing (CAWI) online survey from the local government bodies/officials of all Czech Republic's statutory cities (in total 26 cities)	Findings show that the praxis of local flood-related governance in the Czech Republic still largely neglects the up-to-date approaches and practices of flood risk management. The officials addressed mostly continue to rely on the earliest type of floodplain maps and purely technical aspects of floods, while largely omitting the newer flood danger and risk maps; thus, they are also missing the opportunities of applying multi-criteria assessment of the flood risk and more effective communication with the public. The paper concludes with a set of suggestions for relevant praxis and future research. Recommended articles from TrendMD

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110	Circular Maker Cities: Maker Space Typologies and Circular Urban Design	Reham Elwakil, Ingrid Schroder, Koen Steemers	2023	https://doi.org/10.3390/buildings13112894	Circular economy, maker spaces, reuse, repair, remanufacturing, urban design, sustainability, inner loop circularity, urban manufacturing, social collaboration, circular cities	To reveal architectural and urban characteristics of maker spaces that enable circular urban production and to present typologies to guide urban design and policy for circular cities	Case study analysis of 326 maker spaces in 7 European cities, supplemented by desk research, spatial mapping using GIS and open-source data, interviews with 30 international experts and local city planners, and detailed examination of 35 selected case studies	Identification of five maker space typologies related to circular economy activities (reuse, repair, remanufacture, recycle, and hybrid typologies). Maker spaces tend to locate near residential-commercial boundary zones, transport hubs, and dense urban areas supporting inner loop circularity. Chains like Leuven's Think Twice demonstrate scalable reuse strategies with social benefits
111	CLIMATE CHANGE CRISIS AND CITIES	Çiğdem TUĞAÇ	2022	https://dergipark.org.tr/en/download/article-file/2369220	Cities, Climate Change, Mitigation, Adaptation, Resilience	Evaluate bidirectional cause-effect relationship between climate change and cities	focuses on the analysis and evaluation of the bidirectional relationship between climate change and cities, discussing strategies, impacts, and solutions	Greenhouse gas mitigation and adaptation actions contribute significantly to urban resilience. Cities are the key to the solution in combating climate change.
112	CLIMATE CHANGE RESPONSIVE TOURISM PLANNING: OPPORTUNITIES AND THREATS FOR TÜRKİYE	Aysun Aygün Oğur	2022	https://www.researchgate.net/publication/359090551_IKLIM_DEGISIKLIGINE_DUYARLI_TURIZM_PLANLAMASI_TURKIYE_ICIN_FIRSATLAR_VE_TEHDITLER	Climate change, tourism, vulnerability, adaptation, tourism planning	To reveal the opportunities and risks of Türkiye's tourism sector against climate change and to provide insights for future planning and investment decisions.	Literature review, analysis of existing climate change and tourism studies, SWOT analysis, and reference to modeling and scenario studies for Türkiye and global cases.	The tourism sector in Türkiye faces risks such as decreased winter tourism due to snow mass reduction, changes in tourism season length, infrastructure risks from sea level rise, and climate-related disasters. Opportunities include lengthening of tourism seasons, emergence of new destinations, and the potential to develop alternative tourism types.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
113	Climate Change, Sustainable Cities, and Communities: A Multi-Criteria Assessment	Hakan Gökhan Gündoğdu, Ahmet Aytekin	2022	https://doi.org/10.29224/insanveinsan.1104121	Sustainable Development, Climate Change, Sustainable Cities, DEMATEL, PIV	To evaluate how carbon footprint, renewable energy use, and waste management impact the implementation of SDGs related to climate action and sustainable cities, comparing different countries' performances.	Multi-criteria decision making methods: DEMATEL (Decision Making Trial and Evaluation Laboratory), PIV (Priority Importance Value) analysis; evaluations from domain experts; data from World Bank Open Data and SDG indicator databases.	The study found that carbon emission, renewable energy, and waste management significantly impact SDG interactions concerning climate change and sustainable cities. Nordic and some European countries (e.g., Sweden, Norway, Denmark) perform best. Carbon footprint reduction is critical, and governance approaches integrating these factors are essential for policy-making. The results align with existing literature confirming strong interactions and synergies between climate action and sustainable cities.
114	Managing floodplains using nature-based solutions tosupport multiple ecosystem functions and service	Jiří Jakubínský, Marcela Prokopová, Pavel Raška, Luca Salvati, Nejc Bezak, Ondřej Cudlín, Pavel Cudlín, Jan Purkyt, Paolo Vezza, Carlo Camporeale, Jan Daněk, Michal Pastor, Tomáš Lepeška	2021	http://dx.doi.org/10.1002/wat2.1545		This article reviews the recent understanding of floodplain delin-eation, the most common causes of disturbance, the ecosystem functionsbeing performed, discussing in turn the measures being considered to miti-gate the frequency and magnitude of hydrologic extremes resulting fromongoing environmental changes.	This study synthesizes existing scientific knowledge and research on the delineation of floodplains, the causes of their degradation, and the ecosystem functions they provide. It not only focuses on identification and assessment but also evaluates potential solutions and practical management measures.	Preserving ecosystem functions is key to reducing flood frequency and severity. River-floodplain connectivity needs to be maintained and human activities need to be harmonized"

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115	Future Changes in Day-to-Day Precipitation Variability in Europe,	Lhotka, O., Plavcová, E., Beranová, R.	2024	https://doi.org/10.1175/JHM-D-23-0206.1		Regional patterns of day-to-day precipitation variability across Europe was analysed and assessed in frame of their future changes using Coordinated Regional Climate Downscaling Experiment (CORDEX) regional climate models.	Markov chain process	In a warming world, water availability will play a key role in ecosystem productivity. Although future changes in rainfall amounts have been studied extensively, much less attention has been given to changes in their temporal distribution and variability. Because grouping wet or dry days into sequences vitally contributes to characterizing floods or droughts, we aimed to study future changes in these tendencies. We found that although future changes in wet or dry days grouping tendencies are mostly driven solely by change in their frequency, climate models do not agree on the change in the frequency of wet days over large parts of continental Europe. This leaves major uncertainties in a future European hydroclimate and implications for impact modeling.
116	Urban solutions to climate change: an overview of the latest progress	Kuok Ho Daniel Tang	2024	https://doi.org/10.20935/AcadEnvSci7342	urban solutions; nature-based solutions; technological solutions; social solutions; integrated solutions; mitigation; adaptation	To provide an overview of the latest progress in urban solutions to climate change, encompassing nature-based, technological, social, and integrated solutions, and to contribute to informed decision-making for sustainable urban practices.	Systematic literature review of peer-reviewed articles within the past 5-10 years, complemented by reports and authoritative websites. Keywords related to urban solutions and climate change were used in databases such as Scopus, Web of Science, and ScienceDirect, followed by screening based on criteria such as peer review, urban focus, and relevance.	Urban solutions are categorized into nature-based, technological, social, and integrated solutions; examples include urban greening with technological integration, innovative transport subsidy programs (e.g., in Dar es Salaam), and use of big data and IoT for optimized urban resource management. Integration enhances resilience and effectiveness but is complex. Challenges include cost, social inequalities, knowledge gaps, and latency of benefits.

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117	Climate resilient cities. Introducing two complementary projects' approaches to mitigate the negative impacts of climate change.	Libera Amenta, Antonia Arena	2020	https://doi.org/10.6093/2531-9906/7036	Climate Change, Ecosystem Services, Urban Living Labs, Blue and Green Infrastructures, Resilience, Stakeholder Engagement, Urban Planning	To present innovative adaptive solutions and decision-support tools to enhance the resilience of cities facing climate-related hazards; to explore Urban Living Labs methodology for co-creation and stakeholder engagement; to propose integrated approaches combining ecosystem services and infrastructure planning in urban contexts	Analysis of pilot projects including the development of a Spatial Decision Support System (SDSS) based on WEB-GIS for risk evaluation (PLANNER project); case study of Volturara Irpina Municipal Plan focusing on Blue & Green Infrastructures and nature-based solutions; application of Urban Living Labs for involving stakeholders in co-creation and adaptive planning; multidisciplinary data collection and scenario development.	The identified tools and approaches enabled mapping of vulnerabilities, evaluation of climate risks, and scenario development for urban resilience; the use of ecosystem services and Blue & Green Infrastructures was proposed and partially implemented to mitigate risks; the Urban Living Labs showed promise in fostering stakeholder participation and governance innovation though further exploration is recommended.
118	Nature-Based Solutions for Natural Hazards and Climate Change	Edited by Borja Gonzalez Reguero, Fabrice Renaud, Silvana Di Sabatino, Brenden Jongman, Boris van Zanten, Michael W. Beck and Emmanuel le Cohen-Shacham	2022	https://www.frontiersin.org/research-topics/14043/nature-based-solutions-for-natural-hazards-and-climate-change/magazine	nature-based solutions, climate change, natural hazards, disaster risk, risk management, nature-based adaptation, ecosystem-based adaptation	The main goal of this Research Topic is to enhance cooperation and scalability of NBS for climate risk management, hazard mitigation, climate resilience, and adaptation, with a special focus on regions at the forefront of climate change such as small island states. The Topic aims to cover all multidisciplinary aspects of NBS in relation to natural hazards and climate risk adaptation and mitigation.	It is a compilation that addresses NBS implementations in various contexts (forests, coasts, urban areas, islands, agriculture), using a range of scientific methods. Multidisciplinary, case study-based scientific research methods that include field studies and practical applications.	NBS has high potential but limited implementation; there are barriers in areas such as scalability, financing, and regulation; there is a need for knowledge, experience, and models in these areas.

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
119	Potentials and Pitfalls of Mapping Nature-Based Solutions with the Online Citizen Science Platform ClimateScan	Britta Restemeyer, Floris C. Boogaard	2020	https://doi.org/10.3390/land10010005	nature-based solutions; online climate adaptation platforms; citizen science; community-building	Online knowledge-sharing platforms could potentially contribute to an accelerated climate adaptation by promoting more green and blue spaces in urban areas. The implementation of small-scale nature-based solutions (NBS) such as bio(swales), green roofs, and green walls requires the involvement and enthusiasm of multiple stakeholders. This paper discusses how online citizen science platforms can stimulate stakeholder engagement and promote NBS, which is illustrated with the case of ClimateScan	content analysis	ClimateScan has adopted a “bottom–up” approach in which users have much freedom to create and update content. Within six years, this has resulted in an illustrated map with over 5000 NBS projects around the globe and an average of more than 100 visitors a day. However, points of concern are identified regarding the data quality and the aspect of community-building. Although the numbers of users are rising, only a few users have remained involved. Learning from these remaining top users and their motivations, we draw general lessons and make suggestions for stimulating long-term engagement on online knowledge-sharing platforms.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
120	Scaling Nature-Based Solutions for Fluvial Floods: A Worldwide Systematic Review	Marina Howarth, Erica A. H. Smithwick, Lauren McPhillips, Alfonso Mejia	2025	https://doi.org/10.1002/wat2.70011	ecosystem-based adaptations, flood mitigation, fluvial, natural flood management, nature-based solutions	Despite increased understanding and adoption of nature-based solutions (NBSs) within urban and coastal areas, large-scale NBS for fluvial flood mitigation remain challenging to study and implement. A stronger evidence base is needed to identify critical research gaps and to best inform the design and deployment of NBS on the watershed scale. We synthesize evidence of the performance and co-benefits of NBS for fluvial flood mitigation based on a systematic review of 131 peer-reviewed papers worldwide, developing an Ecosystem Focus Type (EFT) to compare flood mitigation across large-scale NBS	The NBS functionality was assessed through a meta-analysis of the 64 papers, which included quantitative analyses of flood mitigation, co-benefits, or both.	While we find that NBS can mitigate fluvial floods across all EFTs, our study also highlights that inconsistencies in measurement methods, a dearth of empirical case studies, and large variability in reported values limit generalization and comparison across NBS. Co-benefits for fluvial flood NBS are numerous, but few are quantified, and study methods vary with regard to specific NBS. Social benefits of NBS, including benefits to communities most in need of support, are infrequently part of these studies. There is a clear need to develop common design and performance standards for large-scale NBS and for guidance on which measures are key to consider and monitor for flood mitigation and co-benefits. The success of large-scale NBS for fluvial flood mitigation will depend on research and practice guided by transdisciplinary systems thinking approaches that can deliver evidence-based, community-driven outcomes.

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121	Redefining flood hazard and addressing emerging risks in an era of extremes	Mohammad Shamsuddoha	2025	http://dx.doi.org/10.1038/s44304-025-00082-7		To propose a more effective, data-driven, and regionally adaptable flood management approach for future extreme flood events. Floods are intensifying globally, primarily due to climate change, with devastating impacts on lives and economies. Recent flash floods in Bangladesh, Central, and Western Europe highlight the ineffectiveness of current resilience strategies (e.g., drainage improvements) in mitigating extreme weather impacts. This commentary highlights the urgent need to shift focus towards flood risk reduction amid evolving flood hazard regimes while strengthening resilience through preparedness (e.g., dynamic warning systems) and adaptation strategies.	The study employs a commentary-based analytical method, drawing on recent flood events and current policy shortcomings to argue for a paradigm shift in flood risk management and climate resilience strategies.	Current flood management approaches still rely on historical data (e.g., 100-year flood return periods); however, under the conditions of the climate crisis, these assumptions are no longer valid. Regional cooperation, transboundary water management, and the development of dynamic warning systems based on new technologies (e.g., "digital twin" systems) are essential. Although approaches like the Bangladesh Delta Plan 2100 are promising, their level of implementation remains very limited.
122	Urban flood risk management needs nature-based solutions: a coupled social-ecological system perspective	Kejing Zhou ,Fanhua Kong ,Haiwei Yin ,Georgie Destouni Michael E. Meadows Erik Andersson ,Liding Chen ,Bin Chen ,Zhenya Li &Jie Su	2024	https://doi.org/10.1038/s42949-024-00162-z		A growing number of Nature-based Solutions (NbS) has been advocated for urban flood risk management (FRM). However, whether NbS for FRM (NbS-FRM) achieves both social and ecological co-benefits remains largely unknown. We here propose and use a conceptual framework with a coupled social-ecological perspective to explore and identify such "win-win" potential in NbS-FRM.	The study employs a scoping review combined with the development and application of a conceptual framework grounded in a coupled social-ecological systems perspective.	Through a scoping-review we find that ecological FRM measures are unevenly distributed around the world, and those solely targeting flood mitigation may have unintended negative consequences for society and ecosystems. In elaborating this framework with evidence from the reviewed studies, we find that NbS-FRM has the potential to provide both social and ecological co-benefits, with remaining gaps including a lack of resilience thinking, inadequate consideration of environmental changes, and limited collaborative efforts to manage trade-offs. The proposed framework shows how to move forward to leverage NbS for equitable and sustainable FRM with improved human well-being and ecosystem health.

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123	Nature-based solutions for hydro-meteorological risk reduction: a state-of-the-art review of the research area	Laddaporn Ruangpan, Zoran Vojinovic, Silvana Di Sabatino, Laura Sandra Leo, Vittoria Capobianco, Amy M. P. Oen, Michael E. McClain, and Elena Lopez-Gunn	2019	http://dx.doi.org/10.5194/nhess-2019-128		Hydro-meteorological risks due to natural hazards such as severe floods, storm surges, landslides and droughts are causing impacts on different sectors of society. Such risks are expected to become worse given projected changes in climate, degradation of ecosystems, population growth and urbanisation. In this respect, nature-based solutions (NBSs) have emerged as effective means to respond to such challenges. A NBS is a term used for innovative solutions that are based on natural processes and ecosystems to solve different types of societal and environmental challenges. The present paper provides a critical review of the literature concerning NBSs for hydro-meteorological risk reduction and identifies current knowledge gaps and future research prospects.	The methodology consisted of two phases as schematised.The first phase consisted of the identification of articles satisfying the search criteria discussed. Next, all articles were screened and filtered based on the selection criteria discussed.	There has been a considerable growth of scientific publications on this topic, with a more significant rise taking place from 2007 onwards. Hence, the review process presented in this paper starts by sourcing 1608 articles from Scopus and 1431 articles from the Web of Science. The full analysis was performed on 146 articles. The analysis confirmed that numerous advancements in the area of NBSs have been achieved to date. These solutions have already proven to be valuable in providing sustainable, cost-effective, multi-purpose and flexible means for hydro-meteorological risk reduction. However, there are still many areas where further research and demonstration are needed in order to promote their upscaling and replication and to make them become mainstream solutions.

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124	Flood emergency management in a municipality in the Czech Republic: A study of local strategies and leadership	Mohan Kumar Bera	2023	https://doi.org/10.1016/j.nhres.2023.06.004		After the fall of Communism in the Czech Republic, the centralised flood management was entrusted to a municipality. The new approach to disaster management in 1997 emphasised on emergency preparedness at the local level. The changing paradigms of emergency management and the changing rules and regulations of insurance companies have increased the responsibility of the local government to reduce the loss of property and save lives in villages. A qualitative method was used to explore a phenomenon in a bounded system and to understand the role and responsibilities of the municipality and the villagers' expectations. In addition, policy papers were examined to help understand the emergency planning of the municipality	The study uses a qualitative case study approach to explore emergency management within a bounded municipal system. It incorporates document analysis of policy papers and focuses on the roles, responsibilities, and leadership dynamics at the local government level.	The study found that successful emergency leadership is associated with adequate planning, appropriate strategies and effective implementation. The leaders must encourage subordinates and other individuals to participate actively in emergency management. It has been observed that the mayor created a 'sense of urgency' after assessing the prevailing institutional situation so that the plans to manage the emergency may be implemented immediately. The municipality also improves its disaster management strategies by identifying the causes of failure in the past, rectifying existing gaps, building confidence among villagers and preventing migration. It is not expected that all the stakeholders, staffs and elected members at the grassroots level engage in emergency management activities equally. However, leadership of a mayor can bind all the stakeholders to achieve a successful emergency management.

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125	The influence of damming on landscape structure change in the vicinity of flooded areas: Case studies in Greece and the Czech Republic	Z. Keken, D. Panagiotidis, J. Skaloš	2015	https://doi.org/10.1016/j.ecoleng.2014.11.002	Many studies have recently been published on changes in land use/land cover (LU/LC), but only a few have been concerned with the impact of technical hydrological measures on LU/LC. This study evaluated physical landscape structure changes due to the realisation of important hydrological facilities (in 1959) in central Greece. he results were compared with the locality where the dam can be extended in the future (in the Czech Republic), (i.e. the potential flooded area is protected from the development of urban structures by a territorial limit). Changes were monitored in a zone that was 500 m from the border of the directly flooded area (Greece) and 500 m from the border of the potential directly flooded area (Czech Republic).	landscape ecology metodological approachs	The importance of the study relates to a comparison of landscape characteristics, which emerged following the analysis of aerial photos in two different time periods. The spatial landscape dynamics from 1945 until 1996 (Greece) and from 1950 to 2012 (Czech Republic) in the study area were monitored and changes were analysed, together with the effects that the dam/territorial limit might have had on structure of the surrounding landscape. All data were processed using Arc-map GIS by the Environmental Systems Research Institute (ESRI). The results showed that from early 1945s to 1996s, the landscape within the study area in Greece has undertaken a complicated evolution in landscape structure and composition. The human activities have significantly changed the distribution and quantities of each land cover types in surrounding of Plastiras reservoir. The decrease of Shannon's diversity index in Greece manifested intensive management and reconstruction of landscape by human beings, which means reduced landscape heterogeneity and landscape diversity, leading to the decrease of environmental benefits and ecological stability. The different and methodically new way that we analysed landscape changes forms the basis for analysing landscape functional changes in the future. This may help us to better evaluate historic effects of anthropogenic activities like dam or similar construction on landscape structure and its changes and predict possible

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								changes, in case of new dams realization. However, to achieve effective NBS, a multi-actor approach in developing appropriate measures for specific sites is required as NBS occupy more space than 'grey' infrastructure and often overlap with private land. NBS also necessitate a multidisciplinary approach, to maximise environmental, social, and economic benefits. Thus, a transdisciplinary approach is needed for the effective implementation of NBS. Viewing NBS as a boundary concept, focusing on the common ground for different disciplines and actors, can facilitate communication and provide a first step towards effective flood risk mitigation.
126	Multi-, inter-, and transdisciplinary approaches to nature-based flood risk management	Peter R. Davids, Thomas Hartmann, Carla S. S. Ferreira, Zahra Kalantari and Paulo Pereira	2024	https://doi.org/10.1016/j.coesh.2024.100537	Nature-based solutions, Flood risk management, Transdisciplinary, Boundary concept, Governance	Nature-based solutions (NBS) can act as a valuable complement to conventional 'grey' infrastructure for stormwater management (e.g. dams and dikes) in reducing flood risks as these 'green' solutions are perceived to be more flexible and multifunctional.	research mote	
127	Clarifying "flood experience": A novel conceptual model demonstrates how a flood experience emerges and what determines its intensity and character	Ivan Andráško, Kamila Dolák Klemešová, Petr Dvořák	2024	https://doi.org/10.1016/j.ijdrr.2023.104150	Floods, Experience, Memories, Model, Meanings, Emotions, Czech Republic	Understanding the ways people experience and remember floods is of key importance for flood risk management policies; accordingly, there is a considerable body of studies and findings on flood experience and its various aspects. However, despite these efforts and their significance for relevant research and praxis, the concept of flood experience by itself remains undertheorized and underexamined. In this study, we address this crucial knowledge gap both in terms of theory and empirical evidence; we propose a novel conceptualization and model covering the ways a flood experience emerges, outlining its constituents and their relations, and demonstrating how these translate into the respective memories, meanings, and knowledge.	questionnaires and interviews	This study provide a novel conceptualization and model of flood experience emergence and structure. We probe the model by examining field research data by means of content and network analyses. The model explains the character of a flood experience through the unique configuration of its components. Personal involvement plays a key role in how people experience and remember disastrous events such as floods.

128	Modelling, Measuring, and Visualising Community Resilience: A Systematic Review	Hoang Long Nguyen & Rajendra Akerkar	2020	https://doi.org/10.3390/su12197896	community resilience; resilience modelling; knowledge representation; resilience assessment; information visualisation	The aim of this paper is to provide a comprehensive systematic review of the existing literature, projects, and tools related to modelling, measuring, and visualising community resilience. It seeks to offer an overview of diverse approaches within these three phases, helping researchers, practitioners, and policymakers understand the current state-of-the-art, identify gaps, and guide future efforts in enhancing community resilience through better analysis and representation of resilience information	The methodology of this paper involves conducting a systematic review of 77 different literature records published from 2000 to 2020. The review is structured around five research questions focusing on existing resilience studies, the threats faced by communities, the components and properties defined for resilience, the methods used for measurement (qualitative, quantitative, or hybrid), and visualization techniques. The process includes selecting credible and relevant studies, analyzing and synthesizing the approaches to community resilience modeling, measurement, and visualization, and categorizing the methods into qualitative, quantitative, and hybrid approaches. This structured review aims to compare and summarize different methodologies across the literature to generate insights into best practices and emerging trends in community resilience	The main results of the review highlight the diversity and complexity of approaches employed to model, measure, and visualize community resilience. The study identifies numerous frameworks and tools developed over the past two decades, emphasizing that there is no one-size-fits-all methodology but rather a spectrum of qualitative, quantitative, and hybrid approaches tailored to specific community contexts and aims. Qualitative methods at both the framework and component levels are prevalent, offering insights into internal community dynamics through stakeholder engagement, interviews, observations, and documentation analysis. Quantitative approaches primarily utilize composite indices, surveys, and statistical models to produce measurable resilience indicators, enabling comparisons across communities and timeframes. Hybrid methods combining qualitative and quantitative data are increasingly recognized for their comprehensiveness and ability to capture both tangible and intangible aspects of resilience. Visualization techniques play a crucial role in interpreting and communicating resilience information effectively, especially during emergencies, by employing dashboards, maps, charts, and interactive tools supported by advanced digital technologies like machine learning and artificial intelligence. Overall, the review underscores the importance of a comprehensive, multi-method approach to accurately assess community resilience, facilitating

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								informed decision-making for researchers, practitioners, and policymakers to enhance preparedness and response strategies.
129	A review on the prevention and control of flash flood hazards on a global scale: Early warning systems, vulnerability assessment, environmental, and public health burden	Ghazi Al-Rawas, Mohammad Reza Nikoo, Malik Al-Wardy	2024	https://doi.org/10.1016/j.ijdrr.2024.105024	Flash flood, Early warnings, Vulnerability assessment Mortalities, Communicable diseases, Chemical contaminants	Flash floods' frequency and intensity are increasing because of climate change and their impact on communities. This paper aimed to critically review>100 studies about the current evidence of flash floods across different global geographies, focusing on early warning systems, risk and vulnerability assessment, attributable mortality, toxic chemical exposures, and burden of diseases.	literature review	The performance of flash flood early warning systems was critically reviewed globally. The various flash flood vulnerability assessment models were identified. Reviewed deaths, waterborne and vector-borne diseases link to flash floods. Identified the various non-threshold chemical contaminants associated with flash floods.
130	Perception of new trends in rainwater management in Czech cities: Barriers and tools of implementation	Jan Kopp, Pavlína Hejduková, Tomáš Hejduk	2025	https://doi.org/10.1016/j.landusepol.2025.107551	Rainwater management, Perceptual barriers, Blue-green infrastructure, Urban development, Socio-hydrology, Czech Republic	The demand for settlements to adapt to the impacts of climate change is reflected in the increased interest of the Czech public administration in promoting changes in the field of rainwater management (RWM). In the Czech Republic, city representatives and politicians are gradually leaning towards the development of blue-green infrastructure, i.e. towards promoting functional green spaces and other elements to support a nature-based water cycle in the urban landscape. Despite this fact, there are still a number of barriers limiting the speedier implementation of RWM changes. The research focused on the entire portfolio of possible barriers and promotional tools for the implementation of new trends; however, we also delve deeper into issues of perception.	questionnares	Fourteen potential barriers of new trends in rainwater management were identified. The most significant barriers in the Czech cities are related to economic issues. A perceptual barrier is the lack of confidence regarding the new systems. Perceptual barriers can be removed by collaborative, voluntary and ethical tools.

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
131	Refining zoning of artificially-drained mine subsidence areas: Relative elevation models and hydrological hazard frameworks as decision support tools for spatial planning and mitigation of flood-related geohazards and risks regardless of prevailing water regimes	Dariusz Ignacy	2025	https://doi.org/10.1016/j.resourpol.2025.105572	Artificial drainage, Decision support tool Geohazards, Mining impacts, Mitigation strategies, Spatial planning	The extraction of minerals is the main reason for the permanent maintenance of forced flows of surface and ground waters in mining and post-mining areas. When natural water flows are restored the inundated areas most often may be many times larger than the hitherto existing ones. This requires rethinking of existing land use in artificially-drained mining areas by using tailor-made spatial planning policy to address future changes in water conditions. The main goal of this paper is to show that in such areas the current prevalent practice of classical hydrological modeling using only the base flood translates into inadequacies in spatial planning policies.	The hydromorphological and cartographic method of assessing the HH in artificially-drained MAs and PMAs	Restoration of natural water flows in mining areas increases the scale of flood-related geohazards and risks. The scale of the hydrological hazard in mining areas requires amending land use and spatial planning policies. Site-specific relative elevation models and hydrological hazard frameworks as tools used in spatial planning policy. Use of these tools introduces, allows and maintains mitigation strategy options for flood-related geohazards and risks.

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
132	Investigating the public perception of green, hybrid and grey flood risk management measures in Europe	Nejc Bezak, Pavel Raška, Jan Macháč, Jiří Louda, Vesna Zupanc, Lenka Slavíková	2024	https://doi.org/10.1016/j.pdisas.2024.100360	Public perception, Flood risk management, Green measures Grey measures, Acceptability, Feasibility, Effectiveness	This study examines the differences in the perceived effectiveness, feasibility and acceptance of different types of flood risk management measures in three European countries (Slovenia, Czechia, and the Netherlands). The results show statistically significant differences in the perceived effectiveness, feasibility and acceptance of the studied measures. With respect to individual measures, respondents in all three countries tend to view conventional grey measures (dams and cisterns) as more effective and acceptable than green and hybrid measures. However, grey measures are perceived as difficult to implement. The results reveal that the perceived effectiveness and acceptability of the measures are related. The major drivers affecting the differences in the perceptions of different measures are the countries of the respondents and the sociodemographic variables of income and age	self-administered online questionnaire survey Statistical methods	The public perception survey was conducted in Slovenia, Czechia and the Netherlands. Effectiveness, feasibility and acceptability of multiple FRM measures was investigated. Grey measures (dams and cisterns) are perceived as more effective and acceptable. Perceived effectiveness and acceptability of the measures are related. Aggregate social drivers should be considered in implementing FRM measures."

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
133	Stakeholder engagement and institutional context features of the ecosystem-based approaches in urban adaptation planning in the Czech Republic	Eliška Krkoška Lorencová, Lenka Slavíková, Adam Emmer, Eliška Vejchodská, Kristýna Rybová, Davina Vačkářová a	2021	https://doi.org/10.1016/j.ufug.2020.126955	Climate change adaptation, Czech Republic, Ecosystem-based adaptation Institutions, Participation, Stakeholders, Urban	The study illustrates how to initiate strategical adaptation planning "from the scratch" and facilitate the implementation of an adaptation planning process based on examples of three pilot cities in the Czech Republic (Prague, Pilsen, and Brno), using the outputs and experiences gained from participatory workshops and gathered stakeholder and institutional evidence. We focus particularly on stakeholder's perception of climate change-related risks as well as prioritization of specific EbA measures and the institutional context of the decision-making processes concerning implementation of those measures in order to enhance adaptation planning.	Participatory assessment of climate change-related problems and preferences towards EbA measures	Participatory approaches and institutional context of ecosystem-based adaptation (EbA) are investigated. Perception of individual EbA measures vary substantially among three pilot cities. Strong cooperation between the city, NGOs and academics supports innovative solutions. Low awareness of the problem leads to non-action. The non-existence of the institutional framework can be a severe barrier for EbA implementation.
134	Urban flood dilemmas: How European cities growth shapes flood risk and resilience strategies?	Wiktor Halecki, Dariusz Młyński	2025	https://doi.org/10.1016/j.jenvman.2025.124161	Green spaces Urban resilience River flooding Sealing Stormwater management	Extensive research across European cities underscores the importance of assessing urbanization's impact on flood risk, focusing on river-induced floods and impermeable areas. Using advanced statistical tools, we investigated urban green coverage, Urban Morphological Zones (UMZ), and sealing (imperviousness) levels and effects. Our analysis found that Continuous Urban Fabric (sealed surface >80%) and Discontinuous Dense Urban Fabric (sealed surface 50%–80%) showed negative relationships within river flooding risk. In contrast, arable land (annual crops) showed a positive relationship, highlighting its unique influence. Medical services prone to flooding were prevalent in Spain, Sweden, and Romania, while educational services had the highest distribution in Italy and Latvia.	Structural Equation Modeling (SEM); Urban Morphological Zones (UMZ), Continuous Urban Fabric	High imperviousness and limited green spaces were observed in most cities. Medical services prone to flooding are prevalent in Spain, Sweden, and Romania. Schools exposed to river flooding are most distributed in Italy and Latvia. Flood-prone population exceeds 50% in some Belgian, French, Italian, German cities. Nordic urban planning prioritizes green spaces, promoting sustainability.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
135	Czech farmers' perspectives on sustainable agriculture and water management: Implications for climate change adaptation	Marek Bednář, Renata Pavelková, Patrik Netopil, Bořivoj Šarapatka	2025	https://doi.org/10.1016/j.agwat.2025.109470	Sustainable agriculture Water management measures Climate change Farmers' attitudes Czech agricultural landscape Questionnaire survey	Climate change significantly challenges agricultural water management, requiring a shift to sustainable practices. This study examines Czech farmers' attitudes towards sustainable agriculture and water management based on a survey of 1176 farmers.	Traditional and innovative methods were used, such as factor analysis, ANOVA, and machine learning, to uncover patterns in the data. Additionally, we apply AI language model methods to reclassify open-ended responses, enhancing our understanding of farmers' attitudes.	This study explores Czech farmers' attitudes towards sustainable agriculture and water management. We analyze factors that influence farmers' willingness to adopt sustainable practices. The research identifies regional differences in attitudes towards water management. Results indicate an increasing awareness of the importance of wetlands in the agricultural landscape. We offer recommendations for developing effective agricultural policies.
136	Adaptation pathways in planning for uncertain climate change: Applications in Portugal, the Czech Republic and the Netherlands	Mark Zandvoort, Inês S. Campos, André Vizinho Gil Penha-Lopes, Eliška Krkoška Lorencová, Rutger van der Brugge, Maarten J. van der Vlist, Adri van den Brink, Ad B.M. Jeuken	2017	https://doi.org/10.1016/j.envsci.2017.08.017	Spillway radial gates Mode-coupling parametric vibration Instability mechanism Damping effects Instability mitigation	Adaptation pathways are developed to design adaptive policies to handle climate change uncertainty. Use of this tool varies across planning practices and adaptation challenges and adjusting the tool to particular practices can foster its adequate use. To gain insight into the use of adaptation pathways, we compared four initiatives (one each in Portugal and the Czech Republic and two in the Netherlands) with regard to design choices made. We found six design choices which need to be considered when adjusting adaptation pathways.	comparative study	"Adaptive planning tools need to be purposefully tailored to particular planning practices. Accounting for local practices determines the successful transfer of tools. Adaptation pathways are flexible enough to be adjusted to different practices. Six design choices influence the adequate tailoring of adaptation pathways. Delivery of adequate adaptation policy remains a highly challenging endeavour."

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
137	Drivers of future fluvial flood risk change for residential buildings in Europe	Max Steinhausen, Dominik Paprotny, Francesco Dottori, Nivedita Sairam, Lorenzo Mentaschi, Lorenzo Alfieri, Stefan Lüdtke, Heidi Kreibich, Kai Schröter	2022	https://doi.org/10.1016/j.gloenvcha.2022.102559	Flood loss Climate change Probabilistic Uncertainty Exposure River flood	In this study, recent datasets for hazard and flood protection standards are combined with high resolution exposure projections and attributes of vulnerability derived from open data sources. The independent and combined influence of exposure change and climate scenarios rcp45 and rcp85 on fluvial flood risk are evaluated for three future periods centered around 2025, 2055 and 2085. Scenarios with improved and neglected private precaution are examined for their influence on flood risk using a probabilistic, multivariable flood loss model ; BN-FLEMOps ; to estimate fluvial flood losses for residential buildings in Europe.	ChatGPT: This study employs a comprehensive modeling framework to assess flood risk across Europe by integrating hazard, exposure, and vulnerability data under current and future climate scenarios. River flow and inundation are simulated using the LISFLOOD hydrological model and LISFLOOD-FP, producing high-resolution flood hazard maps for six return periods. Structural flood defenses are incorporated through spatial datasets that define protection levels, assuming zero loss below design thresholds. Residential building exposure is estimated for 1995 and projected for 2025, 2055, and 2085 using probabilistic simulations of population, GDP, and wealth-to-income ratios. Vulnerability is modeled using BN-FLEMOps, a Bayesian network that estimates relative building loss based on flood characteristics, building type, and precautionary behavior derived from empirical and proxy data. Flood risk is expressed as Expected Annual Damage (EAD), accounting for protection and residual risk. Multiple scenarios explore the impacts of climate change, socio-economic development, and private precaution levels on future flood losses, enabling comparative assessment of adaptation strategies across the EU and neighboring countries.	Flood risk is projected to increase in the British Isles and Central Europe. Risk will stagnate or decline in many regions of Scandinavia and the Mediterranean. Urban centers and their surrounding regions are hotspots of flood risk in Europe. Improved private precautionary measures could reduce flood risk in Europe by 15%

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
138	Experiences of individuals with disabilities sheltering during natural disasters: an integrative review	Andrée Malpass, Caryn West, Jennifer Quaill, Ruth Barker	2018	https://search.informit.org/doi/pdf/10.3316/ielapa.379764292029961		The aim of this review is to synthesise current literature in this area and to identify gaps in current knowledge to inform future research.	The methodology involved an integrative literature review, systematically searching databases such as Medline, CINAHL, PsycINFO, and Scopus for peer-reviewed articles published between 1998 and 2018, using specific keywords related to disasters and disability. Out of 185 articles identified, six studies met the inclusion criteria, incorporating qualitative, mixed-methods, and narrative review designs. Data collection methods included semi-structured interviews, surveys, and literature synthesis, covering various disasters (earthquakes, floods, tsunamis, cyclones) across countries like Japan, Iran, the USA, and the UK, involving participants with different disabilities, although some studies did not specify participant demographics	The main results highlighted that the experiences of people with disabilities in emergency shelters are highly context-dependent, influenced by physical and social environmental factors, such as shelter accessibility, social support, communication, and training levels of shelter staff. Key challenges identified include inadequate shelter environments that do not meet accessibility needs, stigma, lack of specialized support, and poor communication, which can hinder safety, independence, and well-being during disasters. The review underscores the importance of context-specific, needs-based planning and greater engagement with individuals with disabilities to improve shelter inclusivity and effectiveness.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
139	Global Increase in Climate-Related Disasters	Vinod Thomas and Ramón López	2015	http://dx.doi.org/10.2139/ssrn.2709331	climate, climate hazards, government policy, natural disasters, sustainable development	This paper considers three main disaster risk factors; rising population exposure, greater population vulnerability, and increasing climate-related hazards; behind the increased frequency of intense climate-related natural disasters.	The study employs econometric analysis using panel data from 157 countries covering the period 1971–2013. Specifically, it utilizes fixed-effects models; both one-way (country effects) and two-way (including time effects); estimated via negative binomial regression to account for count data of natural disasters. The methodology involves examining the relationship between climate change indicators (atmospheric CO_2 concentrations and sea temperature deviations), population exposure, vulnerability variables, and disaster frequency. Key aspects of the methodology include: Incorporation of global climate variables as explanatory factors Use of fixed-effects to control for unobserved heterogeneity across countries and over time Analysis of cointegration among variables, especially the relationship between CO_2, sea temperatures, and global disaster effects Implementation of time series analysis to confirm the long-run relationships between estimated global effects and climate indicators	The main results are: Significant positive relationships between increased atmospheric CO_2, rising sea temperatures, and the frequency of natural disasters Evidence of cointegration between the global effects on disasters and climate indicators, suggesting a meaningful long-term relationship Global climate variables significantly influence disaster risk factors, alongside population exposure and vulnerability The findings support the hypothesis that anthropogenic climate change is a contributing driver behind the rising incidence of climate-related natural disasters, indicating a need for climate mitigation and adaptation strategies.

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
140	Construction Workforce's Mental Health: Research and Policy Alignment in the Australian Construction Industry	Hosseini, O., Loosemore, M., Fini, F. A.A.	2023	https://doi.org/10.3390/buildings13020335	mental health; construction industry; systematic literature review; occupational health and safety; well-being; Australian regulations	This paper addresses this knowledge gap by reporting the results of a systematic review of peer-reviewed mental health research using the PRISMA scoping review methodology.	Methodology: The study employed a three-stage systematic scoping review using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology. This process involved: Extracting relevant peer-reviewed research articles related to mental health in the Australian construction industry. Screening articles for relevance and removing duplicates to produce a final sample of 32 research papers. Content analysis was conducted, focusing on identifying the most frequently reported mental health risk factors and assessing the alignment between research findings and existing laws, regulations, and codes of practice.	Results: The review identified a significant discrepancy between research and regulatory policies concerning mental health in the Australian construction sector. Key risk factors such as violence and traumatic events, financial stress, workplace injustice, and poor organizational change management were underrepresented in research compared to their importance in policy frameworks. The overall similarity between laws/regulations and research literature regarding mental risk factors was high (LOS = 0.77), but critical gaps remain in specific areas. The findings underscore a need for future research to focus on these underrepresented areas to enhance policy relevance and effectiveness, promoting better mental health outcomes for construction workers.

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141	ORTAK AKIL ANTAKYA	Ortak Akıl - Antakya Platformu	2025	https://www.ortakakilantakya.com/		The platform aims to: Enable locals as active actors in the decision-making and reconstruction process, ensuring their needs and voices guide redevelopment. Promote inclusive and transparent planning via open participation, documentation of meetings, and accessible planning processes. Advocate for institutional structures; like a dedicated planning office; to facilitate coordinated, integrated planning at the local level. Ensure holistic urban recovery, addressing not just immediate structural rebuilding but also infrastructure gaps (drainage, utilities, housing, social and cultural facilities). Develop a replicable model for post-disaster urban revitalization, combining historical sensitivity, disciplinary integration, and stakeholder collaboration.	Strategic Improvement for Disaster-Focused Settlement Strategies, Planning Strategies, Economic Strategies, Cultural Strategies, Social Strategies, Ecological Strategies, Transportation and Infrastructure Strategies, and Construction Strategies have been determined.	The conclusion section focuses on open city planning.
142	2024 Disasters in Numbers	UCLouvain, CRED, USAID	2024	https://files.emdat.be/reports/2024_EMDAT_report.pdf		This document focuses on natural disasters recorded by the Emergency Events Database (EM-DAT) in 2024.	disasters are related to natural hazards, excluding biological and extra-terrestrial hazards, reported at the country level in EM-DAT.	These events resulted in the deaths of 16,753 people and affected 167.2 million people. Economic losses totalled 241.95 billion US dollars. The year 2024 was marked by extreme heat events in Asia that caused the deaths of thousands of people, severe droughts in Africa that affected more than 25 million people, and destructive tropical storms in the United States (US) that caused total damage exceeding 100 billion US dollars.

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
143	How To Make Cities More Resilient A Handbook For Local Government Leaders A contribution to the Global Campaign 2010-2020	UNISDR	2017	https://www.unisdr.org/campaign/resilientcities/assets/toolkit/Handbook%20for%20local%20government%20leaders%20%5B2017%20Edition%5D_English_ed.pdf		This Handbook contains: an introductory part; the main body elaborating on the rationale for investing in disaster risk reduction (DRR) and resilience, the New Ten Essentials for Making Cities Resilient, the five (5) steps to develop a process called the Resilience Building Cycle, and annexes containing useful resources for Handbook users. Several practical examples illustrate how local governments, together with stakeholders and partners, are able to achieve resilience. These examples demonstrate that local governments can embed disaster risk reduction in their development strategies to the benefit of their citizens.	Examples contained in the Handbook were collected from mayors and local government representatives, technical municipal staff and other practitioners	
144	Resilient Cities Guide	Ayşe Ece Durmaz	2021	https://yereliz.org/wp-content/uploads/2023/02/Dayanikli_Kentler_Rehberi_9ocak-dijital-2.pdf		Enhancing urban resilience through an integrative, solution-oriented, guiding and transformative approach at the strategic level of urban governance.	Resilient City Action Plan Preparation Processes have been defined.	Reducing disaster risk requires a systematic, multi-faceted and proactive approach to identifying, evaluating and developing plans to reduce disaster risk. Local governments can follow the 5 steps in the Resilience Building: 1. Introduction to Resilient Cities: Organisational Structure and Preparation 2. City Risk Analysis and Vulnerable Areas 3. Creating an Action Plan for a Resilient City 4. Financing and Implementing the Action Plan 5. Monitoring and Evaluating the Resilience Action Plan

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
145	An Overview of Climate Change Adaptation Spatial Planning Integration Problem through Literature: Evaluation of the Context in Türkiye	Demircan, G., Sılaydın, B.	2024	https://dergipark.org.tr/tr/download/article-file/4360581	Climate change adaptation; Spatial planning; Integration problem; Türkiye.	The objective of this article is to identify existing problems by revealing the impediments to the integration of adaptation policy with spatial planning through a review of the relevant literature.	An evaluation was made based on a literature review.	"As a result of the literature review, obstacles/challenges that can be grouped under five main headings have been identified. These challenges are: (1) the problem of unique, applicable actions at the local level and scale conflicts, (2) the lack of local knowledge, climate data, and guiding guidelines, (3) institutional and governance issues, insufficient financial resources, (4) insufficient vulnerability analyses, and (5) the lack of local adaptation plans that can guide urban planning. When examining the situation in Turkey within the framework of the problem areas identified in the existing literature, it is observed that the issues identified in the literature regarding the spatial planning process and adaptation integration are also present in Turkey. "

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146	Designing public open space to support seismic resilience: A systematic review	Emily L. French, Jeff Birchall, Karen Landman, Robert D. Brown	2019	https://doi.org/10.1016/j.ijdrr.2018.11.001	Earthquakes, Disaster prevention parks, Seismic resilience, Landscape architecture	The aim of this paper is to investigate how landscape architects and related design disciplines can proactively plan and design public open spaces to support seismic resilience. Through a systematic review of both grey literature and peer-reviewed academic papers, the study seeks to identify key themes and strategies that can enhance the physical and social functions of open spaces in earthquake-prone areas. The ultimate goal is to develop a foundational understanding and practical guidelines that enable these professionals to better incorporate seismic resilience into the planning, design, and management of open spaces, ensuring that they serve as effective resources for community response, recovery, and ongoing social cohesion in the aftermath of earthquakes.	The methodology of this paper involved conducting a systematic review of both grey literature and peer-reviewed academic articles related to the planning and design of open spaces for seismic resilience. The process began with defining broad inclusion criteria to encompass a wide range of interventions addressing mitigation, preparedness, response, or recovery from earthquakes and related hazards. An extensive search strategy was employed across multiple electronic databases, including ProQuest, Web of Science, Google Scholar, and Google, using carefully refined keywords grouped into categories such as disaster type, emergency cycle stage, open space typologies, and relevant disciplines. The search results were first screened through title and abstract review, ensuring that only relevant documents were selected. Full texts of eligible articles were then assessed for specific relevance, and reference snowballing was used to identify additional pertinent sources. In total, 35 documents were retained for detailed analysis. The selected literature, which varied in methodology, was summarized narratively, and key data were compiled into tables. Through reviewing these summaries, the authors identified common themes and subthemes, which informed the development of a coherent analysis of strategies for designing open spaces for seismic resilience. This systematic and iterative approach ensured transparency, replicability, and a comprehensive synthesis of current knowledge in the field.	The review identified six key themes that underpin effective planning and design strategies: multifunctionality; networks; site location and suitability; size and function; site elements; and social resilience. These themes highlight the importance of designing open spaces that serve multiple functions; such as supporting daily community life and disaster response; and ensuring they are well-connected within the urban fabric for redundancy and accessibility. The literature emphasizes that open spaces should be strategically located and appropriately scaled to meet post-disaster needs, including evacuation, shelter, and social gathering. Incorporating features that alert users to hazards and facilitate community engagement through programming and education is also critical. Furthermore, the findings stress that landscape architects and related professionals play a vital role in proactively integrating seismic resilience into open space planning, despite currently having limited involvement in this area. Overall, the review underscores the potential of multifunctional, well-connected open spaces to enhance both everyday livability and post-disaster recovery, providing a foundational basis for future guidelines and design interventions.

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No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
147	New approach to integrating disaster resilience into public open space planning and design	Mohsen Alawi & Dongzhu Chu	2024	https://doi.org/10.24294/jipd.v8i9.5222	Urban resilience, open space planning and design	The main aim of the study is to enhance the responsiveness of public open spaces; such as parks, squares, and sports fields; to disasters by integrating disaster resilience into their planning and design processes. Specifically, it seeks to develop a comprehensive framework based on four key resilience criteria; multifunctionality, efficiency, safety, and accessibility; that can guide planners, architects, and decision-makers in creating public open spaces capable of effectively supporting communities during various disasters while maintaining their everyday functions	The methodology of the study involved a systematic, two-stage literature review and framework development process. Initially, a broad search yielded 5,600 documents related to public open spaces, which was refined through additional searches focusing on planning, design, and disaster resilience, resulting in subsets of 350 and 640 relevant documents respectively. From these, 67 articles were selected based on their relevance to disaster resilience and public open space planning and design. The review provided insights into current research trends, gaps, and the role of public open spaces during disasters. Based on this analysis, the researchers developed a comprehensive conceptual framework that incorporates four main resilience criteria; multifunctionality, efficiency, safety, and accessibility; aimed at guiding the integration of disaster resilience into urban planning and design practices for public open spaces	The main results of the study highlight a growing body of research on disaster resilience in public open spaces, particularly since 2010, with a focus on climate change impacts, floods, and earthquakes. Out of 350 relevant documents, only 67 specifically addressed planning and design strategies for disaster resilience, indicating a gap in practical guidelines. The literature emphasizes the increasing recognition of the role of public open spaces in responding to and mitigating disasters, especially in the last few years. The study also revealed that current research often lacks clear guidance for planners and designers on incorporating disaster resilience into public open space planning. Additionally, four key resilience criteria; multifunctionality, efficiency, safety, and accessibility; were identified as essential for developing disaster-resilient public open spaces, supporting their effective function during normal times and in disaster situations

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148	The History of Urban Ecology	Mark J. McDonnell	2011	https://link.springer.com/chapter/10.1007/978-3-031-82927-7_2	Urban ecology	This book chapter aims to discuss the early roots of urban ecology and the emergence of the interdisciplinary science of urban ecology. The author includes 'an ecologist's perspective' to explicitly expose biases in the appraisal of this history. The chapter acknowledges the contributions of ecologists, human ecologists, planners, architects, geographers, economists, political scientists, engineers, sociologists, social workers, anthropologists, psychologists, and health scientists in shaping urban ecology		Urban ecology emerged as a subdiscipline of ecology in the early 1970s due to documented human impacts and environmental problems. Ecologists acknowledged human settlements as legitimate subjects of ecological study, influenced by events and the demise of the 'balance of nature' paradigm. Urban ecology integrates disciplines to investigate ecological and human dimensions, creating knowledge for sustainable cities
149	The ecological imperative for environmental design and planning	Frederick Steiner, Mark Simmons, Mark Gallagher, Janet Ranganathan, Colin Robertson	2013	https://doi.org/10.1890/130052	Environmental design and planning; Resilience; Urban ecology	The aim of the article is to emphasize the ecological imperative in environmental design and planning, proposing that integrating ecological principles and ecosystem services can enhance the sustainability, resilience, and overall function of urban environments. It advocates for a paradigm shift from viewing nature as something to be protected from development to understanding and investing in ecological systems as integral to urban health and livability.	The methodology involves a comprehensive review of existing literature, case studies, and conceptual frameworks from ecology, landscape architecture, urban planning, and engineering. The authors synthesize interdisciplinary insights to develop a compelling argument for integrating ecological understanding into design practices. They examine real-world examples; like green infrastructure projects and urban resilience strategies; to illustrate how ecological principles can be operationalized in planning and design.	The main results demonstrate that embedding ecological literacy and ecosystem services into planning and design processes can lead to resilient urban environments capable of mitigating natural hazards, supporting biodiversity, and providing economic and social benefits. The article highlights the need for cross-disciplinary collaboration, revised educational curricula, and policy support to realize these ecological imperatives effectively. Overall, it advocates for a future where ecological understanding becomes central to the development of sustainable and resilient cities.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
150	Spatial planning for multifunctional green infrastructure: Growing resilience in Detroit	Sara Meerow, Joshua P. Newell	2017	http://dx.doi.org/10.1016/j.landurbplan.2016.10.00	Green infrastructure, Ecosystem services, Resilience, Detroit, Spatial planning, Urban greening	To introduce and apply a spatial planning approach (the GISP model) that identifies tradeoffs and synergies among ecosystem services provided by green infrastructure, to identify priority areas in Detroit for strategic green infrastructure placement to maximize multiple ecosystem service benefits.	The study develops the Green Infrastructure Spatial Planning (GISP) model combining spatial data and expert stakeholder weighting in a GIS-based multi-criteria evaluation of six criteria (stormwater hazard, social vulnerability, access to green space, air quality, urban heat island, landscape connectivity). Stakeholders provided priority weights through surveys. Data sources include parcel-level land use, sewage discharge records, Social Vulnerability Index (SoVI), and others. Current and planned green infrastructure projects were mapped and statistically compared with model outputs via Pearson correlations. The model's outputs were presented through ESRI Story Maps and weighted linear combinations.	The GISP model identified 'hotspots' where green infrastructure could provide multiple co-benefits. Analysis revealed current Detroit green infrastructure projects reduce park poverty but are not located where stormwater, urban heat island, air quality, or landscape connectivity benefits are highest; in fact, their siting is negatively correlated with some priority criteria. Findings reveal tradeoffs and synergies among ecosystem service benefits and show the need for more strategic planning to maximize resilience and equity benefits citywide.
151	Forest resilience research using remote sensing and GIS – A systematic literature review	Rosniati A Risna, Lilik Budi Prasetyo, Eimear Nic Lughadha, Muhammad Nur Aidi, Damayanti Buchori, Dian Latifah	2023	https://iopscience.iop.org/article/10.1088/1755-1315/1266/1/012086	Forest resilience, remote sensing, GIS, vegetation index, biomass, forest disturbance, climate change, tropical forest, statistical analysis, machine learning	To provide insights on methods for quantifying forest resilience using RS/GIS, assessing indicators, modeling techniques, and challenges to support future research and management.	Systematic literature review using bibliometric analysis tools (Bibliometrix R, VosViewer) on Web of Science data (2011-2021); selection criteria narrowed 117 to 31 studies; metadata extracted on ecosystem types, sensors, indicators, and methods; statistical and machine learning methods overviewed from reviewed studies	Majority used satellite imagery (Landsat predominant); vegetation indices (NDVI, EVI), biomass, tree-ring data utilized; combined RS with field data improves modeling; challenges: scale, resolution, cloud cover, data availability; diversity in methods and indicators; need standardized frameworks

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152	EVALUATING GEODESIGN WITH ECOPHYSIOGRAPHY	Saye Nihan Çabuk, Mehmet Değerliyurt, Taki Can Metin and Alper Çabuk	2016	https://www.researchgate.net/publication/308368182	famine, drought, global climate change, mismanagement of clean water resources, national security questions, wars, disasters and environmental problems	To introduce the terms ecophysiography and geodesign; discuss significance of ecophysiography during geodesign process; and emphasize what geodesign may promise for creating sustainable environments.	The study is based on conceptual evaluation and discussion of ecophysiography within geodesign framework supported by literature review, and covers methodological explanations referring to the geodesign framework by Carl Steinitz and ecophysiographical features (climate, geomorphology, lithology, land cover). GIS and landscape evaluation techniques are also referenced as methods to conduct analyses.	The paper concludes that ecophysiographical evaluation provides a comprehensive viewpoint essential for describing landscape characteristics and assessing impacts of interventions during the geodesign process. It highlights ecophysiography's applicability mostly to rural or semirural areas at scales above 1:5000. The integration of ecophysiography improves precision in modeling and planning in geodesign framework stages, especially assessment and intervention stages.
153	INFORMATION EXTRACTION AND DEPENDENCY ON OPEN GOVERNMENT DATA (OGD) FOR ENVIRONMENTAL MONITORING	Hussein Abdulmuttalib	2016	https://isprs-archives.copernicus.org/articles/XLI-B4/79/2016/isprs-archives-XLI-B4-79-2016.pdf	Open Government Data, Environmental Monitoring, GIS Data, spatial Analysis, Geo-design, Geo-knowledge	Assessment performed on a small sample of OGD, considering data availability, usefulness, repetition periods, dependency and quality in relation to environmental monitoring needs; includes review of open data principles, tools, and community roles.	Efforts in OGD usage for environmental monitoring have been performed, but more formalization and community engagement is needed; examples of OGD in water quality monitoring illustrate potential; open tools and community involvement are essential; many governments have released data to the public expanding openness.	The paper highlights the potential of OGD to support environmental monitoring and decision-making for sustainability; stresses need for open tools, data quality awareness, and community involvement to maximize benefit; identifies challenges like data update frequency and interoperability.
154	Ecological Model of Disaster Management	Randal Beaton, Elizabeth Bridges, Mary K. Salazar, Mark W. Oberle, Andy Stergachis, Jack Thompson, Patricia Butterfield	2008	https://journals.sagepub.com/doi/pdf/10.3928/08910162-20081101-01?download=true	ecological model, disaster management, occupational health nursing, disaster planning, preparedness, response, recovery	To propose a comprehensive ecological model for disaster management useful to occupational health nurses and disaster planners to systematically address multi-level disaster planning, preparedness, response, and recovery efforts.	Conceptual framework development based on ecological theory, literature synthesis from disaster management, occupational health nursing, public health, and integration with national response frameworks.	The ecological model highlights the dynamic interactions among nested organizational levels, showing most interaction occurs between proximal levels (e.g., workplace with family and community). It encompasses most elements of the National Response Framework and the National Incident Management System, offers a broader systemic perspective, and emphasizes evaluations like After Action Reports to inform future planning.

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155	Geographic Information and Covid-19 outbreak: Does the spatial dimension matter?	Michele Campagna	2020	http://dx.doi.org/10.6092/1970-9870/6850	Coronavirus; Covid-19; Geographic information; GIS; Planning support systems (PSS); Geodesign	To formalize observations and reflections on Covid-19 pandemic spatial dimension, focusing on data availability and spatial planning support in Italy and Europe; to suggest the role of spatial information in emergency response.	Discussion paper based on analysis of scattered official and volunteered spatial datasets, literature references, policy documents, official dashboards, and the author's experience in spatial planning and GIS technologies.	- Lack of large-scale, accessible spatial data hindered pandemic understanding and response in Italy. - Spatial dimension is critical at all scales for informed decision-making and tailored lockdowns. - Existing tools like Johns Hopkins CSSE dashboard demonstrated effective web-based monitoring. - Differentiated, locally customized emergency measures may reduce socio-economic impacts while protecting health.
156	Geodesign the Multi-layered Water Safety	Panayiotis Sophronides, John Steenbruggen, Henk J. Scholten, Maria Giaoutzi	2016	https://doi.org/10.7480/rius.4.825	Multi-layered water safety; Geodesign; Flood risk management; Stakeholder participation; Flood safety measures; Netherlands; Spatial planning; Emergency response	To theoretically orchestrate the multi-layer safety concept in a geodesign structure that promotes stakeholder participation and collaboration supporting decision-making about balanced and desirable water safety measures across different spatial and temporal scales. To systematize the multi-layer safety concept methodologically enabling evaluation of safety measures based not only on economic efficiency but also on social acceptability and local values.	Conceptual study applying the geodesign theoretical framework to the Dutch multi-layered flood safety concept. Methods include: (1) Comprehensive inventory of required spatial and non-spatial data for flood safety decision-making. (2) Qualitative assessment of the multi-layered safety concept as a parallel system. (3) Framework development supporting stakeholder participation and collaboration with iterative feedback and trial-and-error logic. (4) Review of relevant literature and policy documents. (5) Proposed future use of interactive geotechnologies (e.g., touch tables) to facilitate communication and decision-making.	- Multi-layered safety resembles a parallel rather than serial system: failure in one layer does not mean failure of whole system. - Geodesign framework encourages stakeholder collaboration, experimentation, and joint learning to select optimal flood safety measures. - Importance of high quality, spatially explicit data to underpin decisions. - Ethical and social values influence decision-making alongside economic considerations. - Geodesign enables iterative evaluation boosting consensus and balanced water safety planning. - Framework requires future real-world testing to validate its effectiveness and usability.
157	Flood Prediction through Hydrological Analysis and Simulation Techniques	Halil İbrahim Şenol	2024	https://dergipark.org.tr/tr/download/article-file/4402222	Remote sensing, LiDAR DEM, GIS, Hydrological analysis, Flood simulation	Study application of GIS and LiDAR for 3D urban flood simulation and risk identification	Use of LiDAR DEM data, D8 algorithm for flow direction, hydrological analysis, flood simulation with 200 mm rainfall	Results identified flow models, catchment areas, potential flood zones; showed regional flood impacts and urban infrastructure damage; damage possible in as short as 10 minutes during flash floods. D8 algorithm effective for flow directions; 3D simulations useful to assess extreme rainfall impact on urban infrastructure.

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158	An Agent-Based Model of Public Participation in Sustainability Management	Robert Aguirre and Timothy Nyerges	2014	http://jasss.soc.surrey.ac.uk/17/1/7.html	Social Actors, Public Participation, Decision Making, Sustainability Management, Geodesign, Geographic Information Systems (GIS)	Simulation of public participation to understand consensus building among geographically distributed social actors in sustainability management,Agent-based modeling of socially intelligent agents with differing preconceptions communicating via an online platform; factorial experimental design with 27 treatments varying social and geographic distribution of agents, abundance of agents, and diversity of preconceptions.,Findings did not confirm initial expectations that increasing social/geographic diversity and preconception diversity would significantly impact consensus. Some treatments (18 out of 27 planned) were run; high abundance treatments abandoned due to computing limits. The theory of self-organizing resource users lacks specification of interdependence between social/geographic orientation and preconceptions.	Highlights limits of current theory of self-organization in sustaining social-ecological systems at regional scales; demonstrates need for integrating social/geographic dimensions and computing power in modeling; supports use of integrated GIS and agent-based modeling for sustainability science and management.	Focus on integrating GIS and agent-based modeling within a geodesign platform for understanding public participation in sustainability decisions over large regions. Computing limitations restricted scope of experiments. The study extends from previous works on online public participation and social simulation. The use of symbols in agent communication modeled aspects of mental models.
159	Evaluating Practical Implementation of Geodesign and its Impacts on Resilience	Yexuan Gu, Brian Deal, Brian Orland, Michele Campagna	2020	https://doi.org/10.14627/537674024	Geodesign, evaluation, International Geodesign Collaboration (IGC), systems thinking, resilience	To address two fundamental questions: 1) How are the geodesign processes implemented in different design projects? 2) Do geodesign practices improve resilience in landscape design?	Content analysis of 35 geodesign projects from IGC 2019, coding the projects based on the Steinitz geodesign framework principles and resilience evaluation principles; Use of multivariate regression to analyze relationships between geodesign processes and resilience criteria	Most projects included comprehensive design objectives and diverse strategies; many failed to address process relationships, which might limit diversity and dynamics of outcomes. Regression results show design strategy principle strongly predicts resilience (R^2=0.465, $p<0.01$). Process relationship and impact assessment also have positive influences on resilience. Impact assessment was unrelated to uncertainty and overall resilience.

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160	Criteria and Methodology for the Evaluation of Flood Risk Mitigation Measures		2015	https://www.varam.gov.lv/sites/varam/files/content/files/pludu_riski_zinojums_4_versija_gala.pdf	Flood risk mitigation, Evaluation criteria, Infrastructure protection, Pollution prevention Community resilience, Crisis adaptation, Local governance, Crisis prediction models, Sustainable water resources, Participatory management, Climate change adaptation, Drought resilience, Water scarcity and drought Hurricane Harvey (mentioned in related refs but not primary focus),Green infrastructure; Nature-based solutions; Flooding; Climate adaptation; Governance; Equity	To establish a comprehensive framework for evaluating and prioritizing flood risk mitigation projects that mitigate national level flood risks, protecting population, infrastructure, and environment in urban and densely populated areas.	Utilizes exclusionary (Yes/No) and scoring criteria based on population affected, protection of key infrastructure (electrical lines, gas pipelines, roads, Natura 2000 sites), and pollution risk prevention; based on tables and evaluation scales (pages 14-23)	Defines mandatory project inclusion criteria and scoring system prioritizing projects by number of residents protected, infrastructure safeguarded, and pollution risk averted; supports only projects fully aligned with SAM 5.1.1 objectives.
161	A Review of Participatory Management's Role in Reducing Vulnerability and Enhancing Resilience to Climate Change and Drought (2006-2024)	Moein Tosan, Raziyeh Shamshirgaran, Malihe Falaki	2024	https://www.researchgate.net/publication/391908715_A_Review_of_Participatory_Management's_Role_in_Reducing_Vulnerability_and_Enhancing_Resilience_to_Climate_Change_and_Drought_2006-2024		To critically examine the role of participatory management in reducing vulnerability and enhancing resilience to climate change and drought.	Research data were collected from Web of Science database covering 2007 to 2024 publications. The study used bibliometric analysis tools including VOSviewer and Biblioshiny to analyze scientific trends, co-authorship, citation networks, and keyword clustering.	The study shows a significant increase in participatory management research related to climate change and drought, especially after 2015. It identifies key authors, journals, countries contributing, and thematic shifts from theoretical to applied research integrating new technologies. The analysis highlights topics like resilience, vulnerability, participatory decision-making, and technology use in water management.
162	Beyond flood risk reduction: How can green infrastructure advance both social justice and regional impact?	Linda Shi	2020	https://doi.org/10.1007/s42532-020-00065-0		To explore how green infrastructure for flood risk reduction (GI-FRR) can achieve both large-scale ecological benefits and promote social justice through reframing its role and regional governance reform.	Perspective essay synthesizing existing literature and critical analysis.,No original empirical data; literature review and theory-based synthesis.	- Current green infrastructure is shaped by neoliberal governance focusing on land development competition; - GI-FRR can lead to gentrification without justice-oriented framing; - Proposes connecting GI-FRR with urban agriculture, community development; - Advocates strengthening regional governance to overcome municipal fiscal pressure

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163	Nature-based solutions and ecological urban planning and design for the sustainable urban environments	Shilky; Pawan Ekka; Manjari Upreti; Amit Kumar; Purabi Saikia	2024	https://doi.org/10.1016/B978-0-323-99164-3.00005-7	Nature-based solutions (NbSs), ecosystem services (ESs), green infrastructure (GI), urban sustainability, urban resilience, ecological urban planning	To present the concept and importance of nature-based solutions and ecological urban planning to achieve sustainable urban environments that respond to climate change, biodiversity loss, and human well-being challenges	Literature review and synthesis of interdisciplinary studies and examples on NbSs, ecosystem-based adaptations, and urban ecological planning.	NbSs provide multifunctional benefits including mitigation of urban heat islands, improved water management, bioremediation of degraded lands, and enhancement of urban biodiversity. They support climate change adaptation and resilience and promote healthier urban social-ecological systems.
164	The Role of GIS in Disaster Response: Improving Efficiency and Overcoming Challenges	Yue Han, Guanhong Liu	2025	https://www.researchgate.net/publication/389524130_The_Role_of_GIS_in_Disaster_Response_Improving_Efficiency_and_Overcoming_Challenges	Geographic Information Systems (GIS), Disaster Response, Risk Assessment, Real-Time Monitoring, Resource Allocation, Remote Sensing	To review and analyze recent advancements and trends in GIS applications for disaster response focusing on improving efficiency and accuracy.	Systematic literature review of peer-reviewed articles from 2021 onward selected from the Web of Science Core Collection; data extraction and thematic analysis including methodologies, GIS integration with emerging technologies, and practical applications.	GIS facilitates real-time data collection, analysis, and visualization improving operational efficiency. Integration with BIM, remote sensing, AI enhances prediction accuracy and resource management. There is a trend from reactive mapping to proactive disaster risk management. Examples include improved evacuation management in wildfires, and enhanced damage assessments. Challenges include data quality, interoperability, and user training.
165	Geodesign for Open Spaces Management in Mining-Dependent Urban Settlements	Luiz Glück Lima, Camila Marques Zyngier, Christian Freitas, Ana Clara Mourão Moura	2024	https://doi.org/10.1007/978-3-031-54118-6_13	Geodesign; Mining-dependent urban settlements; Open space management; Environmental control	To empirically address the potential application of geodesign as a methodological, advisory, and decision-making process to support open space management in mining-dependent urban settlements	Development of a WebGIS for recording and presenting data on environmental control performance indicators of open spaces; adaptation of the GISColab platform for collective and consensual construction of proposals using geodesign framework.	The model facilitates the qualification of open spaces based on morphological and functional characteristics; supports the definition of environmental control functions; enables participatory planning and monitoring; and promotes timely spatialization of proposals via a web-based platform.

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166	Civilās aizsardzības un katastrofas pārvaldīšanas likums		2016	https://likumi.lv/ta/id/282333-civilas-aizsardzibas-un-katastrofas-parvaldisanas-likums	civil protection, disaster management, early warning, evacuation, risk assessment, emergency response, recovery, state institutions, municipal institutions	To establish legal framework and organizational structure for civil protection and disaster management to ensure safety of people, environment, and property during disasters and threats.	Legislative codification and regulation of civil protection and disaster management responsibilities and procedures.	Defines disaster and threats, classifies high-risk facilities, assigns duties to ministries, municipalities, legal entities, and individuals; mandates early warning systems and collaboration mechanisms.
167	AI-Enhanced GIS Solutions for Sustainable Coastal Management: Navigating Erosion Prediction and Infrastructure Resilience	Seyed Reza Samaei; Mohammad Asadian Ghahfarrokhi	2024	https://doi.org/10.1007/s13762-021-03321-2	Geographic Information Systems (GIS); Artificial Intelligence (AI); Coastal Management; Erosion Prediction; Marine Infrastructure; Machine Learning	To explore the synergy between AI and GIS for predicting coastal erosion and enhancing resilience in marine infrastructure.	Integration of machine learning models trained on historical and real-time geospatial and sensor data with GIS platforms for prediction and visualization; real-time monitoring via IoT devices were incorporated; use of supervised learning methods such as Random Forest and Support Vector Machines; GIS data preprocessing, cleaning, visualization, and predictive mapping; alert system development.	Machine learning models enabled nuanced understanding and prediction of coastal erosion risks; GIS provided intuitive visualization and decision-making support; real-time monitoring improved responsiveness; infrastructure maintenance recommendations were enhanced based on predictive analytics.

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168	Multi-Sensor Remote Sensing and AI-Driven Analysis for Coastal and Urban Resilience Classification	Sumei Ren, Bushra Ghaffar, Muhammad Mubbin, Muhammad Haseeb, Zainab Tahir, Sher Shah Hassan, Dmitry E. Kucher, Olga Dmitrievna Kucher. M. Abdullah-Al-Wadud	2025	https://ieeexplore.ieee.org/document/10938888	resilience classification, multi-sensor remote sensing, LSTM, deep learning, urban resilience, coastal resilience, spatiotemporal patterns, AI, Copernicus Marine Data Service	To develop a scalable, adaptive, and data-driven framework using LSTM networks and multi-sensor satellite data to classify urban and coastal resilience levels, enabling better disaster risk management and sustainable urban planning.	Combines multi-step data preprocessing (normalization, feature engineering), class balancing (weighted loss, SMOTE) and a two-layer LSTM deep learning classifier trained on Copernicus Marine Data Service satellite sea water velocity data (uo and vo). Employs dropout regularization (0.3), Adam optimizer (learning rate 0.0003), performance metrics (accuracy, F1-score, confusion matrix), and multi-sensor data fusion. Model validated by comparison of predicted versus observed ocean velocity fields.	The LSTM-based model achieves high overall classification accuracy (~91%) and robust F1-score (0.88) across five resilience categories. Confusion matrix analysis shows effective categorization with minor misclassifications mostly between adjacent resilience classes. Multi-sensor fusion enhances accuracy, and challenges remain with class imbalance and interpretability. Future directions include transformer architectures and explainable AI integration.

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169	Türkiye Cumhuriyeti İstanbul İli Sismik Mikro-Bölgeleme Dahil Afet Önleme/Azaltma Temel Plan Çalışması	Japon Uluslararas birlii Ajans (JICA) stanbul Büyükehir Belediyesi (BB)	2002	https://depremzemin.ibb.istanbul/uploads/prefix-jica-turkce-raporu-66a39c6e9b70d.pdf	Earthquake, disaster mitigation, seismic micro-zoning, urban planning, structural reinforcement, emergency preparedness	To propose measures for reducing earthquake disaster impacts in Istanbul province, including urban and structural planning and public preparedness	involves a comprehensive approach combining structural assessment and strengthening of vulnerable buildings, especially critical facilities like hospitals, alongside the development of financial support systems such as low-interest credit schemes and revised property taxes to encourage seismic-resilient construction. It emphasizes establishing and enhancing district-level Disaster Management Centers with advanced communication and emergency response capabilities, alongside developing prioritized emergency transportation networks for rapid access. Public awareness is enhanced through dedicated training and education centers for community leaders, while technical measures like feasibility studies for automatic seismic shut-off systems are pursued. This multi-dimensional strategy integrates technical, financial, administrative, and social components to effectively reduce earthquake risks and build long-term urban resilience	Includes recommendations for earthquake resilient housing credit systems, bridge strengthening, training for rescue and first aid, development of emergency transportation routes, and establishment of disaster management centers

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170	Risk and Vulnerability Assessment and Identification of Adaptation Measures in Civil Protection and Emergency Assistance	Noslēgum a ziņojums	2017	https://www.kem.gov.lv/sites/kem/files/media_file/Risku%20un%20ievainojam%C4%ABbas%20nov%C4%93rt%C4%93jums%20un%20piel%C4%81go%C5%A1an%C4%81s%20pas%C4%81kumu%20identific%C4%93%C5%A1ana%20civil%C4%81s%20aizsardz%C4%ABbas%20un%20%C4%81rk%C4%81rtas%20pal%C4%ABdz%C4%ABbas%20jom%C4%81.pdf	civil protection, emergency assistance, climate change, risk assessment, adaptation, vulnerability, extreme weather, disaster management	To identify and assess risks and vulnerabilities relating to civil protection and emergency assistance in Latvia under climate change and to propose prioritized adaptation measures to enhance resilience.	Risk assessment following ISO/IEC 31010:2010 standards including risk identification, detailed analysis, and risk evaluation; expert surveys; analysis of historical disaster occurrence and loss data using Munich Re NatCatSERVICE and national data; multi-criteria analysis for adaptation options.	Key climate-related hazards identified include spring floods, ice jams, storms, storm surges, forest and peat fires. Improved disaster reporting and early warning systems have enhanced emergency response. Adaptation priorities include establishing a unified disaster loss database, improved forecasting, landuse zoning, public safety training, and innovative technology use such as drones for disaster response. Data limitations for extreme events exist.
171	The Regional Scale of Landscape Planning: the Possibilities for Measuring the Effectiveness of Nature-Based Solutions	Rubens do Amaral, Maria do Carmo de Lima Bezerra	2024	https://doi.org/10.24857/rgsa.v18n11-037	Heat wave risk; water resilience; ecological degradation (implied),Ecological processes; Nature-Based Solutions (NBS); Landscape planning; Regional scale; Geodesign; Green infrastructure; Ecosystem services; Soil moisture; Carbon flux	To investigate the measurement of landscape integrity from supporting ecological processes in the Federal District to define a multiscale and multifunctional Regional Green Infrastructure Network based on Nature-Based Solutions (NBS).	Analysis of supporting ecological processes using CO2 flux (multispectral index related to vegetation photosynthetic efficiency and proxy of energy, carbon and biomass inputs) combined with Topographic Wetness Index (related to water and sediment flow and accumulation) from Landsat 8 multispectral satellite scenes collected during dry season; Application of Geodesign process.	Identification of areas with ecological integrity (~80–90% in vegetation fragments); differential demand for ecological recovery classified as adaptation and transformability; importance of ecological corridors and ecological support patches especially at springs to enhance water resilience and ecological support processes; consideration of environmental protection units (UCPI and Water Protection Areas) as hotspots and buffers.

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172	Geodesign and Urban Environmental Assessment in São Paulo, Brazil	Adriana Afonso Sandre, Amanda Lombardo Fruehauf, Augusto Akio Lucchezi Miyahara, Ashiley Adelaide Rosa, Cíntia Miua Maruyama, Giuliano Maselli Locoselli, Leticia Figueiredo Candido, Magda Adelaide Lombardo, et.al.	2021	https://doi.org/10.1007/978-3-030-86979-3_33	Urban expansion; street trees; water reservoirs; detention ponds; informal settlements; urban heat island; geodesign; São Paulo; MapBiomas	Assess urban environmental changes and impacts in São Paulo from 2020 to 2050 using geospatial analysis and scenario modeling	Spatial-temporal analysis using MapBiomas data platform (1985-2019), projection scenarios (current, early, late, non-reference) for 2020, 2035, 2050; balance of planted and removed street trees; modeling impervious surface impact on water recharge; assessment of detention ponds/ wetlands; urban sprawl analysis	- Decrease in street trees (by up to 50% in late scenarios), - Reduction in water reservoir recharge (up to -76% by 2050 in late scenario), - Increase in detention ponds and wetlands, - Urban sprawl increasing by up to 34%, - Natural forest area decreasing, planted forest area increasing, - Urban heat island temperature increase up to 22°C by 2050 in some scenarios
173	Integrating GeoDesign with Landscape Sustainability Science	Lu Huang, Weining Xiang, Jianguo Wu, Christoph Traxler and Jingzhou Huang	2019	https://doi.org/10.3390/su11030833	GeoDesign; Landscape Sustainability Science; landscape design/planning; ecosystem services; information technology; evaluation	To explore how GeoDesign, driven by advanced spatial information technologies, can be integrated with Landscape Sustainability Science (LSS) to advance sustainable landscape design and planning. Specifically, the goal is to examine GeoDesign's suitability for supporting LSS, identify challenges, and propose a conceptual framework that links GeoDesign with LSS from multiple perspectives (e.g., sustainability types, scales, ecosystem services, indicators, big data, sense of place) to improve sustainable landscape design and planning outcomes.	Literature review and conceptual analysis of LSS and GeoDesign; review of indicators, big data applications, and sustainability perspectives; proposal of a conceptual LSS-based GeoDesign framework supported by visualization and interaction technologies.	GeoDesign improves LSS by enhancing spatially explicit analyses, enabling real-time assessment and dynamic visualization, supporting scenario analysis, and involving multi-stakeholder participation. A conceptual framework linking six perspectives was proposed to guide integration and application. The integration addresses uncertainties, data challenges, and human/social factors. Real-time design assessment, big data, and interaction technologies are promising tools to advance sustainable landscape design.

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174	BIM based environmental impact assessment for infrastructure design	Maarten Albert van Eldik, Faridaddin Vahdatikhaki, João Miguel Oliveira dos Santos, Maarten Visser, Andre Doree	2020	https://doi.org/10.1016/j.autcon.2020.103379	BIM; Environmental Impact Assessment; Infrastructure; Sustainability; Life Cycle Assessment; Automation; Design process	Development of a data structure linking BIM model elements with environmental impact databases (Dutch databases); implementation of a prototype tool using Dynamo and Revit; case study application on an infrastructure project; visualization of environmental impact scores within BIM; expert panel evaluation.	The BIM-based EIA enables faster and more integrated environmental assessment during design; visualization aids designers in identifying critical elements and materials; expert evaluation indicates improved usability and sustainability consciousness; limitations include need for expert in database configuration, focus on environmental aspect only, and Dutch context.	Proposes an innovative workflow integrating BIM and EIA to address fragmented, late-stage environmental assessments in infrastructure design; potential to improve sustainability consideration and decision making in early design phases.
175	Advances in urban mapping of local climate zones for heat mitigation: A systematic review	G.A. Acosta-Fernández, K.E. Martínez-Torres, M.E. González-Trevizo, M. Santamouris	2025	https://doi.org/10.1016/j.landusepol.2025.107540	Local Climate Zones, Urban Heat Island, Remote Sensing, Machine Learning (Random Forest, CNN), Urban Morphology, Climate Change, Health, Thermal Comfort, Digital Elevation Models, GIS	Systematically review literature on LCZ classification methods and parameters and their application in UHI and climate change research, with focus on future directions	Systematic review of 126 publications using bibliometric and qualitative synthesis methods; analysis of parameters, models, approaches, and their application in LCZ classification	Identified Sky View Factor and Height Roughness Elements as most studied parameters; found ML methods (RF, CNN) increasingly used; highlighted gaps in tropical/arid regions and emerging economies; suggested integrating LCZs into urban planning for heat mitigation; noted data limitations and methodological challenges

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176	Amendments to the Cabinet of Ministers Regulations No. 401 of July 14, 2015 'State and European Union Support Allocation Procedure for the Measure 'Restoration of Agricultural Production Potential Damaged by Natural Disasters and Catastrophic Events and Implementation of Appropriate Preventive Measures	Latvian Cabinet of Ministers	2015	https://likumi.lv/ta/id/276062-grozijumi-ministru-kabineta-2015-gada-14-julija-noteikumos-nr-401-valsts-un-eiropas-savienibas-atbalsta-pieskirsanas-kartiba-pa...	Rural support, biosecurity, phytosanitary measures, support calculation, state and EU support, loss compensation	Regulatory amendments related to granting support to farmers in case of natural disasters and implementation of preventive measures.	Amendments to normative acts, clarification of requirements, formulation of calculation formulas, administrative control, definitions of farm requirements.	The regulations define a clear approach to loss calculation, support granting conditions, biosecurity plan requirements, and penalties for non-compliance.
177	Ecological Connectivity of Forest Ecosystems	Katharina Lapin, Janine Oettel, Martin Braun, Heino Konrad (Eds.)	2024	https://doi.org/10.1007/978-3-031-82206-3	forest restoration, ecological connectivity, deer browsing, management strategies, Scottish Highlands	To introduce the concept and significance of ecological connectivity in forest ecosystems and set the framework for the volume's case studies and thematic chapters.	Literature synthesis and thematic framing by editors and contributing authors.	Highlights the multidimensional benefits of maintaining and restoring connectivity, such as enhanced biodiversity, ecosystem service provision, and resilience to climate change. It stresses the urgent need for multi-scale, interdisciplinary approaches to address connectivity loss.
178	Innovation in Urban and Regional Planning-Volume1	Alessandro Marucci, Francesco Zullo, Lorena Fiorini, Lucia Saganeiti (Eds.)	2023	https://doi.org/10.1007/978-3-031-54118-6	urban planning; regional planning; sustainability; land management; climate change	To present and frame the central themes and objectives of INPUT 2023 with emphasis on sustainable land use, spatial planning innovations, and addressing socio-ecological complexity.		
179	Achieving Sustainable Construction Safety Management: The Shift from Compliance to Intelligence via BIM–AI Convergence	Heap-Yih Chong, Qinghua Ma, Jianying Lai, Xiaofeng Liao	2025	https://doi.org/10.3390/su17104454	BIM; AI; sustainable construction safety management; proactive; dynamic; prototype; project lifecycle	To propose and develop an integrated BIM–AI platform that unifies safety supervision across the construction project lifecycle for sustainable construction safety management, transitioning from compliance-based to data-empowered proactive governance.	Design Science Research (DSR) methodology, including holistic framework development, iterative prototype platform development using Autodesk Revit, Python, TensorFlow, and mixed-methods evaluation through interviews and case studies.	Prototype evaluation shows user satisfaction with system functionality (mean Likert scores >3.8), improved risk detection accuracy, reduced reliance on manual processes, automated dynamic risk adjustment and inspection scheduling, efficient resource allocation, and enhanced cross-departmental collaboration.

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
180	An Overview of Integrating GIS and BIM for Smarter Infrastructure Development	Santhosh Kumar P S, Eunice J, Jeya Priya M	2025	https://doi.org/10.47392/IRJAEH.2025.0376	Urban Planning, Lifecycle Management, 3D Models, Urban infrastructure, Data Interoperability	To illustrate a newly developed data integration approach supporting the continued operation of GIS and BIM within different settings; to highlight smartness during the planning stage; to analyze benefits of GIS and BIM integration in infrastructure and facility management, urban planning and disaster management.	Survey methods including online questionnaire with 500+ construction professionals, followed by 15 in-depth interviews; SWOT analysis for BIM-GIS integration evaluation; case studies including a rock church scan to BIM survey in Italy; automatic framework to georeference BIM to GIS coordinates.	The study shows that the integration enhances decision-making, operational efficiency, quality asset management, forecast material intensity, assists urban disaster management, and supports sustainable development goals.
181	Review and perspectives of digital twin systems for wildland fire management	Yizhou Li, Tianhang Zhang, Yifei Ding, Rahul Wadhwani, Xinyan Huang	2024	https://doi.org/10.1007/s11676-024-01810-x	Digital Twin, wildland fire management, wildfire detection, wildfire modeling, wildfire prevention, simulation, data integration	To review and analyze the development, application, challenges, and future directions of Digital Twin systems in wildland fire management, and to inspire further research and practical implementation in the wildfire community.	Literature review and thematic synthesis of current wildfire sensing technologies, wildfire modeling methods, and Digital Twin applications both in industrial sectors and wildfire contexts.	Digital Twin systems offer enhanced real-time wildfire management through multi-source data integration, simulation-based training capability, and decision support. However, the wildfire research community lacks a unified understanding and implementation of Digital Twins. Sensor deployment cost and durability, modeling complexities, and integration of diverse data sources remain challenges. The paper proposes the phased approach starting with Digital Shadow and emphasizes interdisciplinary collaboration.
182	Remote Sensing-Based Proxies for Urban Disaster Risk Management and Resilience: A Review	Saman Ghaffarian, Norman Kerle, Tatiana Filatova	2018	https://doi.org/10.3390/rs10111760	urban DRM; remote sensing; damage; recovery; vulnerability; resilience; economic; social; proxy; indirect measurement	To survey and analyze RS-based proxies for urban DRM phases, identify strengths and limitations, and suggest future research directions to improve comprehensive urban disaster assessment.	Systematic literature review of 114 selected publications via multiple academic databases focusing on RS proxies for damage, recovery, vulnerability, and resilience in urban areas.	Identified 35 proxies for built-up environments, 21 each for economic and social, and 13 for natural environment proxies; highlighted imbalance favoring physical damage assessment; low representation for resilience proxies; noted terminological inconsistencies and interdisciplinary gap.

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183	Frontiers in urban ecological design and planning research	Frederick Steiner	2014	http://dx.doi.org/10.1016/j.landurbplan.2014.01.023	Urban ecology, Urban design, Urban planning, Ecological design, Resilience	The main objective is to fundamentally change how we plan and design communities, landscapes, cities, and regions to address the dramatic challenges of rapid population growth, urbanization, and ecosystem changes caused by human activities. This requires advancing research in four interrelated fields: ecosystem services, natural disaster impacts and green infrastructure, renewal of degraded urban areas, and linking knowledge to action for sustainable and regenerative urban ecological design and planning	Literature review, case study analysis, research questions development	Systematic case study research can help improve how we learn from past projects and enable advancement of best practices. Case studies enable understanding of why some projects fail or succeed and how good ideas spread. Research areas highlight sustainable and regenerative design, adaptation to disasters, ecological renewal, and linking knowledge to action.
184	A Review on the Use of Geodesign Processes in Managing Flood Vulnerability	Bo Pang and Brian Deal	2024	https://doi.org/10.3390/land13060723	geodesign; vulnerability analysis; landscape design; urban and environmental planning; sustainable and resilient planning; interdisciplinary; flood vulnerability; comparative case study	To assess geodesign processes in the development of vulnerability indices and assessments; explore their effectiveness and limitations in flood vulnerability management; and provide insights for application across different scales and contexts.	A comparative case-study approach using two cases: League City, Texas (data-rich urban context) and the Tohono O'odham Nation's Sif Oidak District (data-scarce rural context). Methodology includes evaluation based on spatial analysis, stakeholder engagement, interdisciplinary integration, and feedback/iterative processes.	- Integration of diverse spatial datasets (e.g., FEMA flood maps, DEM, rainfall, land use) - Use of spatial analysis techniques (overlay, vulnerability mapping, flood risk modeling) - Stakeholder engagement through community participation, surveys, visioning, workshops - Interdisciplinary integration combining design, GIS, geography, urban planning, and indigenous knowledge - Application of resilience planning scorecards, geodesign tools, and landscape performance calculators - Development of flood vulnerability maps and community-based flood resilience plans

No	Name of the Article	Author(s)	Year	Source/ doi number	Tags & Key words	Aim	Method	Results
185	Ecological Scenarios: Embracing ecological uncertainty in an era of global change	Clark-Wolf, K., W. E. Moss, B. W. Miller, I. Rangwala, H. R. Sofaer, G. W. Schuurman, D. Magness, et al.	2025	https://doi.org/10.1002/ecs2.70278	ecological scenarios, climate change adaptation, uncertainty, ecological modeling, scenario planning, decision support, temporal dynamics	To develop and synthesize ecological scenario approaches that incorporate ecological uncertainties and temporal complexity for use in climate adaptation planning and natural resource management.	Review and synthesis of existing literature and frameworks for integrating ecological uncertainties into scenario development; examples of methods include qualitative participatory workshops, quantitative simulation modeling, multivariate scenario synthesis, and integration with decision-support tools.	Provides a flexible framework and set of tools for developing ecological scenarios capturing uncertainties and plausible trajectories of ecosystem change; demonstrates how ecological scenarios can inform adaptive management and planning under climate uncertainty.
186	Geodesign as a support for proposing actions to fulfil the Sustainable Development Goals	Ana Clara Mourão Moura, Fabiana Carmo de Vargas Vieira, Camila Fernandes de Morais	2021	https://doi.org/10.5194/ica-proc-4-75-2021	Geodesign, Sustainable Development Goals (SDGs), GISColab, participatory planning, Spatial Data Infrastructure (SDI), WebGIS, Brazil, environmental approach, territorial planning, co-creation, decision support, cartography	To explore how Geodesign, supported by GISColab, can be used to promote actions fulfilling the UN Sustainable Development Goals through participatory and co-creative territorial planning workshops. To raise awareness of SDGs among participants and support decision-making processes aligned with sustainable development principles.	Methodological framework based on participatory workshops structured in stages: reading enrichment, idea building, dialogs, and voting using the GISColab platform which integrates spatial datasets through SDI and WebGIS. Participants analyze geospatial data, create ideas, associate them with SDGs, and evaluate them using a matrix linking ideas, systems, and SDGs with weighted positive or negative impact values. Workshops include dynamic visualization tools (histograms, dashboards) to assess SDG contributions and stimulate discussion. Case studies across 13 Brazilian metropolitan areas tested scenarios across different adoption timelines (2020, 2035, 2050).	Inclusion of SDGs raised participants' awareness and interest. Informational staging before idea creation improved idea quality and relevance to local realities. Participants created ideas mainly focused on landscape and risk themes. SDGs 11 (Sustainable Cities and Communities) and 13 (Climate Action) were most referenced. The evaluation process demonstrated subjectivity but allowed comparative scenario analysis showing gradual improvement in SDG fulfillment from non-adopter to early-adopter scenarios. Workshops fostered a transformative learning experience, reinforcing the educational role of Geodesign.

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187	Ecological and Digital Transition in Cities Measuring Ecosystem Services for Urban Planning and Design	Francesca Moraci, Carmelina Bevilacqua, Pasquale Pizzimenti (Eds.)	2025	https://doi.org/10.1007/978-3-031-82927-7_8	Ecosystem Services, Innovation, Contemporary City, Climate Change, Land Consumption, Urban Planning, Nature-Based Solutions (NBS), Green and Blue Infrastructure	To advocate reformulating urban planning processes by integrating ecosystem services and green-blue infrastructures to increase urban resilience and sustainability in the face of ecological vulnerability and climate change	Reviewing existing frameworks (e.g., CICES classification), analyzing EO-based mapping and evaluation of ES, and introducing innovative planning approaches such as the Blue Green City project and pilot projects focusing on climate adaptation via ICT and AI technologies	Identification of the critical role of ES in urban resilience, the success of ecosystem services mapping for guiding planning, and implementation of pilot projects demonstrating green and blue infrastructure planning's effectiveness in mitigating soil sealing and enhancing urban climate adaptation
188	Artificial intelligence and machine learning-powered GIS for proactive disaster resilience in a changing climate	Justin Diehr, Ayorinde Ogunyiola & Oluwabunmi Dada	2025	https://doi.org/10.1080/19475683.2025.2473596	Climate change; GIS; artificial intelligence; machine learning	To explore key challenges and opportunities of integrating AI, ML and GIS to improve disaster preparedness and response, with a focus on enhancing resilience amid climate change induced disasters	Systematic literature review of 71 peer-reviewed empirical studies published between 2012 and 2024, with qualitative interpretive analysis guided by ROSES standards and coding of themes related to opportunities and challenges	Identification of eight key opportunities including improved disaster management and risk assessment, flood and landslide prediction, visualization techniques, real-time monitoring, early warning systems, and data processing efficiency; main challenges related to data quality, ethical concerns, model bias, privacy, interpretability, and computational demands
189	BIBLIOMETRIC ANALYSIS OF PUBLISHED GRADUATE THESES IN THE FIELD OF GREEN CHEMISTRY	Zeyneb Meryem ÖKTEN, Emel GÜVEN, Tamer EREN	2025	https://dergipark.org.tr/tr/download/article-file/4908489	Green Chemistry, Postgraduate Theses, Bibliometric Analysis	To conduct a bibliometric analysis to identify publication trends, research topics, university involvement, and research methods in postgraduate theses related to green chemistry in Turkey, providing guidance for future research.	Systematic bibliometric analysis of 126 postgraduate theses (97 master's and 29 doctoral) identified in the YÖKTEZ database using the keyword "yeşil kimya" (green chemistry), covering theses until 20.04.2025. Categories evaluated include thesis type, year, university and institute, main science branch, subject, research method, and keywords. The theses were verified for relevance. Data is presented in tables and charts.	Majority of theses (77%) are master's level; doctoral theses constitute 23%. Highest number of theses in Chemistry main science branch. Increase in the number of theses over recent years with peak in 2024. Wide disciplinary spread beyond chemistry including engineering, pharmacy, and bioengineering. Analysis includes university types and institutes but specific findings on leading universities are not detailed here.

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190	BIM-Based Environmental Impact Assessment Framework for Infrastructure Projects	Maarten Albert van Eldik, Faridaddin Vahdatikhaki, João Miguel Oliveira dos Santos, Maarten Visser, Andre Doree	2020	https://doi.org/10.1016/j.autcon.2020.103379	BIM, Environmental Impact Assessment (EIA), Infrastructure design, Sustainability, Life Cycle Assessment (LCA), Automated assessment, Data integration	To develop and demonstrate a BIM-based framework for automated, integrated, and continuous environmental impact assessment in infrastructure design projects to help designers make sustainability-driven decisions	Development of a data structure facilitating bidirectional data exchange between BIM and EIA databases; embedding life cycle environmental impact indicators into BIM models; prototype tool development and testing on a case study; expert panel evaluation	he BIM-based EIA is significantly faster and more integrated compared to traditional fragmented processes. Visualization in BIM helps pinpoint elements with high environmental impact. The tool achieved high accuracy in Environmental Impact Scores (EIS) compared to manual calculations Experts rated the tool highly for effectiveness and fostering sustainability consciousness
191	Geodesign for Urban Ecosystem Services	Daniele La Rosa	2014	https://doi.org/10.6092/1970-9870/2537	Geodesign, Urban Ecosystem Services, Urban Planning, 3D GIS, Land-use planning, Sustainability	To propose a methodological framework integrating Geodesign tools and Ecosystem Services concepts to improve urban planning for sustainable ecosystem service provision	- Identification of physical features (land-use/land cover, socio-ecological variables) as components influencing ecosystem services - Use of 3D GIS software for modeling and scenario building - Definition of Geodesign solutions combining land-use/land cover elements - Creation of planning scenarios to assess spatial configurations impact on ecosystem services - Multi Criteria Model with Analytical Hierarchy Process to optimize cost-effectiveness	- Example design scenario in a non-urbanized area of Catania combining buildings, greenspaces, and community agriculture to optimize ecosystem services - Quantification of effects of different Geodesign scenarios on ecosystem services provision - Provision of tools to planners to evaluate cost/benefit of land-use decisions

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192	Geodesign Processes and Ecological Systems Thinking in a Coupled Human-Environment Context: An Integrated Framework for Landscape Architecture	Jin, X.; Loures, L.; Xu, J.; Loures, L.; Nunes, J.R.	2018	https://doi.org/10.3390/su10093306	geodesign, ecological systems thinking, landscape architecture, sustainability, coupled human-environment systems, public participation, interdisciplinary collaboration, resilience	To review existing geodesign literature, clarify its connection with ecological systems thinking, and propose an integrated framework to enhance landscape architecture practices and sustainability-oriented design.	Systematic literature review and synthesis of geodesign studies combined with theoretical integration of ecological systems thinking and adaptive cycle concepts; development of a heuristic framework.	The paper identifies four major themes of geodesign (geography-centered multidisciplinary science, iterative design process, community participatory planning tool, and landscape-based sustainability approach), discusses challenges in operationalizing geodesign, and proposes a new adaptive cycle-based heuristic framework to better understand and guide landscape design within complex coupled systems.
193	Urban Water Innovation Network. Sustainability Research Network, Annual Report (2020-2021)	Project Director: Mazdak Arabi; Co-Investigators: Roy Haggerty, Sharon Harlan; Graduate Students and Staff Scientists listed in personnel sections.	2021	https://erams.com/UWIN/	Urban Water Sustainability, Research Network, Datasets, Modeling Tools, Education, Outreach, Environmental Justice, Urban Climate, Water Management	To document and communicate the progress, outputs, and impact of UWIN on advancing scientific understanding and solutions for sustainable urban water systems nationwide.	Compilation of project descriptions, publication listings, development and sharing of datasets and software tools, stakeholder engagement webinars, outreach materials dissemination, and reporting to NSF.	- Enhanced Urban Sustainability Data Hub with 40 datasets published - Development and deployment of software tools for forecasting and lifecycle analysis - Publication and dissemination of 20+ scientific outputs - 27 webinars and outreach materials delivered - Broad collaboration among multi-institutional research teams

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194	Studying long-term changes in cultural landscapes: outlines of a research framework and protocol	Carole L. Crumley, Jan C. A. Kolen, Maurice de Kleijn, Niels van Manen	2017	https://doi.org/10.1080/01426397.2017.1386292	geodesign, cultural landscapes, long-term change, interdisciplinary, sustainability	The aim is to develop a new research framework and protocol to tackle long-term changes in cultural landscapes, making landscape studies relevant for contemporary landscape services and future landscape changes, by integrating multiple disciplinary perspectives and employing geodesign as a connecting tool.	The method develops a trans-temporal approach based on integrating landscape biography, historical ecology and complex systems theory, tested through case studies in the Netherlands, Sweden, and Estonia. It includes operational principles and premises, and uses dynamic modeling, participatory processes, and geospatial tools to understand and visualize landscape change over long periods.	The results include the development of a protocol for studying long-term cultural landscape change, insights from multiple interdisciplinary case studies showing the importance of cultural transformations alongside ecological and economic drivers, and exploration of geodesign as a framework and tool for linking research, heritage, and planning.
195	Enabling Green and Blue Infrastructure to Improve Contributions to Human Well-Being and Equity in Urban Systems	Erik Andersson, Johannes Langemeyer, Sara Borgström, Timon McPhearson, Dagmar Haase, Jakub Kronenberg, David N. Barton, McKenna Davis, Sandra Naumann, Lina Röschl, and Francesc Baró	2019	https://doi.org/10.1093/biosci/biz058	green and blue infrastructure, ecosystem services, urban systems, equity, resilience, institutions, infrastructure, perceptions	To develop and propose a systems-based approach (ENABLE project) to understand and improve the flow and equitable distribution of ecosystem service benefits from green and blue infrastructure in urban contexts.	Mixed methods including spatial analysis, environmental quality monitoring, policy/document analysis, participatory approaches, interviews, surveys, and agent-based modeling to study the three filters that affect benefit flows.	Identification and conceptualization of three key systemic filters influencing the flow of ecosystem service benefits; insight into their interactions; raising awareness of the need to reconcile infrastructure, governance, and user perceptions to enhance the resilience and equity of ecosystem service flows in cities.

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196	Ecological Connectivity in Urban and Semi-Urban Forests	Andrea Kodym, Katharina Lapin, and Debashis Sanyal	2025	https://doi.org/10.1007/978-3-031-82206-3_18	Biodiversity conservation · Ecological connectivity · Ecosystem services · Green infrastructure · Urban forestry · Urban forest management · Urban green spaces	The primary aim of the chapter is to examine how ecological connectivity in urban and semi-urban forests can be assessed and enhanced, particularly through integrative spatial planning. It focuses on the preservation and restoration of landscape connectivity for biodiversity conservation within human-modified environments, addressing both biological and landscape-level challenges in fragmented urban systems .	The chapter employs a multiscale spatial analysis approach using Geographic Information Systems (GIS) and landscape metrics. It integrates landscape ecology principles, spatial data analysis, and connectivity indices to assess the current state of ecological connectivity. A case study approach is used to illustrate the application of these methods in real-world urban forest contexts. Techniques include least-cost path modeling, circuit theory analysis, and evaluation of structural and functional connectivity metrics .	The analysis reveals that urbanization severely disrupts ecological corridors, yet strategic planning can mitigate these effects by identifying key green infrastructure components that enhance connectivity. The case study demonstrates how ecological connectivity varies significantly across the urban-rural gradient, with peri-urban forests playing a critical role as stepping-stones and buffer zones. The findings support the feasibility of integrating connectivity measures into urban planning tools and policies .
197	Exploring the Relation of Livability Mapping and Flood Exposure Analysis by Combining Remote Sensing and Citizen Science	Florencio Campomanes V, Lorraine Trento Oliveira, Mariana Belgiu, Angela Abascal, Anne Dijkstra, Monika Kuffer	2025	https://doi.org/10.5194/isprs-archives-XLVIII-M-7-2025-215-2025	deprivation, AI, Sentinel-2, flood model, climate change, citizen science, urban resilience	To understand and map urban flood exposure in deprived urban areas through a combined approach of livability mapping perceived by citizens and flood exposure modeling, using open-access satellite data and participatory methods.	Livability mapping through citizen perception surveys (pairwise image comparison), combined with deep learning on Sentinel-1 and Sentinel-2 imagery; flood exposure modeled with the FastFlood simulation model; integration of community-collected flood observations; study performed in 6 Sub-Saharan African cities (Nairobi, Kisumu, Accra, Tema, Beira, Chimoio).	Higher flood exposure was found in least livable areas (informal settlements/slums) characterized by poor housing, low service access, and poor environmental conditions. Citizen science data improved flood risk insights. Vulnerability and exposure are deeply interconnected.

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ANNEX 2. Case studies

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
1	Evaluating the impact and risk of pluvial flash flood on intra-urban road network: A case study in the city center of Shanghai, China	Yin, Jie; Yu, Dapeng; Yin, Zhane; Liu, Min; He, Qing	2016	http://dx.doi.org/10.1016/j.jhydrol.2016.03.037	Pluvial flash flood (PFF),	This paper presents a novel approach to identify the impact and risk of pluvial flash flooding on intra-urban road networks through an integration of pluvial flood numerical modeling, GIS-based road failure analysis and risk assessment model.	an integrated methodology is proposed by incorporating flood inundation modeling, transportation disruption (i.e. road closure) detection and risk assessment to measure the impact and risk of PFF on intra-urban road networks. This is the first attempt to apply high resolution 2D hydrodynamic model and flood depth-dependent measure for evaluating the impact of pluvial flooding on road disturbance at the intra-urban level. The city center of Shanghai, China, where roads are in particular prone to pluvial flash flooding, is selected as a case study area.	The results obtained are promising and indicate that given the flash nature of rainfall, extensive pluvial flood mainly occurred in municipal roadways within a relatively long duration. The road flooding depends not only on precipitation timing and intensity, but also relies on local drainage capacity and topographic characteristics. Although increasing pluvial flood may lead to a proportionate but non-linear impact on the functions (e.g. connectivity and accessibility) of urban road system, we should give priority to common and fairly frequent events as there is a high degree of positive correlation between risk and probability.
2	Urban planning, flood risk and public policy: The case of the Arno River, Firenze, Italy	Stefano Morelli , Samuele Segoni, Goffredo Manzo, Leonardo Ermini, Filippo Catani	2012	doi:10.1016/j.apgeog.2011.10.020	GPS GIS Geoid Geodatabase Dikes Hydraulic policy Hydrological risk	A geodatabase is a practical tool to store and manage such information. When working at small scales, however, no well established methodology exists to map the position and the height of the various elements with centimetric accuracy. For this purpose, we propose a methodology and we tested it on the Arno river and its most urbanized tributaries, a demonstrative case of hydrological risk around large fluvial systems.	The mapping of the morphologic and man-made elements located in such a wide study area requires the adoption of a methodology with the following characteristics: i) fast acquisition of the position (i.e. absolute coordinates) of the elements; ii) possibility of a full integration of the schematic representation of such elements in a GIS; iii) unambiguous recognition of all the elements of interest and definition of their main characteristic and present use.	The Arno reach was described in detail starting from 18,179 reference points variously distributed among the categories of interest. A comparable number of points was obtained for the tributaries instead (18,316), although their total length was about half that of the Arno river course. This apparent contradiction is due to some concomitant circumstances in the minor watercourses: reduced hydraulic sections, planimetrically fixed riverbeds and dikes and other flood defenses realized close to the running water

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3	A software framework for assessing the resilience of drinking water systems to disasters with an example earthquake case study	Klise, KA; Bynum, M; Moriarty, D; Murray, R	2017	http://dx.doi.org/10.1016/j.envsoft.2017.06.022	Water Network Tool for Resilience, the hydraulic performance of a water, earthquake damage strategies	This paper presents a comprehensive software framework for assessing the resilience of drinking water systems to disasters, including earthquakes. The software improves upon currently available capabilities by fully integrating hydraulic and water quality simulation, damage estimates and response actions, and resilience metrics into a single platform. This software is available as an open source software package called the Water Network Tool for Resilience (WNTR, pronounced winter).	This paper introduces WNTR, a new open source Python package designed to help water utilities investigate resilience of water distribution systems to a wide range of hazardous scenarios and to evaluate resilience-enhancing actions. Unlike current modeling tools, WNTR integrates hydraulic and water quality simulation, a wide range of damage and response options, and resilience metrics into a single framework, allowing for a seamless evaluation of water network resilience. The software can help water utilities estimate potential damages, understand how damage to infrastructure would occur over time, evaluate preparedness strategies, prioritize response actions, and identify worse case scenarios, efficient repair strategies, and best practices for maintenance and operations.	The earthquake damage and repair strategies used in this case study were based on reasonable assumptions. These parameters can all be adjusted within WNTR to customize analysis for a specific water utility and disaster scenario.
4	Assessment of Geohazards and Preventative Countermeasures Using AHP Incorporated with GIS in Lanzhou, China	Lyu, HM; Shen, JS; Arulrajah, A	2018	http://dx.doi.org/10.3390/su10020304	Analytic Hierarchy Process (AHP) structure,	The objectives of this paper are to investigate potential geohazards in Lanzhou, to evaluate geohazard risk levels for the various districts in Lanzhou City, and to propose appropriate countermeasures to mitigate future catastrophic disasters.	Risk assessment is a quantitative or qualitative measure of risk related to a well-defined situation and an acceptable threat. Quantitative risk assessment needs to calculate two components of risk: the magnitude of potential loss and the probability of loss occurrence. An acceptable risk is one in which the cost or difficulty of implementing an effective countermeasure exceeds the expectation of loss.	This work has investigated geohazards affecting Lanzhou. Local landforms, topography, geology, and hydrogeology were analyzed and risk assessment was applied to evaluate geohazard risk levels in different regions. Based on our investigations and risk assessment, countermeasures for prevention of geohazards have been discussed

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5	Evaluating GIS-Based Multiple Statistical Models and Data Mining for Earthquake and Rainfall-Induced Landslide Susceptibility Using the LiDAR DEM	Dou, J; Yunus, AP; Tien Bui, D; Sahana, M; Chen, CW; Zhu, ZF; Wang, WD; Pham, BT	2019	http://dx.doi.org/10.3390/rs11060638	Landslide susceptibility mapping (LSM), digital elevation model (DEM), the Chuetsu area, Niigata Prefecture, Japan,	Our study is built upon this prior experience in different models to investigate the comprehensive performance of the susceptibility models using LiDAR DEM data. We address two research questions in this paper: (i) do the sophisticated data mining methods provide a better predictive competency compared with the traditional statistical methods? And (ii) how different the results while using multi-type landslides instead of single type landslides? For achieving the first objective, we analyze and compare the accuracy of LSM maps generated by five different techniques including three traditional statistical methods, that is, probabilistic likelihood-frequency ratio model (PLFR), information value (InV), certainty factor approach (CF); and the two machine learning techniques namely, artificial neural network (ANN) and support vector machine (SVM) in a regional-scale analysis. For achieving the second objective, we used the inventory of both earthquake-and rainfall-induced landslides in the analysis.	Different statistical methods have been used for individually producing a series of modeling of landslide susceptibility maps. Probabilistic likelihood-frequency ratio model (PLFR) The information value (InV) method The certainty factors (CF) Artificial Neural Networks (ANN) Support vector machine (SVM) Accuracy Assessment of the Models	This work carried out a comprehensive assessment of landslides at Chuetsu region in the Niigata Prefecture, Japan. These landslides occurred due to combinations of both earthquake and rainfall-induced events.

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6	Integrating health into the complex urban planning policy and decision-making context: a systems thinking analysis	Helen Pineo, Nici Zimmermann & Michael Davies	2020	https://doi.org/10.1016/0304-3800(79)90008-5	thematic analysis, semantic levels, urban health indicator (UHI) tools, Urban economics, Land-use politics, Participatory workshop	his study addresses a knowledge gap by providing a rich account of the specific mechanisms through which our case study UHI tools support urban planning policy and decision-makers to promote health in complex governance contexts in San Francisco, Melbourne and Sydney. Our research objectives were as follows: (1) explore indicator producers and users' views (or mental models) of the use and value of UHI tools for health promotion in the complex policy process, and in relation to the complexity of urban health, and (2) develop and test in a participatory manner a causal loop diagram of users and producers' mental models.	urban health indicator (UHI) tools a multiple case study design focusing on interview participants in cities with significant experience using UHI tools, We analysed interview data using thematic analysis (Braun and Clarke, 2006; Nowell et al., 2017), adopting a hybrid inductive and deductive coding approach (Fereday and Muir-Cochrane, 2006), analysing data at latent and semantic levels.	UHI tools and indicator producers' advocacy and relationship-building activities re-framed knowledge about urban health issues and challenged urban planning professional norms and ways of working (Fig. 2, Loops R6 and connected to B3). These efforts affected urban planners and wider stakeholders, including the community, politicians and developers. By re-framing knowledge, indicator projects did not necessarily provide users with new knowledge, rather they provided a different way of looking at a problem, showed 'interconnections' or a 'fuller picture' and may have 'expand[ed]' knowledge.

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7	Participatory scenario planning in place-based social-ecological research: insights and experiences from 23 case studies	Elisa Oteros-Rozas, Berta Martín-López, Tim M. Daw, Erin L. Bohensky, James R.A. Butler, Rosemary Hill, Julia Martin-Ortega, Allyson Quinlan, Federica Ravera, Isabel Ruiz-Mallén, Matilda Thyresson, Jayalaxshmi Mistry, Ignacio Palomo, Garry D. Peterson, Tobias Plieninger, Kerry A. Waylen, Dylan M. Beach, Iris C. Bohnet, Maike Hamann, Jan Hanspach, Klaus Hubacek, Sandra Lavorel	2015	https://www.jstor.org/stable/26270296	Scenario planning, participatory scenario planning (PSP), Stakeholders' engagement, m the hierarchical cluster analysis,	Despite the increased application of PSP, as far as we know, there has been no comparison or review that assesses the multiple claims of PSP studies, e.g., social learning, innovation, or empowerment, and synthesizes the knowledge gathered. This limits the understanding of the applicability of different methods, and the strengths and weaknesses of different processes relative to different goals and contexts within PSP (van Vliet et al. 2012). Such an understanding is needed to improve the rigor, inclusiveness, and effectiveness of PSP, and to inform future practice as PSP becomes more common through its adoption by global initiatives such as the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES)	This paper is based on a structured ex-post multiple-case enquiry (Yin 2009) and reflection by researchers who have been involved in place-based PSP in social-ecological systems as part of an action research project or as a participatory component of a larger research project . As a starting point, a core group of researchers from multiple disciplines and with relevant experience in qualitative scenario exercises initiated this synthesis activity at the "Resilience 2014: Resilience and Development: Mobilizing for Transformation" conference. A subsequent snowball search procedure among colleagues in the resilience and socialecological systems research communities resulted in identifying 23 scenario cases that were included in our analysis	The case studies were located in 17 different countries and six continents (Fig. 1). Most cases were from Latin America (seven cases), closely followed by Europe (six cases), then North America (three cases), and Australia (three cases). Africa and Asia were represented by two case studies each Almost half of the cases (11) were defined by political boundaries, e.g., municipality, district, province, or officially recognized community boundaries, while another 10 defined their boundaries according to natural features such as watersheds, coastal regions, or landscapes The vast majority of cases involved complex governance and institutional arrangements. The most prominent institutions participating were municipalities (22 cases), regional and national governmental institutions (20 cases); community councils, indigenous organizations, and tribal forms of organization (16 cases); and conservation groups, NGOs, comanagement groups, and natural resources regulatory agencies including park authorities (22 cases; In most cases (20) agriculture was the primary sector supporting local livelihoods (Appendix 2). The services sectors, including trade and tourism, were also important (18 cases), while extractive industries, such as fishing, mining, palm oil and timber plantations, were important in 11 cases. Nine cases dealt with subsistence economies or economies with a strong dependence on subsidies or remittances. In four cases, illegal economic activities, such as coca

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		and Sandra P. Vilardy						plantations or illegal timber extraction and mining, were an important part of the local economy
8	Eco-City Analysis in The Framework of Sustainable Planning Case Study in Jordan	Irmeili G. A 1 , Çınar H.S	2021	DOI: 10.9790/2402-1512013747	Sustainability, Eco-Friendly Cities, Jordan Geography, Site Analysis.	The aim of this study is to take advantage of all the environmental, climatic and geographical factors that characterize Jordan	The study is based on analyzing Jordan's location and geographical, climatic, demographic and environmental characteristics and the plant species found in it by the maps, and analyzing environmental problems that Jordan is exposed to, such as gas and carbon emissions, high electrical energy consumption and scarcity of water resources.	The proposed area is part of the southwestern region and northeastern region of Jordan, located in the provinces of Tafileh, Ma'an and Karak city, these results include collecting specialized maps, analyzing the information on them, working in layers and common areas suitable for green building and eco-urban conditions.
9	Morphological Perspective of Urban Resilience Through Eco Urban Landscape: Iraq - Basra as a Case Study	Haneen Ali Abd Mohy* , Khanssa Ghazi Rasheed	2022	https://doi.org/10.18280/ijdne.170601	ecological urban landscape, morphology, space syntax, resilience principles, Morphology of urban landscape	The current study focuses on presenting the resilient ecological urban landscape by exploring the mechanisms and indicators that achieve the principles of urban resilience through it. Accordingly, the objective of the research was to formulate guidelines that support the ecosystem and provide a multi-level theoretical framework based on the principles of urban resilience that contribute to increasing the ability of urban landscapes to innovate and stay strong through long-term change, and then provide a comprehensive assessment within the study area according to the indicators	we working on modeling the spatial organization of the important main street network in the urban fabric of the city center of Basra - Iraq by using the space syntax theory and methods in the Depthmap10 analysis program to analyze the urban road network as an axial map and select some of the main axes within its urban fabric, that are related to green and open urban spaces that affect in the spatial organization of land use with those axes as an integrated urban landscape. We examine the basic ecological indicators that achieve resilience in order to be able to measure, evaluate and quantify the interrelationship between resilience and the ecological urban landscape from a morphological perspective.	The results indicate that urban environments that have urban spaces connected to nature are the most capable of morphological development and innovation, and therefore the most resilient. Actually, more resilient axes actually got lower values in the configurational analysis indicators, Whereas the highly integrated axes are completely separated from the open space, in other words, the resilience performance was high with the part strongly associated with the green and open space extension where most of the ecological resources are located,

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10	Multi-hazard assessment modeling via multi-criteria analysis and GIS: a case study	Hariklia D. Skilodimou, George D. Bathrellos, Konstantinos Chousianitis, Ahmed M. Youssef & Biswajeet Pradhan	2019	https://doi.org/10.1007/s12665-018-8003-4	Analytical hierarchy process · Natural hazard assessment maps · Suitability map for urban development · Peneus River, Western Peloponnesus, Greece	Within the framework of the present paper, we implemented a multi-hazard approach considering landslide, flood and seismic hazard so as to ultimately evaluate and specify the appropriate locations for urban development	As a case study, we chose the region of the Peneus River basin, which is located at western Greece and specifically at western Peloponnesus The landslide, flood and seismic hazard assessment maps were produced using several factors. The weighting coefficients for the selected factors that were considered for the assessment of the three geohazards were calculated by applying the AHP, which is a quantitative and multi-criteria method that was designed for the hierarchical representation of a decision-making problem	The landslide hazard analysis highlighted that the eastern, north-eastern, north-western and southern part of the area under investigation host the most landslide-prone regions (i.e., the high and very high hazard zones) The applied multi-hazard analysis within the framework of the present study achieved reliable results regarding the delineation of areas that are suitable for urban development with respect to the location of the past landslide and flood events. The results highlighted that the parts of the study area which are found to be prone to natural hazards are located in the western and north-eastern part of the drainage basin of Peneus (Pinios) River (Western Peloponnesus, Greece). The produced multi-hazard map indicated that the most suitable areas for urban development are located in the eastern part of the study area, where the level of exposure to natural hazards is low and very low

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11	Integrated Methodology for Urban Flood Risk Mapping at the Microscale in Ungauged Regions: A Case Study of Hurghada, Egypt	Abdrabo, K. I., Kantoush, S. A., Saber, M., Sumi, T., Habiba, O. M., Elleithy, D., & Elboshy, B.	2020	https://doi.org/10.3390/rs12213548	flood risk mapping; city strategic plans; microscale; GIS; spatial planning; ungauged regions; satellite remote sensing; AHP; 2D hydrological model; RRI; Egypt,	This study aims to (1) enhance the quality of hazard and vulnerability mapping at the urban microscale in ungauged regions and (2) to produce flood risk maps to support decision-makers in (A) determining the impact of urban development planned for 2027 on the existing urban area in Hurghada, (B) evaluating the 2027 CSP from a flood risk perspective, and (C) prioritizing intervention points.	The proposed methodology utilizes a noncommercial 2D RRI simulation model with remote-sensing data to produce high-quality inundation maps and exploit the limited available data. Moreover, high-quality CSP data sets (land use, building height, building condition, building material, total population, population density, and land value) are used to enhance the vulnerability mapping. These parameters have been used by the official authorities responsible for urban planning in Egypt and by several studies as urban vulnerability mapping indicators	In this study, an integrated methodology for flood risk mapping of ungauged urban areas at the microscale was proposed. This methodology integrates CSPs and remote sensing data using the AHP approach, a 2D hydrological RRI model, and GIS techniques and was implemented in Hurghada, Egypt.
12	The review revealed several challenges in mapping urban resilience. Resilience being context-dependent, it is hard to find relevant variables or indicators that are practical for every city. Also, there is a need to develop methods and to find relevant proxies in order to validate these indicators and variables.	Peijun Lu a b , Yimin Sun a , Nijhuis Steffen b	2023	https://doi.org/10.1016/j.landurbplan.2023.104804	Flood resilience, Green-grey-blue infrastructure systems, Performance assessment, Inundation model, TOPSIS, urban water management system, Urban flood resilience,	This research employs a typical river network region in Guangzhou, China, as a case study and offers an integrated scenario-based assessment framework to quantify and rank the resilience performance of various infrastructure spatial designs. It adopts an accurate, coupled hydrodynamic model to study the dynamic flood performance indicators in a green-grey-blue system.	An integrated scenario-based assessment framework will aid urban planners and designers in examining the performance of various spatial structures to choose the optimal infrastructure design to boost coastal flood resilience.	This study developed an integrated scenario-based assessment framework to assess the flood performance of various spatial solutions of infrastructure systems and rank the solutions based on dynamic performance. Our study reveals the relationship between the spatial structure of the green-grey-blue infrastructure system and flood performance in spatiotemporal scales. It delivers beneficial conclusions for decision-makers and urban planners based on a case study of GBA, China. According to the research, different blue-green-grey infrastructure designs with the same amount of water and green space and the same cost of LID demonstrate vastly varying flood resilience performance, notably in water storage capacity and the size and duration of submerged land.

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13	Water in the city: Green open spaces, land use planning and flood management – An Australian case study	Gemma Schuch a , Silvia Serrao-Neumann a b , Edward Morgan a b , Darryl Low Choy	2017	https://doi.org/10.1016/j.landusepol.2017.01.042	Water management, Ecosystem services, Regional planning, Flood regulation, Catchment	This paper aims to improve our understanding of how urban and regional planning supports green open space planning for improved water resources management, with a particular focus on flooding and related ecosystem services.	This paper starts by identifying attributes of green open spaces relevant to ecosystem services beneficial to flood management, and related planning approaches suggested in literature. This is followed by a description of the framework used to review the approaches taken in the Australian metropolitan regions of South East Queensland (SEQ), Melbourne and Perth. The planning documents reviewed along with the methods used to extract relevant data are then presented, followed by the results of the evaluation.	This paper reported on the extent to which current land use planning and water resource management support green open space planning for ecosystem services and functions such as flood regulation in three Australian capital city regions: SEQ, Melbourne and Perth.
14	An integrated method for DEM simplification with terrain structural features and smooth morphology preserved	Yu, W., Zhang, Y., Ai, T., & Chen, Z.	2020	https://doi.org/10.1080/13658816.2020.1772479	Terrain feature, digital elevation model (DEM), filter cartography	this paper proposes an integrated method for DEM simplification that preserves both of the two types of features. More specifically, the structural analysis is firstly employed to extract the discrete structural features (i.e., critical points and structural edges) from the original DEM surface. With these features, a new TIN based surface is reconstructed which has an accurate skeleton structure with respect to the landscape.	(1) The critical points and structural edges are extracted by using the structural analysis method. These structural elements are then used to reconstruct the TIN that represents the terrain surface at a certain scale. In this step, the local variations of topography between structural elements are ignored. (2) The guided normal filter is implemented to smooth the TIN surface with the guidance of the structure of the original DEM. Note that such a TIN surface is obtained from the first step. (3) The guided normal filter is implemented repeatedly by changing the input data as the result of the previous iteration until the accuracy of the filtering DEM meets the application requirement.	This work has the following future perspectives: (1) some streams are not very istinctive topographically, particularly in depositional areas where stream lines are often not even the lowest point in the landscape (e.g., the Yellow River in China). Therefore, to accommodate various geographical environments, additional structural edge extraction operations can be introduced. (2) Since our method integrates two different algorithms, it would take more processing time than the traditional methods. In the future, we plan to optimize our method by using the parallel processing. (3) Moreover, since our method is based on the mesh surface, it can be also extended to handle other structures of DEM such as point cloud data

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15	River basin-scale flood hazard assessment using a modified multi-criteria decision analysis approach: A case study	Amirhossein Shadmehri Toosi a , Giancarlo Humberto Calbimonte b , Hamideh Nouri c d , Sina Alaghmand e	2019	https://doi.org/10.1016/j.jhydrol.2019.04.072	River basin management, Flood hazard mapping, SWAT, Analytical hierarchy process, GIS application, Flood hazard index (FHI),	The present study aimed to: (1) introduce a flood hazard index based on hydrological modeling to identify flood-prone areas in data scarce regions, (2) develop a sensitivity analysis of each of the criteria selected, and compare FHI and mFHI map results with the last 42 years recorded events to validate the accuracy of the proposed approach.	The proposed methodology is an innovative combination of techniques and use of data to identify flood prone areas. The proposed method includes some successive steps which are presented briefly in Fig. 1. The method spatially analyzes seven parameters, combining the information in the Flood Hazard Index (FHI). The parameters are runoff coefficient (R), elevation (E), slope (S), distance from the drainage network (D), rainfall intensity (RI), soil erosion (SE) and land use (L). The weight of each parameter was calculated by using the Analytic Hierarchy Process, that consists of a sophisticated statistical analysis. The highest weight was assigned to the runoff coefficient and the lowest to land use.	The output values were validated by overlaying historical flood in the basin, as well as the development of a statistical sensitivity analysis on the values assigned to the different criteria to validate the accuracy and consistency of the developed methodology. The proposed modified method is named mFHI. The comparison of the flood hazard maps obtained with the FHI and mFHI indices indicate that both indices are reliable, however, it is necessary to use the historical flood records to test the consistency of the results in high- and very high-flood hazard areas.
16	A basin-level analysis of flood risk in urban and periurban areas: A case study in the metropolitan region of Buenos Aires, Argentina	Andrea Pamela Floresa · Leandro Giordanoa ,b · Carlos Alberto Ruggerio	2020	DOI: 10.1016/j.heliyon.2020.e04517	Lowland river basin Supervised classification Impervious surface Flooding risk Flood vulnerability Environmental management Environmental risk assessment Geography Hydrology Natural hazard Environmental science	the main objective of our study was to analyze the flood risk in urban and periurban areas of the RMBA to facilitate the decision-making processes to mitigate the damages caused by floods. Our working hypothesis is that flood risk in the region is managed without policies of land-use planning aimed to prevent urbanization in floodplains	We tested this hypothesis by assessing: 1) the factors that affect flood frequency and 2) the processes involved in urban expansion. First, we focused on the analysis of variation in precipitation by using hydrometric information and hydrological models, then applied supervised classification of remote sensing images to detect land cover changes, and finally combined both analyses to identify and characterize the main drivers of the process of urbanization-related flood risk.	The strategy of governments to solve the problem here exposed has been based on structural measures to prevent floods. However, floods seem to be more recurrent, having much more negative impacts. The situation in the Luján River basin has the same logics and evidences the lack of land use planning and policies to prevent the flood risk in the region. The integration between the hydrological analysis and the process of urbanization reveals that the increase in urban growth observed in the last period coincides with a period of low hydrological activity between 2005 and 2012. Such information may serve as a warning to urban land managers about preventing land occupation in flood-prone areas

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17	Scenario-based flood risk assessment for urbanizing deltas using future land-use simulation (FLUS): Guangzhou Metropolitan Area as a case study	Weibin Lin a b , Yimin Sun a , Steffen Nijhuis b , Zhaoli Wang	2020	https://doi.org/10.1016/j.scitotenv.2020.139899	Flood risk management, Future land-use model, Urbanization, Pearl River Delta, Guangzhou, Scenario-based planning,	This paper elaborates on an approach that employs a future land-use simulation (FLUS) model for computational scenario-based flood risk assessment. This study also exemplifies the integration of the FLUS model with environmental change-based storm surge inundation. The Guangzhou Metropolitan Area (GMA) located in the Pearl River Delta in China, one of the fastest urbanizing deltas in the world, is used as a case study to explore the probable implications of future land-use changes due to the ongoing urbanization process in the region in relation to projected environmental changes (sea-level rise, storm surge, and land subsidence).	The FLUS model interactively combines an artificial intelligence approach (an artificial neural network, ANN) and a CA model to simulate nonlinear land-use change while taking into account parameters related to the environment, social economy, climate change, etc. (Li et al., 2017). The model also employs self-adaptive and competitive mechanisms to stimulate the complex interactions of different land-use types, including neighborhood influence, weight factors, self-adaptive land inertia, conversion costs, and roulette wheel selection (Li et al., 2017). The FLUS model has a high simulation accuracy as compared with other mainstream land-use change models, such as CA models and CLUE-S (Liu et al., 2017).	The findings of this research can aid in the development of effective spatial strategies for climate-adaptive urban development. From the perspective of adaptive urban planning, scenario-based flood risk assessment using the FLUS model not only facilitates a more comprehensive understanding of the development of urbanizing deltas and its related challenges, but also enables the prioritization of flood mitigation measures at the most critical locations in the region
18	Towards an Urban Resilience Index: A Case Study in 50 Spanish Cities	Suárez, M., Gómez-Baggethun, E., Benayas, J., & Tilbury, D.	2016	https://doi.org/10.3390/su8080774	urban resilience; sustainability indicators; urban resilience index; Spanish province capitals,	Our work builds on various bodies of literature in the field of sustainability science, resilience and vulnerability. These include the literature on indicators and indexes to measure the sustainability of cities, countries and regions [36,37,40,41]; the literature on vulnerability assessment [42,43], considered by many authors as an antonym for resilience [6,44,45,46]; and the literature addressing resilience and risk reduction to known threats [19], such as earthquakes [45], floods [47,48,49,50] or heat waves [51], or broader ranges of natural hazards [38,46,52,53,54,55,56]. Most of these indicators are composed of social, economic, institutional and physical dimensions [38,45,46,47,53,54,55]	We followed Nardo et al.'s [63] approach to build composite indicators. This methodology was adapted to the objectives of the resilience index proposed in this paper along the following steps: (i) selecting an appropriate spatial scale of analysis; (ii) identifying key factors for sustaining resilience; (iii) selecting indicators; (iv) normalizing data; and (v) weighting and aggregating data.	Our results show that most of the Spanish province capitals present low values of resilience, (Figure 3). According to our results, Cáceres, Cuenca, Albacete and Badajoz with resilience values over 50 are the most resilient province capitals in Spain (Table 2), followed by Córdoba, Teruel, Jaén and Ávila, whose resilience values are 48, 34, 27 and 23, respectively. The remaining Spanish province capitals present values lower than 20%, and 60% of the municipalities obtained values below 10.

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19	Effect of river training on flood retention of the Bavarian Danube	Daniel Skublics, Günter Blöschl, Peter Rutschmann	2016	10.1515/johh-2016-0035	Flood retention; Flood plain; Inundation areas; Flood management; Hydrodynamic modelling	To evaluate how river training has influenced flood retention capacity along the Bavarian Danube.	Two-dimensional hydrodynamic modeling comparing historic and current floodplain scenarios.	River training delayed floodplain filling, increasing attenuation effects. Natural retention is less efficient than controlled retention for extreme flood management.
20	Equity Impacts of Urban Land Use Planning for Climate Adaptation: Critical Perspectives from the Global North and South	Isabelle Anguelovski, Linda Shi, Eric Chu, Daniel Gallagher, Kian Goh, Zachary Lamb, Kara Reeve and Hannah Teicher	2016	https://doi.org/10.1177/0739456X16645166	land use planning, climate adaptation, resilience planning, critical adaptation studies, environmental justice	This article assesses whether and how a selection of current climate adaptation planning approaches exacerbates or creates new urban socio-spatial inequalities. Our study addresses the lack of critical scholarship at the nexus of land use planning and climate adaptation by examining experiences in eight cities around the world: Boston (USA), New Orleans (USA), Medellin (Colombia), Santiago (Chile), Metro Manila (Philippines), Jakarta (Indonesia), Surat (India), and Dhaka (Bangladesh). These cities have adopted diverse planning strategies, including developing explicit adaptation plans, linking adaptation to disaster risk reduction or broad efforts to promote resilience, and meeting longstanding infrastructure and developmental backlogs	This article explores ways in which land use planning for climate adaptation can lead to maladaptive outcomes for disadvantaged communities. With the goal of identifying key drivers of maladaptation in mind; but without prior knowledge of which kinds of equity issues may be present; we selected emblematic cases of cities that are at the forefront of climate adaptation planning across the global North and South. Much academic and policy literature documents how each city is responding to climate risks, although not all are labeling their efforts as adaptation	, this article highlights how adaptation interventions can reinforce historic trends of socioeconomic vulnerability, compound patterns of environmental injustice, and create new sources of inequity. We find that unjust climate adaptation planning is not merely defined as a neglect of marginalized communities; rather, injustice should also be theorized and examined relationally (and spatially) against interventions in other; often more privileged; communities, sectors, and urban spaces. Rather than relying on technocratic or apolitical (or postpolitical) approaches often found in land use, infrastructure, or sustainability planning (Swyngedouw 2007), climate adaptation plans must take into account historic legacies of social and racial injustice in order to avoid turning adaptation into a private and privileged environmental good with exclusionary and maladaptive externalities.

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21	Urban green space availability in European cities	Nadja Kabisch, Michael Strohbach, Dagmar Haase, Jakub Kronenberg	2016	https://doi.org/10.1016/j.ecolind.2016.02.029	Urban green space availability, European Union, Urban Atlas, Environmental justice, Berlinfódź	this study addresses the following objectives: to uncover potential differences in UGS availability across macro-geographical regions (Northern, Western, Eastern and Southern Europe) when applying a recommended UGS availability threshold; to check whether the selected UGS-availability threshold values are met in two European case study cities, which underwent very dynamic land-use developments in recent decades; to discuss the opportunities and limitations, as well as complementarities, of using different European and municipal land-use datasets as indicators of the availability of UGS	In this study, we understand the availability of urban green space as the amount of green area in a certain defined distance to where urban residents live. Availability in our understanding is not the same as accessibility. Although green spaces may theoretically be available, we do not know anything about their physical accessibility for example, whether they are publicly accessible or private, fenced but open only during daytime or because they are perceived to be dangerous at night because of drug traffic, etc.	our analysis focused on UGS availability, including discussions on source, resolution, thresholds etc. UGS availability is an important indicator necessary to navigate urban complexity to improve human health and wellbeing and one component of the intricate social-ecological interactions within cities. For a more comprehensive assessment of the social-ecological system, indicators of actual UGS accessibility and use as well as indicators of ecosystem service supply and demand will have to be included in the future
22	Using GIS analysis to assess urban green space in terms of accessibility: case study in Kutahya	Cetin, M.	2015	https://doi.org/10.1080/13504509.2015.1061066	green spaces; GIS analysis; Kutahya	In this study, the adequacy of the location of Kutahya with regard to the current area of public green spaces and the potential accessibility to meet recreational needs are evaluated	The city of Kutahya was incorporated into the ecological urban green space system in order to identify potential areas. Manual digitizing (on-screen) was done in ArcGIS 10.0 software using 1:1000 implementation plans.	Kutahya has landscape planning issues with a fair average green area in terms of adequacy, but it is a city that has a rich, natural potential because of its geographic location and hydrographic wealth. Functionally linked, an integrated system of green spaces will allow the city to develop this natural potential in a sustainable way. Planning systems for green areas of the city considering the intense process of urbanization over the last 20 years will provide a great contribution to urban development in the sense of guidance.

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23	The contribution of travel-related urban zones, cycling and pedestrian networks and green space to commuting physical activity among adults – a cross-sectional population-based study using geographical information systems	Tomi E. Mäki-Opas, Katja Borodulin, Heli Valkeinen, Sari Stenholm, Anton E. Kunst, Thomas Abel, Tommi Härkänen, Leena Kopperoinen, Pekka Itkonen, Ritva Prättälä, Sakari Karvonen, Seppo Koskinen	2016		Transport-related physical activity, Green space, Built environment, Socioecological model, Population study, GIS, Finland	the aim of this study was to examine how the proximity of green space and living in different travel-related urban zones contribute to commuting physical activity among employed Finns. Individual-level factors, namely age, gender, education, leisure-time and occupational physical activity as well as health and social support, were also taken into consideration as potential background and confounding factors.	Health 2011 was a health examination survey in Finland that was conducted between August 2011 and June 2012 by the National Institute for Health and Welfare (THL). The cross-sectional study-design involved a representative sample of 8,135 women and men aged 30 years or more, drawn from the national population registers [32]. All participants (n = 5,903, participation rate 72.5 %) underwent the following survey protocol: they were clinically examined (including measurements such as anthropometrics, blood pressure, and blood sample as well as functioning test) and interviewed using structured interview (including such as health, illnesses, services, oral health, living habits, functional capacity and working capacity). Participants were also asked to fill out several self-administered questionnaires on health behaviours, health and quality of life.	Home location in a pedestrian zone of a main centre (odds ratio = 1.63; 95 % confidence interval = 1.06–2.51) or a pedestrian zone of a sub-centre (2.03; 1.09–3.80) and higher proportion of cycling and pedestrian networks (3.28; 1.71–6.31) contributed to higher levels of commuting physical activity. The contribution remained after adjusting for all the environmental attributes and individuals. Based on interaction analyses, women living in a public transport zone were almost two times more likely to be physically active while commuting compared to men. A high proportion of recreational green space contributed negatively to the levels of commuting physical activity (0.73; 0.57–0.94) after adjusting for several background factors. Based on interaction analyses, individuals aged from 44 to 54 years and living in sub-centres, men living in pedestrian zones of sub-centres, and those individuals who are physically inactive during leisure-time were less likely to be physically active while commuting

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24	Integrating ecosystem services into spatial planning; A spatial decision support tool	Adrienne Grêt-Regameya ,*, Jürg Altweggb, Elina A. Siréna, Maarten J. van Striena, Bettina Weibela	2016	https://doi.org/10.1016/j.landurbplan.2016.05.003	Multi-criteria, Urban development, Participatory planning, Tradeoffs, Ecosystem services, Urban peripheries	The study aims to bridge the gap between ecosystem service (ES) research and practical spatial planning by developing a decision support tool that integrates ES assessments into planning processes. Recognizing that traditional planning often overlooks the multifaceted benefits of ecosystems, the authors seek to create a framework that allows planners to evaluate and visualize the trade-offs and synergies among various ES, thereby facilitating more informed and sustainable land-use decisions.	The authors developed the PALM (Planning and Assessment of Land-use and Management) tool, a web-based spatial decision support system designed to incorporate ES into planning. The tool operates through a multi-step process: Goal Definition: Planners define specific objectives related to ES and land-use factors. Mapping: Spatial data on ES and locational factors are collected and mapped. Standardization: The mapped data are standardized to ensure comparability. Weighting: Decision-makers assign weights to different ES based on their priorities. Aggregation: A simple additive weighting approach aggregates the data to identify optimal land-use scenarios. Visualization: Results are presented through interactive maps and charts to aid decision-making. The tool was tested in a workshop setting with practitioners to evaluate its usability and effectiveness in real-world planning scenarios.	The implementation of the PALM tool demonstrated that integrating ES into spatial planning is both feasible and beneficial. Planners found the tool intuitive and helpful in visualizing complex ES data, which enhanced their understanding of potential trade-offs and synergies in land-use decisions. The participatory approach facilitated by the tool encouraged stakeholder engagement and consensus-building. However, the study also noted challenges, such as the need for high-quality spatial data and the importance of tailoring the tool to specific planning contexts. Overall, the PALM tool proved to be a valuable asset in promoting sustainable and informed spatial planning practices.

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25	A 4-dimensional model and combined methodological approach to inclusive Urban planning and design for ALL	Nataša Rebernik, Barbara Goličnik Marušić, Alfonso Bahillo, Eneko Osaba	2019	https://doi.org/10.1016/j.scs.2018.10.001	Open space, Planning and design, Inclusion, Bottom-up, Ethnography, Behavioural mapping, Post-occupancy evaluation	in this context, the main questions are how to approach inclusive city design with such a complexity, diversity and individuality of the citizens' needs, and how to approach it holistically. The hypothesis behind this paper and development of the combined methodological approach (CMA) is that a true understanding of the users and their needs, as well as creating partnerships with them based on a bottom-up approach, can significantly support the planning, design and decision-making processes. The following specific question is therefore addressed: How can a CMA that merges different user-centred techniques with tools of ethnography and urban and environmental studies respond to the complexity of inclusive urban planning, design and governance, respecting the needs of disabled citizens in the most holistic way?	•On the human level: Who are the public space users, and what are their needs and characteristics? •On the spatial level: What kind of spaces do we investigate; how are they being planned, designed, governed; and what really makes a space a place? •On the technological level: What kind of digital tools exist, how they are designed, and what are their technical features? •On the relational level: We explore a wide array of relations between the users and the space, the users and technology, and the space and technology	The originality of this paper lies specifically in designing the CMA as a new, highly applicable methodological approach in comparison to the existing urban practice towards inclusive city design. Its main idea is an in-depth qualitative exploration of the users, the spaces and the technology through a combination of techniques, grounded in a bottom-up ethnographic approach, exploring the potential complementarity with environmental and urban-studies techniques, such as POE and BM, and digital tools. The combination of the three methodologies is iteratively intertwined with participatory actions and participants' engagement with diverse digital tools. Such an approach supports user engagement; enhances communication between stakeholders; and eases data collection, management, analysis and interpretation.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
26	Influence of risk factors and past events on flood resilience in coastal megacities: Comparative analysis of NYC and Shanghai	Xian, Siyuan; Yin, Jie; Lin, Ning; Oppenheimer, Michael	2018	http://dx.doi.org/10.1016/j.scitotenv.2017.07.229	Flood protection; Coastal resilience; Coastal megacities; Flood hazard; Exposure at risk; Decision making	The study aims to investigate the differing levels of flood protection in two major coastal megacities; New York City (NYC) and Shanghai; by examining how various risk factors and historical flood events have influenced their respective flood resilience strategies. The authors seek to understand why Shanghai has implemented more robust flood defenses compared to NYC, despite both cities facing significant flood risks	The researchers conducted a comparative analysis using extreme value analysis to assess flood hazards and inundation modeling to evaluate exposure levels in both cities. They examined historical data on urban development, population growth, and economic expansion over the past three decades. Additionally, the study analyzed the impact of significant flood events; such as typhoons in Shanghai (1962, 1974, and 1981) and Hurricane Sandy in NYC; on the evolution of flood protection measures.	The analysis revealed that Shanghai experiences a higher flood hazard and greater exposure to extreme flooding than NYC. This heightened risk, coupled with rapid urbanization and economic growth, has led Shanghai to adopt more stringent flood protection standards, including reinforced concrete sea walls designed for 200-year flood events. In contrast, NYC's flood defenses have been less robust, often consisting of vertical brick and stone walls or sand dunes. The study also found that past extreme flood events had a more direct influence on flood protection decision-making in Shanghai, whereas NYC's response to such events has been comparatively limited, with the notable exception of Hurricane Sandy. The authors conclude that both cities would benefit from adopting more systematic and dynamic approaches to coastal flood protection in light of ongoing climate change and sea-level rise.
27	The Inclusive City: Urban Planning for Diversity and Social Cohesion	Franziska Schreiber & Alexander Carius	2016	https://doi.org/10.5822/978-1-61091-756-8_27	case studies from Berlin, Germany; Guangzhou, China; Medellín, Colombia; and Oslo, Norway	BOOK CHAPTER		

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
28	A comprehensive approach to understanding flood risk drivers at the municipal level	Santos, Pedro Pinto; Pereira, Susana; Zezere, Jose Luis; Tavares, Alexandre Oliveira; Reis, Eusebio; Garcia, Ricardo A. C.; Oliveira, Sergio Cruz	2020	http://dx.doi.org/10.1016/j.jenvman.2020.110127	Flood risk; Hazard; Exposure; Vulnerability; Portuguese municipalities	The study aims to develop an integrated methodology for assessing flood risk at the municipal level by analyzing the key drivers: hazard, exposure, and vulnerability. Focusing on 278 Portuguese municipalities, the research seeks to provide a nuanced understanding of how these factors interact to influence flood risk, thereby informing more effective and tailored flood risk management strategies.	The researchers constructed a Flood Risk Index (FRI) for each municipality by quantifying and combining three components: Hazard: Assessed through flood susceptibility and the frequency of weather and climate events that may generate peak flows Exposure: Evaluated using indicators such as population density, road density, and the average degree of impervious surfaces Vulnerability: Determined by analyzing the criticality and support capability of each municipality, reflecting social and infrastructural resilience. Each component was normalized to a [0,1] scale using the max-min method. The FRI was then calculated as the geometric mean of the three components, following the formula: FRI=(Hazard×Exposure×Vulnerability)1/3FRI=(Hazard×Exposure×Vulnerability)1/3 To identify patterns and classify municipalities based on their flood risk profiles, a Ward's hierarchical clustering analysis was performed, resulting in seven distinct clusters.	The analysis revealed significant spatial variability in flood risk across Portugal. Municipalities in the northwest and along major river valleys exhibited high levels of both hazard and exposure, while vulnerability was more dispersed throughout the country. The clustering identified municipalities with similar risk profiles, suggesting that tailored risk management strategies are necessary. For instance, areas with high hazard and exposure may benefit from structural mitigation measures, whereas regions with high vulnerability might require social and infrastructural interventions. The study underscores the importance of a diversified approach to flood risk management, emphasizing that one-size-fits-all solutions are inadequate for addressing the complex interplay of factors at the municipal level.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
29	Social determinants of health, universal health coverage, and sustainable development: case studies from Latin American countries	Prof Luiz Odorico Monteiro de Andrade, PhDa · Prof Alberto Pellegrini Filho, PhDc · Prof Orielle Solar, PhDd · Félix Rígoli, MDe · Prof Lígia Malagon de Salazar, PhDf · Prof Pastor Castell-Florit Serrate, PhDg · et al.	2015	DOI: 10.1016/S0140-6736(14)61494-X		The first domain is concerned with the design of the intersectoral policy, its scope, the programme, and its target coverage; eg, whether the whole population benefits from the programme as a fundamental right or whether an entitlement is restricted to specific population groups. This distinction of general versus targeted groups is especially important in the analysis of equity in Latin America because poverty reduction does not necessarily lead to a reduction in social and health inequities in population groups. Hence, in the context of Latin America, universal health coverage and its progressive realisation needs to emphasise equity and universality; intersectoral action should strengthen health systems to expand access and address social determinants of health to improve the opportunities for the disadvantaged populations to benefit from health-system investments	The second domain relates to methods of organisation, management, and financing of intersectoral actions, which define their success and sustainability. The analysis considers how decisions are made, the intensity of intersectoral action, how monitoring and assessment are done, and the capacity and knowledge built among stakeholders. Effective organisation of intersectoral action needs involvement at the local level. Decentralisation of decision making, which brings managerial processes closer to the local and community level (in which all sectors have sufficient power and freedom for action to jointly address problems and find solutions) improves programme success.10 The intensity of intersectorality extends from information sharing to cooperation and coordination, and to integration of policies and strategies. In our analysis of the organisation of intersectoral action, we focus on the role of the local level and primary health-care services, which are very important for reducing inequities in access and for progressive realisation of universal health coverage. Additionally, we explore the intensity of intersectorality, managerial mechanisms, and the approaches used to address the challenges encountered and to institutionalise actions.	The third domain relates to the coverage and outcomes achieved by the intersectoral policies or programmes, in particular to the success of intersectoral action in the reduction of health and social inequities. The analysis in this domain seeks to show how intersectoral action contributes to the reduction of health inequities, and affects equitable access to services, including the health and financial consequences resulting from service use

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30	Spatial Assessment of Urban Flood Susceptibility Using Data Mining and Geographic Information System (GIS) Tools	Lee, Sunmin; Lee, Saro; Lee, Moung-Jin; Jung, Hyung-Sup	2018	http://dx.doi.org/10.3390/su10030648	flood susceptibility; data mining; spatial database; geographic information system (GIS)	The study aims to evaluate flood susceptibility in the Seoul metropolitan area by integrating data mining techniques with Geographic Information System (GIS) tools. The objective is to identify areas prone to flooding by analyzing the relationships between historical flood events and various hydrological and topographical factors, thereby aiding in urban planning and flood mitigation efforts	The researchers constructed a spatial database encompassing factors such as topography, geology, soil, and land use. They applied two data mining models; Frequency Ratio (FR) and Logistic Regression (LR); to 2010 flood data to determine the correlation between flood occurrences and the selected factors. The models were then validated using 2011 flood data, which were not included in the training phase. The accuracy of the models was assessed using the area under the curve (AUC) metric, yielding results of 79.61% for the FR model and 79.05% for the LR model.	The study successfully generated flood susceptibility maps highlighting areas within Seoul that are at higher risk of flooding. The results demonstrate that both FR and LR models are effective in predicting flood-prone areas, with comparable accuracy levels. These maps serve as valuable tools for decision-makers, enabling the implementation of targeted flood mitigation strategies and informed urban development planning. The research underscores the importance of incorporating data-driven approaches in assessing and managing urban flood risks.
31	Inclusive approaches to urban climate adaptation planning and implementation in the Global South	Chu, E., Anguelovski, I., & Carmin, J.	2015	https://doi.org/10.1080/14693062.2015.1019822	climate adaptation civil society inclusion justice participation urban planning	this article critically assesses the cities of Quito in Ecuador and Surat in India, both of which have long histories of engagement in adaptation planning and are considered leaders in this field, to examine how civil society actors influence adaptation planning and policy making. By juxtaposing theories of participation, justice, and equity in urban climate adaptation planning against empirical evidence from Quito and Surat, this article asks the following questions	This article charts the climate adaptation experiences of Quito, beginning in 2006, and Surat, starting in 2008, with an emphasis on the innovative civil society engagement approaches applied in these two cities to ensure representative processes and just adaptation outcomes.	Our assessment of the Quito and Surat experiences highlights the role of different combinations of civil society actors in participating and facilitating climate adaptation across a city, the ways through which municipalities engage with different actors over time, and how these engagement approaches take into account local development contexts and needs. The results show that Quito's approach has promoted broad inclusivity while Surat's approach has established a robust decision-making structure. The analysis furthers existing scholarship on the planning dimensions of climate adaptation (Anguelovski et al., 2014; Few et al., 2007; Polack, 2009; Sherman & Ford, 2014), and argues that adaptation approaches must be designed and modified according to local institutional strengths, civil society capacities, and urban climate adaptation needs.

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32	Flood impact on Mainland Southeast Asia between 1985 and 2018; The role of tropical cyclones	Aifang Chen, Markus Giese, Deliang Chen	2020	https://doi.org/10.1111/jfr3.12598	floods; Mainland Southeast Asia; mortality; tropical cyclone	The study aims to assess the trends in flood occurrences and their human impacts in Mainland Southeast Asia (MSEA) from 1985 to 2018, with a particular focus on the role of tropical cyclones (TCs). Given the region's vulnerability to flooding and frequent TC landfalls, the research seeks to quantify the contribution of TC-induced floods (TCFloods) to overall flood events and their associated mortality and displacement rates.	Utilizing data from the Dartmouth Flood Observatory's Global Active Archive of Large Flood Events, the researchers conducted a comprehensive analysis of flood events in MSEA over the 33-year period. They categorized floods into two groups: all-cause floods (ALLFloods) and those specifically induced by tropical cyclones (TCFloods). Statistical analyses were performed to identify trends in flood frequency, magnitude, and human impacts, including mortality and displacement rates. The study also examined the spatial distribution of flood events across the region.	Increasing Flood Occurrences: The total number and maximum magnitude of ALLFloods in MSEA significantly increased between 1985 and 2018 ($p < .01$), indicating a rising trend in flood events over time. Role of Tropical Cyclones: TCFloods accounted for approximately 24.6% of all flood occurrences during the study period. While the frequency of TCFloods did not show a significant upward trend, their impact was disproportionately high Human Impacts: TCFloods resulted in higher mortality and displacement rates compared to other flood types. This underscores the severe human consequences associated with TC-induced flooding events. Spatial Distribution: The analysis revealed that certain areas within MSEA are more prone to TCFloods, highlighting the need for targeted disaster risk reduction strategies in these high-risk zones.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
33	Geophysical and social vulnerability to floods at municipal scale under climate change: The case of an inner-city suburb of Sydney	Abbas El-Zein, Tanvir Ahmed, Fahim Tonmoy	2021	https://doi.org/10.1016/j.ecolind.2020.106988	Flood Vulnerability Social vulnerability Climate change Sea level rise Municipal planning	The study aims to develop an integrated framework that combines geophysical and social vulnerability assessments to evaluate flood risks at the municipal scale, specifically focusing on an inner-city suburb of Sydney. By addressing both physical flood hazards and socio-economic factors, the research seeks to provide a comprehensive understanding of flood vulnerability in the context of climate change.	The researchers employed a multi-faceted approach that integrates hydrological modeling with socio-economic analysis: Hydrological Modeling: Advanced hydrologic and hydraulic models were used to simulate flood scenarios under current and projected climate conditions, accounting for factors such as sea-level rise and increased rainfall intensity. Social Vulnerability Assessment: Socio-economic indicators, including income levels, age distribution, and housing characteristics, were analyzed to assess the community's capacity to cope with and recover from flood events. Composite Vulnerability Index: The geophysical and social vulnerability assessments were combined to create a composite index, facilitating the identification of areas with heightened flood risk. This integrated methodology allows for a nuanced evaluation of flood vulnerability, considering both environmental and human factors.	The study revealed that certain areas within the inner-city suburb exhibit high levels of flood vulnerability due to the convergence of physical flood hazards and socio-economic disadvantages. Key findings include: Increased Flood Duration: Climate change projections indicate a significant increase in flood duration, primarily due to reduced drainage efficiency caused by sea-level rise. Socio-Economic Disparities: Populations with lower income levels and limited access to resources are disproportionately affected by flood events, highlighting the importance of incorporating social factors into flood risk assessments. Policy Implications: The integrated vulnerability framework provides valuable insights for urban planners and policymakers, emphasizing the need for targeted interventions that address both physical infrastructure and social resilience. Overall, the research underscores the critical importance of a holistic approach to flood risk management that accounts for the complex interplay between environmental hazards and social vulnerabilities.

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34	Potential and Limitations of Open Satellite Data for Flood Mapping	Notti, Davide; Giordan, Daniele; Calo, Fabiana; Pepe, Antonio; Zucca, Francesco ; Pedro Galve, Jorge	2018	https://doi.org/10.3390/rs10111673	flood mapping; multispectral; SAR; free satellite data; Ebro basin; Po basin	The study aims to evaluate the effectiveness of freely available satellite data and open-source software in mapping flood events. By developing a semi-automatic method, the research seeks to provide a cost-effective and user-friendly approach to flood mapping that can be utilized by individuals involved in flood hazard management, even those without specialized expertise in remote sensing.	The researchers applied their proposed method to three flood events in Spain and Italy. They utilized multispectral satellite data from MODIS, Proba-V, Landsat, and Sentinel-2, as well as synthetic aperture radar (SAR) data from Sentinel-1. Various methodologies were employed to detect flooded areas, including the Modified Normalized Difference Water Index (MNDWI), SAR backscattering variation, and supervised classification. To enhance accuracy, the automatic mapping was refined using free ancillary data such as digital elevation models (DEMs) and available ground truth data.	The study found that the timing of satellite data acquisition relative to the flood peak is crucial for accurate flood mapping. Co-flood multispectral images were able to detect more than 90% of the flooded area in the 2015 Ebro flood case study. However, post-flood multispectral data showed a significant drop in detection performance, with flood ratios under 50% a few weeks after the 2016 flood in Italy. SAR data proved effective only during the co-flood stage, with detection performance dropping below 5% just days after the flood event. The research underscores the importance of selecting appropriate satellite data based on the specific characteristics and timing of flood events.

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35	River flood mapping in urban areas combining Radarsat-2 data and flood return period data	Tanguy, Marion; Chokmani, Karem; Bernier, Monique; Poulin, Jimmy; Raymond, Sebastien	2017	https://doi.org/10.1016/j.rse.2017.06.042	Flood mapping, Synthetic Aperture Radar, C-band, Flood return period	The study aims to enhance the accuracy of flood mapping in urban areas by integrating high-resolution Synthetic Aperture Radar (SAR) data from RADARSAT-2 with flood return period (FRP) data derived from hydrodynamic modeling. This approach seeks to address the challenges posed by complex urban environments, where traditional SAR-based flood detection methods often face limitations due to factors like building-induced shadows and layover effects.	The researchers developed a semi-automated flood mapping algorithm that combines RADARSAT-2 SAR imagery with FRP data to improve flood detection in urban settings. The methodology involves: * Data Acquisition: Utilizing RADARSAT-2 SAR images to detect flooded areas, particularly focusing on rural regions where SAR performance is more reliable. * FRP Integration: Incorporating FRP maps, which indicate the probability of flooding over specific periods, to infer flood extents in urban areas where SAR data may be less effective. * Validation: Applying the approach to two case studies of the 2011 Richelieu River flood in Canada to assess its effectiveness.	The integrated approach demonstrated significant improvements in flood mapping accuracy: * Urban Areas: Approximately 87% of flooded pixels were correctly identified, with a false negative rate of about 14%. * Rural Areas: The method achieved a 97% accuracy rate in detecting flooded pixels, with false negative rates close to 3% and false positive rates between 3% and 35%. These results highlight the effectiveness of combining SAR data with FRP information to overcome the limitations of SAR-based flood detection in urban environments. The study underscores the potential of this integrated approach for precise flood extent mapping, which is crucial for emergency response and urban planning.
36	Study on Urban Resilience from the Perspective of the Complex Adaptive System Theory: A Case Study of the Lanzhou-Xining Urban Agglomeration	Yang, L., Yang, H., Zhao, X., & Yang, Y.	2022	https://doi.org/10.3390/ijerph192013667	complex adaptive system theory; evolutionary resilience; adaptive cycle model; urban system; Lanzhou-Xining urban agglomeration	This paper also believes that resilience analysis from the perspective of evolution promotes a clearer understanding of how cities develop stably in a complex environment. Urban resilience defines the relationship between a disturbance and the subject experiencing disturbance from a dynamic perspective. On the one hand, it recognizes the usualness of disturbances and the dynamic balance of the system, while on the other hand, it is recognized that the results of disturbances on systems with different resilience levels may be quite different.	based on the CAS theory and adaptive cycle model, this paper builds an urban resilience research framework and evaluation index system from the four aspects of urban systems, including stability, self-organization, learning adaptability and transformability, and comprehensively applies the Technique of Order Preference Similarity to the Ideal Solution (TOPSIS) method, system entropy flow method, spatial analysis method and other analysis methods to examine the spatio-temporal evolution of the urban resilience characteristics of the Lanzhou-Xining urban agglomeration to enrich the relevant theoretical and empirical research on urban resilience.	this paper analyzes through a literature review the basic dynamic mechanisms important to the evolution of urban systems. Combined with Holling's definition of resilience and adaptive cycle model, urban resilience is understood as the comprehensive results of four basic attributes in an urban system: stability, self-organization, learning adaptability and transformability. A multi-level open index evaluation system is then constructed. An evolutionary urban resilience analysis framework is proposed to quantitatively analyze the spatial and temporal characteristics of the urban resilience of the Lanzhou-Xining urban agglomeration from 2010 to 2017.

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37	Climate adaptation as strategic urbanism: assessing opportunities and uncertainties for equity and inclusive development in cities	Eric Chu, Isabelle Anguelovski, Debra Roberts	2017	https://doi.org/10.1016/j.cities.2016.10.016	Climate change adaptation Strategic planning Development Governance Cities	this paper surveys theories of strategic planning, climate governance, and inclusive development to uncover different opportunities and constraints associated with targeted adaptation actions in cities. Then, we apply these concepts to the case studies of Durban, Indore, and Medellin, and ask: How are strategic climate adaptation objectives being integrated into urban development? To what extent are such processes creating new political coalitions and ensuring more equitable planning outcomes?	o answer these questions, we examine Durban's plans to integrate adaptation into strategic ecological infrastructure, Indore's targeted approach to bring climate resilience into community development projects, and Medellin's strategic actions to reduce climate risks through spatial planning and greening projects. We compare these cases and highlight sources of planning tension – especially between aspects of the planning process and larger urban political economic forces traditionally shaping the development of cities – as well as the prospects of strategic adaptation actions for facilitating inclusive development. When advanced with a focus on procedural alignment with development goals, we argue that strategic adaptation actions can promote integration with urban projects, particularly those around land use, water and sanitation, and ecosystem services. However, although strategic plans can promote leadership, resource support, and agenda awareness, the degree to which they trigger more equitable political economic relationships – both within and beyond individual sectors – and catalyse more inclusive outcomes remains uncertain.	Although Durban, Indore, and Medellin have had some success in pursuing strategic adaptation actions, they continue to face development inequalities that affect how participatory processes are designed, how adaptation projects are prioritised and evaluated, and the extent to which adaptation benefits are equitably distributed across the city.

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38	Urban River Recovery Inspired by Nature-Based Solutions and Biophilic Design in Albufeira, Portugal	Blau, M. L., Luz, F., & Panagopoulos, T.	2018	https://doi.org/10.3390/land7040141	built environment; urban design; regenerative design; sustainable development; river restoration; biophilic urbanism	An objective of this paper was to demonstrate nature-inspired solutions for the recovery of the river of Albufeira in Southern Portugal, which was canalised and transformed in culvert pipes. The project proposal identifies actions to move towards a Biophilic City; ways to promote nature within the built environment; ways to improve well-being and city resilience in the long term; and also proposes a regenerative sustainability approach based on biophilic design. Such actions will reduce the risks of climate change, such as heat island effect and flash floods, and present the benefits of the transition to a regenerative economy and holistic thinking	The study area was analysed by the science of strolling, which is a method in the field of aesthetics and cultural studies with the aim of becoming conscious of the conditions of perception of the environment and enhancement of environmental perception itself.	This paper presented a case of biophilic urbanism using the project of the Albufeira city river restoration. The project was inspired by nature-based solutions and by implementing a green and blue rather than a grey infrastructure to reduce the risks of climate change, such as heat island effect and flash floods, while simultaneously providing greater health and well-being for urban residents and visitors. Another great advantage of the project was the creation of a historical sense of individuality, bringing back the identity of a place that will be memorised and associated with Albufeira and its fishing history. The project created a sense of place by recovering the buried river, reconnecting citizens with nature and the history of the place. Strolling along the symbolic waterline, the connection of people with the river ecosystem was strengthened and the fear of the river's destructive force tangibly turned into an atmosphere for enjoyment. The outcome was the creation of a linear park for Albufeira that was ecologically sound, aesthetically satisfying, economically rewarding, and where the relationship between people and nature was of love and respect rather than domination.

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39	Seven lessons for planning nature-based solutions in cities	Niki Frantzeskaki	2019	https://doi.org/10.1016/j.envsci.2018.12.033	Nature-based solutions Cities Climate adaptation Urban resilience Experiments Co-creation	In our view, this is not due to the research design of the evidenced cases on nature-based solutions but rather it is a time-scale issue: the majority of the cases are analysed and documented in time-distance to contemporary urban agendas and policy issues and implications for their impact or relevance to them is difficult to conceptualise or even impossible to draw	To respond to this gap, we conducted a multi-case study transdisciplinary research in eleven cities in Europe that set up nature-based solutions experiments with the aim to provide integrated knowledge on lessons learnt from experimenting with nature-based solutions for urban policy, planning and governance. Specifically, we researched and analysed a set of 15 contemporary experiments of nature-based solutions that directly contribute to urban resilience in deprived neighborhoods of the eleven cities. In this way, real-life experimentation with nature-based solutions created a knowledge co-production space for urban planners to learn how to co-create these solutions, which planning tools and programs are relevant to urban communities and a knowledge co-production platform for researchers to on-time translate knowledge about nature-based solutions for urban policy and planning.	We recommend that urban planners remain open to learning with other urban actors for co-creating and co-maintaining nature-based solutions while shaping institutional spaces in cities that allow for this co-creation, social innovation and collaboration to continue. A way for such open approach to collaborative governance is experimentation that allows to advance urban planning and urban governance through learning about and with nature-based solutions.

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40	A review of nature-based solutions for urban water management in European circular cities: a critical assessment based on case studies and literature	Hasan Volkan Oral, Pedro Carvalho, Magdalena Gajewska, Nadia Ursino, Fabio Masi, Eric D. van Hullebusch, Jan K. Kazak, Alfonso Exposito, Giulia Cipolletta, Theis Raaschou Andersen, David Christian Finger, et.al.	2020	https://doi.org/10.2166/bgs.2020.932	climate change resilience, nature-based solutions, stormwater, urban water, wastewater treatment	The main research question addressed in this paper is 'How can NBS be integrated with the sustainable UWM?' To answer this question we followed two parallel approaches: (i) a traditional literature review targeting a set of different subtopics, coupled with (ii) an overview of case studies from projects running within the framework of the COST Action. By combining both, we wish to provide not only the most complete overview of the current existing knowledge but also to discuss and challenge the current existing frameworks for NBS implementation. Therefore, the aim of this paper is to define the challenges, present benefits and future trends, provide an overview of the usage of NBS for UWM and to offer implementation recommendations for urban water utilisation towards circular cities.	Owing to the broad scope of the topic, different levels of implementation of NBS and availability of international peer-reviewed literature for certain subtopics, we propose a combined approach where both existing literature and case studies were reviewed using different criteria. This section is divided into two subsections. In the first subsection, we present the details of the literature survey to collect data of relevant international peer-reviewed journals, while in the second we describe the criteria for selecting relevant case studies important for the current review.	The presented review and selected case studies relevant to NBS demonstrate the advantages of NBS both in social and economic terms, i.e., creation of new jobs and saving of energy and resources. Closed-loop recycling of greywater can decrease the amount of potable water used and wastewater by up to 50–60%, reducing water production and sewage treatment costs at centralised WWTPs. Other projects have focused on NBS and the water-food-energy nexus, as summarised in the Supplementary material tables. Hence, NBS include constructed wetlands, restored wetlands, coastal Mediterranean wetlands, green walls and green roofs. NBS, moreover, act as groundwater storage, water retention, water purification and improvement of environmental value.

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41	Nature-based solutions for resilient landscapes and cities	Raffaele Lafortezza, Jiquan Chen, Cecil Konijnendijk van den Bosch, Thomas B. Randrup	2019	https://doi.org/10.1016/j.envres.2017.11.038	Ecosystem services Nature-based solutions Urban ecosystems Ecosystem resilience Sustainability	ın a global context of mounting challenges (e.g., climate change) and human activities (e.g., rapid urbanization), this Special Issue of Environmental Research attempts to lay the theoretical and applicative foundations of the NBS concept by focusing on the most recent innovative strategies and scientific advances for building resilient landscapes and cities. The topics covered include the four principal goals defined by the EU: (i) enhancing sustainable urbanization; (ii) restoring degraded ecosystems; (iii) developing climate change adaptation and mitigation strategies; and (iv) improving risk management and resilience.	The author contributions to this issue represent a diverse international community and provide examples of NBS theories and methods by generating and analyzing ecological and social datasets, developing integrated modeling techniques, and presenting state-of-the-art research results. Other successful cases include environmental and social research aimed at improving the implementation capacity and evidence base of NBS to benefit landscapes and their inhabitants.Other case studies in this issue investigate the economic and inherent value of NBS through business and investment models.	Overall, this Special Issue includes 26 contributions spanning more than 20 countries around the globe (Table 2). NBS applications range from the micro-scale (e.g., UV radiation as NBS to treat algae-polluted water; Chen and Bridgeman, 2017) to the macro-scale (e.g., grasslands as NBS supporting climate change adaptation on the Mongolian Plateau; Shao et al., 2017). The impacts are varied and include mitigation measures (e.g., Cariñanos et al., 2017), health benefits, as well as the ecological and economic value of NBS. We also present lessons learned from these sources to provide a more comprehensive evidence base for NBS applications (e.g., 'NBS planning is used as a place-making tool to strengthen city image and attract global investment'; Fan et al., 2017).

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42	Key insights for the future of urban ecosystem services research	Peleg Kremer, Zoé Hamstead, Dagmar Haase, Timon McPhearson, Niki Frantzeskaki, Erik Andersson, Nadja Kabisch, Neele Larondelle, Emily L. Rall, Annette Voigt, Francesc Baró, Christine Bertram, Erik Gómez-Baggethun, et.al.	2016	https://www.jstor.org/stable/26270402	biodiversity; social-ecological systems; urban ecology; urban ecosystem services; urban green infrastructure; urban liveability; urban planning	we highlight the cumulative results and new understandings of urban ES generated by the URBES project. We present seven insights supported by the URBES project research, including critical achievements an remaining gaps.	İn a quantitative review of literature relating to urban ES, we found that local and regional studies primarily model regulating urban ES using land-use or land-cover classes as indicators. These indicators are used as proxies for ecological, biogeochemical, or biophysical functions, and thus, as proxies for the performance of ecosystems in sustaining services for humans	As fundamentally built on value pluralism, the concept of urban ES can provide an inclusive platform for discursive governance, cocreation of knowledge, and stakeholder involvement in the elicitation of urban ES values. urban ES frameworks have great potential to serve as a bridge between science and policy in the context of urban planning and environmental governance. Knowledge translation and coproduction mediation processes and tools need to be created in a systematic way based on a transdisciplinary ground. Particular attention should be given to the multiplicity of stakeholder backgrounds, perceptions, expectations, and application contexts. The appropriate level of complexity of scientific knowledge that is introduced into planning and governance processes depends on local circumstances. Successful applications require tailoring the scientific processes to fit social and political processes and address scale and boundary mismatches

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43	Testing the applicability of ecosystem services mapping methods for peri-urban contexts: A case study for Paris	Fabien Roussel, Catharina J.E. Schulp, Peter H. Verburg, Astrid J.A. van Teeffelen	2017	https://doi.org/10.1016/j.ecolind.2017.07.046	Vegetation Botanical survey Cluster analysis Green infrastructure Peri-urban ecosystems	his research aims at assessing the congruence between two commonly used ES mapping methods based on land use data, and plant composition for a peri-urban context. We considered (1) proxy-based models (sensu Lavorel et al., 2017: "models that relate ES indicators to land or marine cover, abiotic and possibly biotic variables by way of calibrated empirical relationships or expert knowledge ") – namely the ES assessment matrix by Burkhard et al. (2012) – and (2) phenomenological models (sensu Lavorel et al., 2017: "based on an understanding of biological mechanisms underpinning ES supply [...] They assume, but do not represent explicitly, a mechanistic relationship between elements of the landscape, considered as ES [Providers] units, and the provisioning of ES ") for seven ES: air quality regulation, global climate regulation, flood protection, pollination, wild food provision, erosion regulation, and recreation.	We used Paris, France, as a case study. The peri-urban green space of this large metropolis serves a large population and is heterogeneous in landscape character and therefore likely to have spatial variation in ES provision. For 252 sites, we assessed the plant composition from botanical surveys. For these sites ES were quantified using both types of ES modelling approaches. Next, sites were clustered three times, based on either their plant composition or their ES bundle, as estimated by the two model types, and the degree of congruence among the three sets of clusters was determined.	Peri-urban landscapes are often pivotal in ES provision to the urban community (e.g. Gómez-Baggethun and Barton, 2013). To understand ES provision, mapping ES at such fine-grained, smaller scale level is frequently conducted (Malinga et al., 2015), but often using generic data and methods, especially to quantify several ES. Using seven ES, we have demonstrated that ES bundles estimated by such methods using generic data have low congruence with actual on-the-ground vegetation data, in particular in areas where the land use is heterogeneous.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
44	Adapting the social-ecological system framework for urban stormwater management: the case of green infrastructure adoption	Carli D. Flynn, Cliff I. Davidson	2016	https://www.jstor.org/stable/26270003	green infrastructure; social-ecological systems framework; stormwater management; technology adoption	Our primary goal is to identify the influential SES attributes related to the development of municipal urban stormwater programs that feature GI. We chose the SES framework because it provides a systematic and comprehensive method for defining system attributes and identifying those that are associated with outcomes of interest (Ostrom 2007, 2009). Numerous environmental case studies have applied the SES framework while adding or redefining attributes to best characterize the SES of interest (Fleischman et al. 2010, Gutiérrez et al. 2011, Cinner et al. 2012, Basurto et al. 2013, Nagendra and Ostrom 2014, Marshall 2015, Partelow and Boda 2015). No such effort has been previously undertaken to assess the suitability of the SES framework to characterize urban stormwater management systems. We use qualitative methods to identify and define the attributes most commonly associated with the inclusion of GI in municipal urban stormwater programs.	Exploratory work began with observations at GI summits in 2013 and 2014, in which delegates from U.S. municipalities were invited to discuss their respective community's GI programs. Extensive field notes from both meetings were coded line-by-line to identify factors that affected decisions to adopt municipal GI programs. The resulting codes were grouped into general categories of attributes that emerged during the analysis process. These categories were then incorporated into the SES framework, using first- and second- tier modifications, as suggested by McGinnis and Ostrom (2014), Epstein et al. (2013), and Vogt et al. (2015), as the initial framework. Another stage of data collection included a literature review of original research efforts related to the adoption and implementation of GI in urban stormwater systems. Green infrastructure, green stormwater infrastructure (GSI), low impact design (LID), and best management practices (BMPs) are among the terms used for various suites of urban stormwater management technologies.	The SES framework organizes system attributes into nested tiers. The first-tier attributes of the SES framework, as defined for an urban stormwater management system, are summarized in Fig. 2. We developed a modified SES framework to recognize the combinations of influential variables related to the development of municipal urban stormwater management programs that feature extensive use of GI technologies. The modifications made to the SES framework revealed the need for additional attribute tiers related to variables such as available technologies, actor characterizations, and operational-choice rules. Our findings demonstrate that affecting change in the built structure of urban stormwater systems involves multiple interacting attributes of the actors and governance systems within an SES

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
45	Approach and case-study of green infrastructure screening analysis for urban stormwater control	Timothy T. Eaton	2018	https://doi.org/10.1016/j.jenvman.2017.12.068	Green infrastructure Low impact development Stormwater Urbanization L-THIA LID	In this work, after a brief survey of available software tools, I present one approach of screening analysis for a large urban watershed in New York City. Using an online modeling application, I analyze potential stormwater runoff reductions from GI/LID, and discuss sensitivity to relative proportion of different watershed land use areas. the objectives of this study are to demonstrate such an approach and identify the most effective combinations of different GI/LID techniques for the study watershed to address the problem of excess stormwater	The New York City Department of Environmental Protection (NYCDEP) has divided the New York City metropolitan area into eleven watersheds draining to different waterways, for which proposals called Long Term Control Plans (LTCPs) are developed to meet standards of the Clean Water Act. These watershed LTCPs address regions of differing land-uses, some located in highly urbanized, commercial, even industrial areas, while others are dominated by high to low-density residential housing, but each covers areas of thousands of square hectares. For this study, one of these urban watersheds was selected for analysis, the Alley Creek watershed (Fig. 1), because it was one of the first areas for which a LTCP was completed (NYCDEP, 2014b), and the location of a previous study (Eaton et al., 2013). Although street-level analyses of stormwater have been conducted elsewhere by the NYCDEP, data are not available for this area, however the flashiness of USGS hydrograph records confirm that stormwater affects Alley Creek.	In the case of the Alley Creek watershed, Bioretention/Rain gardens and general Disconnection are most effective because the simulation indicates they are best suited to the dominant Low-Density Residential land use. If Disconnection is not feasible, a combination of several Buildings/Roofs, Streets/Roads and Parking/Driveway strategies would achieve similar or greater reductions (Fig. 4). Certain combinations of favored GI/LID techniques, particularly in Commercial and High-Density Residential areas, include different implementation levels of porous pavement in parking lots and driveways, cisterns and green roofs, and swales or porous pavement (Fig. 4). On the other hand, some techniques, notably rain barrels and porous pavement on sidewalks, are not predicted to reduce runoff significantly in the Alley Creek watershed. In summary, the variety of potential GI/LID strategies available for reducing urban runoff can be very large. Better approaches are needed for decisionmakers to prioritize efforts to implement such environmental strategies that protect local water quality. This study has demonstrated a screening approach using a web-based software application, L-THIA LID, that allows the simulation of potential runoff reductions due to different combinations of GI/LID strategies.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
46	Green stormwater infrastructure eco-planning and development on the regional scale: a case study of Shanghai Lingang New City, East China	Haishun Xu, Liang Chen, Bing Zhao, Qiuzhuo Zhang & Yongli Cai	2016	https://doi.org/10.1007/s11707-015-0516-5	stormwater management green stormwater infrastructure urban master plan landscape security pattern Shanghai Lingang New City	LIMITED ACCESS		
47	Urban Heat Island and Building Energy Consumption	Manoj Panwar1, Sakshi Jindal1, Sneh1	2023	doi:10.1088/1755-1315/1326/1/012080	Urban Heat Island (UHI) Building Energy Consumption ENVI-met Simulation High-Albedo Materials Vegetation Cover Microclimate	The study aims to investigate the impact of urban surface materials and vegetation on microclimatic conditions, particularly focusing on the Urban Heat Island (UHI) effect and its influence on building energy consumption. By analyzing how different materials and green spaces affect air and surface temperatures, the research seeks to identify strategies to mitigate UHI and enhance energy efficiency in urban environments.	The researchers conducted a case study at the State University of Visual and Performing Arts in Rohtak, India. Using the ENVI-met simulation software, they modeled two scenarios: the existing campus layout (EC) and a proposed design (PC) incorporating high-albedo materials and increased vegetation. Simulations assessed air and surface temperatures at pedestrian and canopy levels to evaluate the thermal performance of different urban configurations	The simulations revealed that incorporating high-albedo materials for pavements and roofs, along with enhanced vegetation, significantly reduced surface and air temperatures in the proposed scenario compared to the existing layout. These changes led to a cooler microclimate, which can decrease the cooling energy demands of buildings. The study underscores the importance of material selection and urban greenery in mitigating UHI effects and promoting energy-efficient urban development.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
48	Assessing the vulnerability of urban areas to the urban heat island phenomenon: Strategies for effective mitigation and sustainable urban planning	Pricilia Chika Alexandra Yonathan Philip	2025	http://dx.doi.org/10.61511/jpstd.v2i2.2025.1487	anthropogenic emissions; low vegetation; mitigation; surface albedo; urbanheat islands; urbanization.	The study aims to evaluate the vulnerability of urban areas to the Urban Heat Island (UHI) phenomenon and to identify effective mitigation strategies that can be integrated into sustainable urban planning. By conducting a comprehensive literature review, the authors seek to understand the factors contributing to UHI and propose interdisciplinary approaches to mitigate its adverse effects on urban environments.	Employing a systematic literature review, the authors analyzed existing research on UHI and its mitigation strategies. The review focused on studies that examined factors such as surface albedo, vegetation cover, and anthropogenic heat emissions. By synthesizing findings from various case studies, the authors identified key elements influencing UHI intensity and assessed the effectiveness of different mitigation approaches.	The review highlights that UHI intensity is significantly influenced by factors like building density, the thermal properties of urban materials, lack of green spaces, and human activities. These factors contribute to elevated temperatures in urban areas, leading to increased health risks, especially for vulnerable populations. The study identifies three primary mitigation strategies: enhancing surface albedo through reflective materials, increasing urban vegetation to promote cooling via evapotranspiration, and reducing anthropogenic heat emissions by modifying urban activities and energy use. The authors emphasize the need for interdisciplinary collaboration in urban planning to effectively implement these strategies and enhance urban resilience to UHI effects.
49	Urban Heat Island (UHI) mitigating strategies: A case-based comparative analysis	Christopher O'Malley a, Poorang Piroozfar b, Eric R.P. Farr c, Francesco Pomponi b	2015	https://doi.org/10.1016/j.scs.2015.05.009	Mitigating strategiesUrban Heat Island effectUrban sustainability	The study aims to evaluate the effectiveness and resilience of various Urban Heat Island (UHI) mitigation strategies through a comparative analysis. By assessing different approaches, the research seeks to provide recommendations for sustainable urban planning and design to counteract the adverse effects of UHI.	The researchers employed ENVI-met simulations alongside the Urban Futures Assessment Method (UFAM) to analyze the performance of three primary UHI mitigation strategies: Trees, Shrubs, and Grass (TSG); High Albedo Materials (HAM); and Urban Inland Water Bodies (UIWB). These strategies were evaluated based on their effectiveness in reducing urban temperatures and their resilience to future climate scenarios.	The analysis revealed that all three strategies; TSG, HAM, and UIWB; offer comparable levels of effectiveness in mitigating UHI effects. However, their resilience varies depending on implementation and maintenance practices. The study emphasizes the importance of integrating these strategies into urban design, considering local climatic conditions and urban morphology, to enhance their long-term efficacy in combating UHI.

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50	Cooling Heritage Scenarios: Transforming Historic Squares for Thermal Comfort	Pegah Rezaie 1 , Victoria Patricia Lopez-Cabeza 2 , Javier Sola-Caraballo 1,3 and Carmen Galan-Marin	2025	https://doi.org/10.3390/buildings15040564	thermal comfort; heritage conservation; historic neighborhoods ; mitigation strategies; urban heat island (UHI); urban intervention; ENVI-met simulation	The study aims to enhance thermal comfort in historic urban squares, particularly in Seville's Casco Antiguo neighborhood, which faces challenges due to the Urban Heat Island (UHI) effect. By focusing on two specific squares, the research seeks to identify and propose effective mitigation strategies that respect the cultural and historical significance of these spaces while improving their microclimatic conditions	The researchers conducted in-person environmental monitoring and utilized ENVI-met simulations to assess the thermal performance of two historic squares: San Julián Square (SJS) and Cristo de Burgos Square (CBS). They evaluated various mitigation strategies, including the installation of green walls, canopies, and the application of specific surface materials, to determine their effectiveness in reducing thermal discomfort.	The study found that canopies significantly improved thermal comfort, reducing the Universal Thermal Climate Index (UTCI) by up to 6.5 °C in SJS and 5 °C in CBS during peak hours. Green walls provided localized cooling effects, lowering the Mean Radiant Temperature (MRT) by up to 5 °C. The application of specific surface materials also contributed to moderate cooling effects. These interventions demonstrate that thoughtfully designed strategies can effectively mitigate UHI effects in historic urban environments without compromising their heritage value.
51	Planning multifunctional green infrastructure for compact cities: What is the state of practice?	Rieke Hansen, Anton Stahl Olafsson, Alexander P.N. van der Jagt, Emily Rall, Stephan Pauleit	2019	https://doi.org/10.1016/j.ecolind.2017.09.042	Multifunctionality Urban green space Urban planning Ecosystem services Ecological functions Densification	n the following, we take into account this ambiguity of the multifunctionality concept, using “function” in a broad sense and the term “ecosystem services” only when explicitly meant. In the context of green infrastructure and ecosystem services, multifunctionality is generally considered in three different ways: (1) for spatial assessments of green space functions on various scales; as a principle for (2) strategic planning of urban green spaces (on the city or neighbourhood-level) and (3) the design and management of green spaces (on the site level).	We surveyed 20 European cities to identify the awareness and representation of multifunctionality in current urban green space planning (research objective 1), whereas case studies from three of these cities are used for a more detailed investigation of how approaches for promoting multifunctionality are applied in practice (research objective 2). Combining our findings with the literature, we then developed recommendations (research objective 3, see Fig. 1). The data was collected within the EU-funded GREEN SURGE research project.	Our analysis of 20 cities sheds light on the application of multifunctionality within planning practices across Europe. While there is a general awareness of the multiple functions of urban green infrastructure and the three good practice cases suggest approaches to enhance multifunctionality from city to site-level planning, multifunctionality planning approaches vary considerably between cities. Not all cities adopted a comprehensive approach to planning multifunctionality but were strong on certain aspects, such as the evaluation of green spaces according to multiple functions or ensuring multifunctionality in strategic planning.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
52	Analyzing the Cooling Effects of Water Facilities in Urban Park: The Case of Sangju Namsan Park, South Korea	Young-Shin Lim 1, Hyunmin Daniel Zoh 2, Tae Hyoung Kim 1 and Tae Kyung Kwon	2024	https://doi.org/10.3390/atmos15121456	urban parks; climate adaptation; cooling effects; microclimate; thermal comfort	The study aims to evaluate the effectiveness of small-scale water features; specifically, a water path and a cooling fog system; in mitigating heat and enhancing thermal comfort within Sangju Namsan Park, a neighborhood park in South Korea. By focusing on these interventions, the research seeks to provide insights into practical climate adaptation strategies suitable for urban parks with limited space and resources.	Researchers conducted in-situ environmental monitoring during the summer of 2023, collecting microclimate data such as air temperature, humidity, and surface temperature. They employed thermal comfort indices, including the Universal Thermal Climate Index (UTCI) and Physiological Equivalent Temperature (PET), to assess the impact of the water features. Comparative analyses were performed between areas equipped with the water path and fog system and other zones within the park to determine the cooling effects.	The study found that the pergola area equipped with a cooling fog system achieved the most significant reduction in PET, lowering values to an average of 36.2 °C. In contrast, the small water path area recorded higher PET values, peaking at nearly 50.2 °C, likely due to radiant heat from surrounding surfaces. Surface temperature reductions reached up to 1.1 °C, with the pergola area showing the most significant cooling effect. These interventions provided localized cooling benefits, enhancing thermal comfort in specific areas of the park. However, their overall impact on broader urban temperature reduction was modest. The study suggests that while small-scale water features can effectively enhance thermal comfort in neighborhood parks, they should be integrated into broader urban cooling strategies to maximize their impact.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
53	Nature-based solutions addressing the water-energy-food nexus: Review of theoretical concepts and urban case studies	Pedro N. Carvalho, David Christian Finger, Fabio Masi, Giulia Cipolletta, Hasan Volkan Oral, Attila Tóth, Martin Regelsberger, Alfonso Exposito	2022	https://doi.org/10.1016/j.jclepro.2022.130652	W-E-F nexus Nature-based solution (NBS) Circular cities Resource efficiency Urban sustainability Green infrastructure	Based on the systematic literature review carried out in the present study, and to the best of the authors' knowledge, there is no prior review studying how urban NBS contribute to, or can improve the W-E-F nexus. With this in mind, this study aimed to fill this gap by: ●Reviewing the existing literature conceptualizing both NBS and the W-E-F nexus. ●Analyzing examples and case studies of NBS where indicators of at least one sub-nexus (e.g., W-E) were quantified, as complement to the literature review. ●Discussing the quantitative contribution of NBS to the W-E-F nexus, when possible, otherwise identifying qualitative benefits. ●Identifying the challenges and knowledge gaps that may hinder the usage of NBS to improve the W-E-F nexus.	A review of theoretical concepts was necessary to assess the contribution of NBS to the W-E-F nexus. For this purpose, between May and June 2020, both Web of Science and SCOPUS databases were searched using the query string ["nature-based solution (NBS)" AND water AND energy AND food AND nexus"]. In addition, other related keywords were also used instead of "nature-based solution (NBS)": 1) parks and urban trees, forests and other tree-related green spaces, 2) green roof, 3) green wall, 4) constructed wetland, 5) floodable park, 6) retention pond, 7) urban farming, urban agriculture, urban orchard, and urban livestock, 8) hydroponics, aquaponics, and aeroponics	summary, this study has highlighted that often the W-E-F nexus is included as a keyword in publications, but rarely mentioned or discussed in the work. Moreover, theoretical concepts of NBS addressing W-E-F nexus are frequently driven by technical solutions and less by system analysis. Our review of case-studies has also shown that examples of NBS addressing W-E-F nexus are easily found for microscale, while macroscale examples are mostly related to water management. Regarding the potential benefits of NBS at addressing W-E-F nexus, these have been demonstrated by the reviewed literature, with a special emphasis on direct benefits (e.g., water retention, food production, temperature regulation). On the contrary, indirect benefits have been poorly studied in connection to the W-E-F nexus. Additionally, quantification of benefits is mainly carried out by using not well-established indicators, thus lacking an in-depth and holistic analysis.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
54	Maintaining and Rehabilitating Urban Ecosystems, in the Context of European Green Deal.	ZAMAN, Gheorghe; GRĂDINARU, Giani; MARICUȚ, Alin-Cristian	2021		sustainable developmentEuropean Green Dealpublic policyurban ecosystems	The article aims to analyze Romania's transition towards a green economy within the framework of the European Green Deal, emphasizing the significance of maintaining and rehabilitating urban ecosystems. It seeks to explore the interdependence between environmental protection and economic activity, highlighting the necessity of integrating ecosystem perspectives into policy-making to achieve sustainable urban development	The authors conducted a comparative analysis using official statistical data from two reference years: 2006 (prior to Romania's accession to the European Union) and 2018 (the latest year with available data). This approach allowed them to assess the progress made in environmental protection and economic activities over time. The study focused on evaluating the efficiency of resource use and the impact of economic activities on urban ecosystems, aligning with the objectives of the European Green Deal.	The study found that urban areas are responsible for approximately 60% of global emissions and about one-third of energy consumption. Intensive economic activities in urban settings lead to pollution and irrational use of natural resources, underscoring the need for rehabilitating and maintaining urban ecosystems. The authors emphasize that environmental protection remains a critical issue for achieving a sustainable society. They advocate for policies that promote efficient resource use and the integration of environmental considerations into economic planning, in line with the European Green Deal's goals.
55	Urban planning and policy in Portugal: an overview on the role of EU funds and guidelines	Pedro Chamusca	2021	https://doi.org/10.1080/17535069.2021.1980607	EU urban policy, Europeanisation, urban regeneration, urban planning, Portugal	The article aims to analyze the influence of European Union (EU) funds and guidelines on urban planning and policy in Portugal. It seeks to understand how EU Cohesion Policy has contributed to the urban development of Portuguese cities, with a particular focus on the case study of Porto. The study examines the extent to which EU funding mechanisms have impacted urban regeneration, strategic planning, and governance structures within the Portuguese context	The research employs a qualitative case study approach, focusing on the city of Porto to assess the practical implications of EU Cohesion Policy on urban planning. Data were collected through document analysis of policy frameworks, funding programs, and planning documents, as well as interviews with key stakeholders involved in urban development. This methodology allows for an in-depth understanding of the interactions between EU-level directives and local urban planning practices.	The study finds that EU Cohesion Policy has positively influenced urban development in Portugal, particularly through the rehabilitation of problematic urban areas and the enhancement of strategic planning at the local level. It has also fostered mechanisms for citizen participation, accountability, and public–private partnerships. However, challenges persist, including a highly centralized government structure and intense competition for local funding, which complicate the implementation process. Additionally, there is a tendency for EU concepts to be more prevalent in discourse than in practical application, indicating a gap between policy rhetoric and on-the-ground realities.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
56	Transition towards a circular economy at a regional level: A case study on closing biological loops	Sami Kara, Michael Hauschild, John Sutherland, Tim McAloone	2022	https://doi.org/10.1016/j.cirp.2022.05.008	Life cycleCircular economyAbsolute sustainability	the aim of this paper is to provide a comprehensive review of the historical evolution of closed-loop systems, including circular economy (CE), and to address the overarching question 'to what extent can closed-looped systems and CE help us address society's growing affluence with the predicted population growth within the resource constrained world and minimise environmental footprint towards achieving the 2050 targets for climate change and more broadly protect the integrity of our biosphere as defined by the planetary boundaries?'	This has resulted in development of several models and frameworks to understand sustainability and sustainable development such as the three-tiered model [7,124], the prism model [139], the concentric circles model [175], the two-tiered equilibrium model [80], and bio-economic models [21,127]. These models and frameworks have set a precedence in understanding and manoeuvring around the concept of sustainability To understand what went wrong, we must understand the historical foundation of the current economic system that we live in, the economic conditions that led to the massive consumption and the measures that lead to understanding the impact caused.	Other strategies under the category of Rethink and Reconfigure involve providing result and performance of products, which aims at providing a service (through PSS) as opposed to a product. Although, the result-orientated PSS offers the great prospect of radical resource gain and environmental impact reduction, a PSS will not automatically have a better environmental performance than a conventional product system [154]. Rather, this will depend on when the product category involves high use stage impacts and rapid technological changes

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57	Innovation Ecosystems in the EU: Policy Evolution and Horizon Europe Proposal Case Study (the Actors' Perspective)	Sara González Fernández 1 , Renata Kubus 2,* and Juan Mascareñ as Pérez-Iñigo		https://doi.org/10.3390/su11174735	innovation; innovation ecosystems; innovation helix; EU innovation policy; 9th R&D Framework Program; Horizon Europe; innovation sustainability; socioecological transformation	The article aims to analyze the evolution of innovation ecosystems within the European Union (EU), focusing on the Horizon Europe proposal. It seeks to assess how EU innovation policies have developed over time and how they incorporate various actors; such as academia, industry, government, society, and the natural environment; into the innovation process. The study introduces a framework to evaluate the structural advancement of these ecosystems from the actors' perspective	The authors employ a qualitative analysis grounded in a previously developed framework for assessing the structural advancement of innovation ecosystems. This framework extends the traditional Triple Helix model (academia, industry, government) by adding two more dimensions: society and the natural environment, forming a "reframed innovation helix." The study applies this framework to the Horizon Europe proposal, examining policy documents and identifying the roles and interactions of various actors within the EU's innovation landscape.	The analysis reveals that while the Horizon Europe proposal acknowledges the importance of academia, industry, and government in fostering innovation, the roles of society and the natural environment are less explicitly defined. The study highlights the need for a more integrated approach that includes these additional actors to achieve sustainable and socioecological transformation. Furthermore, the authors emphasize the importance of overcoming the "valley of death" in innovation; the gap between research and market application; and note that private innovation financing remains a concern. The study concludes that for the EU to achieve its sustainability goals, it must orchestrate efforts across all five dimensions of the innovation helix

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
58	Urban Regeneration and Green and Blue Infrastructure: The Case of the "Acilia–Madonnetta" Urban and Metropolitan Centrality in the Municipality of Rome	Crupi, Francesco	2022	https://doi.org/10.3390/urbansci6030056	urban regeneration; urban project; sustainability; green and blue infrastructure	This necessarily requires a paradigm shift capable of making a multitude of dimensions; environmental, economic, social, institutional dimensions, as well as those related to settlement and energy [16]; interact, and of combining "regeneration" and "resilience" [17], by promoting new policies and strategies aimed at improving natural cycles, decarbonizing the energy system [12,18], and using innovative materials and technologies for the environment, transport, well-being, and human health. The objective of guaranteeing high levels of urban and environmental quality, energy efficiency, and circularity of resources must be entrusted to an innovated system of participatory and cooperative practices, institutional geometries, and interscalar and integrated planning instruments based upon adaptive and resilient strategies, and new planning metaphors such as green and blue infrastructure (GI) [19], while putting an end to biodiversity loss and the decay of ecosystem services (ESs)	Of the local planning experiences marked by a high level of theoretical/disciplinary innovation, the Municipality of Rome's 2008 General Regulatory Plan (Piano Regolatore Generale; PRG '08) is an emblematic case of "anticipation, confluence, and updating of the most significant elements of disciplinary elaboration of the past twenty years" [60]. In keeping with the current phase of metropolization, the Plan proposes an overall strategy of integration and urban and metropolitan rebalancing that heralds a new decentralized arrangement of a polycentric urban structure able to counter phenomena of spreading settlement and to promote processes for the city's requalification and regeneration	The contribution had the objective of demonstrating how the multiscalar and multidimensional construction of the "Acilia–Madonnetta" Urban and Metropolitan Centrality (Centralità Urbana e Metropolitana; CUM), supported by new inclusive, sustainable, and resilient design metaphors, in keeping with the processes of technological innovation and of multidisciplinary integration, can ensure the ecological quality of urban environments, more sustainable, efficient, and safer transport, and the elimination and recycling of waste, activating regenerative processes capable of transferring to the city, as a whole, the social, economic, and ecological/environmental benefits that these interventions bring with them. However, in spite of the substantial elements of disciplinary and procedural innovation contained in the approach to regeneration outlined in the General Regulatory Plan, the lack of a clear institutional governance and of sufficient public financing in the enduring recession of the real estate market, as well as a hypertrophic bureaucracy, are hindering the Centralities' implementation.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
59	Exploring (De)politicization in policy-driven urban sustainability experiments: Insights from a case study in Amsterdam	Darren Sierhuis	2025	https://doi.org/10.1016/j.eist.2025.100969	Urban experimentsUrban transformation PoliticsThe political(De)politicization	The study aims to investigate the political dimensions of policy-driven urban sustainability experiments, focusing on how processes of politicization and depoliticization influence their transformative potential. By examining a case study in Amsterdam, the research seeks to understand the implications of neglecting or neutralizing political aspects within urban experimentation.	Employing a qualitative case study approach, the research utilizes theories of the political as an analytical lens to dissect an urban sustainability experiment in Amsterdam. Data collection methods include document analysis and stakeholder interviews, enabling an in-depth exploration of the mechanisms through which (de)politicization operates within the experiment.	The study reveals that ignoring the political dimensions in urban sustainability experiments can lead to the exclusion of certain voices and options, ultimately resulting in stagnation. Depoliticization processes may suppress contestation and limit the scope of transformative change. The research underscores the necessity of acknowledging and engaging with political dynamics to enhance the effectiveness and inclusivity of urban sustainability initiatives.
60	Value of Climate Responsive Design in Respect of Changing Environment of Nearest Future	Md. Monjur Kader Sarker1*, Md. Shahadat Hossain	2025	http://dx.doi.org/10.5281/zenodo.15381933	Climate-ResponsiveDesign, Sustainability, Architecture,Resilience, RenewableEnergy	The article aims to explore the significance of climate-responsive design in the context of the rapidly changing environment. It seeks to highlight how integrating climate considerations into architectural and urban planning can mitigate environmental challenges, promote social equity, and enhance economic sustainability.	The study employs a comprehensive review of existing literature and case studies related to climate-responsive design. It analyzes various design strategies and their effectiveness in addressing environmental issues, focusing on the application of these strategies in different climatic contexts.	The findings demonstrate that climate-responsive design not only mitigates environmental challenges but also fosters social equity and economic sustainability. By aligning architectural practices with local climatic conditions, such designs can reduce energy consumption, enhance occupant comfort, and contribute to the resilience of urban environments against climate change.
61	The effect of climate-responsive design on thermal and energy performance: A simulation based study in the hot-dry Algerian South region	Ahmed Kaihoul a , Leila Sriti b , Khaoula Amraoui b , Silvia Di Turi c , Francesco Ruggiero d	2021	https://doi.org/10.1016/j.jobe.2021.103023	Climate-responsive designPassive strategiesHousingCooling and heating demandSoftware simulationHot-dry climateSouth of Algeria	The study aims to evaluate the impact of passive design strategies, inspired by traditional architecture, on the thermal comfort and energy performance of residential buildings in Algeria's hot-dry southern regions. It seeks to determine how these strategies can reduce energy demand for cooling and heating, thereby enhancing sustainability in the housing sector.	The researchers conducted a comprehensive analysis of a typical El-Miniawy housing unit in Ouled Djellal. They employed psychrometric chart evaluations, in-situ measurements, and dynamic simulations using EnergyPlus software to assess the building's thermal behavior and energy demand. Seven different scenarios incorporating various passive strategies and parameters were analyzed to explore their effects on energy consumption.	The study found that implementing passive design strategies significantly improved indoor thermal comfort and reduced energy demand. On the hottest days, while external temperatures reached up to 47 °C, indoor temperatures ranged between 30.1 °C and 35.4 °C. The building's energy consumption varied across scenarios, with cooling demands between 10.43 kWh/m^2 and 19.87 kWh/m^2. These results underscore the effectiveness of climate-responsive design in enhancing energy efficiency and thermal comfort in hot-dry climates.

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62	Climate-Responsive Architectural Design: Analyzing and Adapting to Diverse Climates in U.S. Cities	Xinzhi Chang	2024	http://dx.doi.org/10.54097/kw0e0c23	Climate-responsive design; Köppen classification; Givoni's psychrometric chart;parametric platform	The study aims to analyze the climatic characteristics of 12 U.S. cities, each representing different Köppen climate classifications, to inform effective passive design strategies. By understanding these diverse climatic conditions, the research seeks to guide architects and urban planners in developing climate-responsive architectural designs that enhance energy efficiency and occupant comfort.	The researchers utilized a parametric design platform to conduct an in-depth analysis of the selected cities' climatic data. This approach involved categorizing the cities under various Köppen climate classifications and assessing key climatic parameters such as temperature, humidity, solar radiation, and wind patterns. The study then evaluated suitable passive design strategies tailored to each climatic context, providing a comparative framework for climate-responsive architecture.	The analysis revealed that passive design strategies must be customized to the specific climatic conditions of each region to achieve optimal energy performance and thermal comfort. For instance, in hot-humid climates, strategies like cross-ventilation and shading are crucial, while in cold climates, maximizing solar gain and insulation is more effective. The study underscores the importance of integrating climatic analysis into the early stages of architectural design to create sustainable and comfortable built environments across diverse U.S. climates.
63	Climate-adaptive landscape design: Microclimate and thermal comfort regulation of station square in the Hokuriku Region, Japan	Jing Xiao, Takaya Yuizono	2022	https://doi.org/10.1016/j.buildenv.2022.108813	Climate adaptationOutdoor thermal comfortUrban microclimateLandscape designLandscape layout patternVegetation configuration	The study aims to investigate how climate-adaptive landscape design can regulate microclimate and enhance thermal comfort in urban public spaces, focusing on a station square in the Hokuriku region of Japan. Given the region's humid subtropical climate, the research seeks to identify effective landscape configurations that mitigate thermal stress and improve outdoor comfort for pedestrians.	The researchers employed a combination of field measurements and numerical simulations to assess the microclimatic conditions of the station square. Field measurements captured data on air temperature, humidity, wind speed, and solar radiation. Subsequently, the ENVI-met simulation tool was used to model various landscape design scenarios, analyzing the effects of different tree species (deciduous and evergreen), vegetation layouts, and surface materials on thermal comfort indicators such as the Physiological Equivalent Temperature (PET).	The study found that certain landscape configurations significantly improved thermal comfort in the station square. Specifically, layouts incorporating a balanced mix of deciduous and evergreen trees provided optimal shading and ventilation, leading to a reduction in PET values. The simulations demonstrated that strategic placement of vegetation and selection of appropriate surface materials can effectively mitigate heat stress in urban public spaces. These findings offer valuable insights for urban planners and landscape architects aiming to design climate-resilient and comfortable outdoor environments.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
64	A case study on facing climate change: optimizing planting density and date of summer maize for stable grain yield in the North China Plain	Zhendong Liu, Shiyu Wei, Xiudi Shangguan, Xin Wang, Meng Yuan, Rui Zong & Quanqi Li	2025	https://doi.org/10.1007/s10113-025-02379-9	Agricultural Economics Agricultural Geography Agriculture Climate-Change Adaptation Crop waste Drought	The study aims to assess the impacts of future climate change on summer maize production in the North China Plain (NCP) and to explore adaptive strategies; specifically, optimizing planting density and sowing dates; to maintain stable grain yields under projected climate scenarios.	The researchers utilized the Water-Heat-Carbon–Nitrogen Simulator (WHCNS) model in conjunction with Global Climate Models (GCMs) from the Coupled Model Intercomparison Project Phase 6 (CMIP6). They examined two Shared Socioeconomic Pathways (SSPs): SSP370 and SSP585. The study simulated various scenarios of planting densities and sowing dates to evaluate their effects on maize yield under future climate conditions.	The simulations indicated that, under SSP370 and SSP585 scenarios, maximum temperatures during the maize growing season are projected to rise by 2.2 °C and 3.3 °C, respectively, leading to potential grain yield reductions of 12.8% and 18.0% compared to historical levels. Solar radiation is expected to increase by 7.0% and 14.4%, respectively. To mitigate these impacts, the study recommends adopting a planting density of 78,000 plants per hectare. Additionally, adjusting sowing dates is advised: postponing to early July under SSP370 and sowing in early June under SSP585. These strategies aim to minimize yield reductions and support climate-adaptive agricultural management in the NCP.
65	Climate Justice in the City: Mapping Heat-Related Risk for Climate Change Mitigation of the Urban and Peri-Urban Area of Padua (Italy)	Valeria Todeschi 1, Salvatore Eugenio Pappalardo 2,3,*, Carlo Zanetti 1, Francesca Peroni 4 and Massimo De Marchi 3	2022	https://doi.org/10.3390/ijgi11090490	urban heat island; GIS-based methodology; satellite imagery; land cover; heat-related elderly risks; functional urban area; mitigation strategies; spatial equity; climate change adaptation; climate justice	The study aims to assess the spatial distribution of heat-related risks in the Functional Urban Area (FUA) of Padua, Italy, with a focus on the elderly population. By integrating urban heat island (UHI) analysis with socio-demographic data, the research seeks to identify vulnerable areas and inform climate justice-oriented mitigation strategies.	The researchers employed an open-source GIS-based approach utilizing satellite-derived data, specifically Sentinel-3 imagery, to map land surface temperatures (LST) and vegetation indices (NDVI) during the summers of 2018–2021. They developed a Heat-Related Elderly Risk Index (HERI) by combining thermal anomaly data with socio-demographic information, such as the percentage of elderly residents, to classify areas into five levels of risk. Data processing and mapping were conducted using open-source software tools, including SNAP and QGIS.	The analysis revealed that approximately 20% of the FUA exhibited high to very high heat-related risks, particularly within the urban core of Padua and three neighboring municipalities. These areas were characterized by thermal anomalies exceeding 2.4 °C, elderly populations over 20%, and HERI values above 0.65. The study underscores the importance of incorporating spatial equity considerations into climate adaptation planning and suggests that nature-based solutions, such as increasing urban greenery, can effectively mitigate UHI effects and enhance resilience for vulnerable populations.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
66	QGIS-based modeling and analysis of urban dynamics affecting land surface temperature towards climate hazards in coastal zones of Portugal	Oznur Isinkaralar	2024	https://doi.org/10.1007/s11069-024-06519-y	Climate change mitigation Climate policy Geographical information science Land surface temperature Land use/cover simulation	The study aims to assess the impact of urban dynamics; specifically land use/land cover (LULC) changes, population growth, and vegetation cover; on land surface temperature (LST) in Portugal's coastal regions. By analyzing historical data and projecting future scenarios, the research seeks to inform climate hazard mitigation strategies and sustainable urban planning.	The research utilized Quantum GIS (QGIS) software to analyze spatial and temporal changes in LULC, population, and LST from 1990 to 2018. Data sources included MODIS satellite imagery for LST, CORINE land cover data, and World Bank population statistics. The Modules for Land Use Change Simulation (MOLUSCE) plugin within QGIS was employed to project LULC and population changes for the year 2046. Statistical analyses were conducted to examine correlations between LST and factors such as vegetation cover (NDVI), built-up areas, and population density.	The study found a significant correlation between increased urbanization and rising LST in Portugal's coastal zones. Between 1990 and 2018, built-up areas expanded notably, particularly in the Leiria region, which experienced an annual increase of 4.04% in built-up land. Projections for 2046 indicate a transformation of 18.74% of agricultural areas and 14.43% of forest areas into built environments. The research highlights the cooling effects of green and water areas, emphasizing the importance of preserving and integrating such spaces in urban planning to mitigate heat-related climate hazards.
67	Eco-environmental quality assessment based on pressure-state-response framework by remote sensing and GIS	Mukesh Singh Boori a , Komal Choudhary a b , Rustam Paringer a c , Alexander Kupriyanov a c	2021	https://doi.org/10.1016/j.rsase.2021.100530	Ecological environmental qualityPSR frameworkRemote sensingGISRSEIEI	The study aims to evaluate eco-environmental quality (EEQ) in the Samara region of Russia by integrating remote sensing data with the Pressure-State-Response (PSR) framework. It seeks to compare the effectiveness of the Remote Sensing Ecological Index (RSEI) and the Ecological Index (EI) in assessing EEQ, thereby providing insights for sustainable regional development.	The researchers employed a combination of remote sensing and statistical indicators within the PSR framework. They constructed the EI using 15 indicators and the RSEI using 4 indicators. The PSR model categorized 12 indicators under 'pressure' and 3 under 'state,' with the 'response' index developed from the pressure and state indicators. A weighting system was applied to integrate these indicators, facilitating a comprehensive assessment of EEQ.	The study found a strong comparability between RSEI and EI in ecological assessments. However, the EI was more effective in reflecting changes in EEQ. The integration of remote sensing indicators within the PSR framework provided a robust basis for decision-making in sustainable development and offered technological support for long-term environmental mapping, monitoring, and assessment.

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68	Spatial evaluation of the ecological importance based on GIS for environmental management: A case study in Xingguo county of China	Hualin Xie a , Guanrong Yao a , Guiying Liu b	2015	https://doi.org/10.1016/j.ecolind.2014.08.042	Ecological landEcological securityEnvironmental managementLand use managementGIS	The study aims to identify key ecological areas essential for maintaining ecological security in Xingguo County, China. By assessing ecological importance through a GIS-based approach, the research seeks to inform environmental management strategies that balance ecological protection with sustainable development. ResearchGate	The researchers developed an integrated index system based on the Pressure-State-Response (PSR) framework, incorporating factors such as water security, biodiversity conservation, disaster protection, natural recreation, and human disturbance. Using GIS technology, they analyzed spatial data; including land use, ecosystem types, digital elevation models (DEM), and Normalized Difference Vegetation Index (NDVI); to evaluate the ecological importance of different regions within Xingguo County. Each factor was quantified and standardized, and the integrated ecological importance index was calculated to classify areas into four categories: extremely important, moderately important, generally important, and not important.	The study found that approximately 30% of Xingguo County's area was classified as "extremely important" for ecological security. These areas primarily included core regions of river systems, wetlands, nature reserves, forest parks, and scenic spots, as well as zones prone to geological hazards. The findings suggest that these critical ecological areas should be strictly protected, with limited or no development activities permitted. The study also recommends implementing zoning regulations and environmental management measures tailored to the ecological importance of each area, thereby promoting sustainable land use planning and ecological conservation.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
69	Planning for a different kind of sea change: lessons from Australia for sea level rise and coastal flooding	Ayşın Dedekorkut-Howes , Elnaz Torabi and Michael Howe	2021	https://doi.org/10.1080/14693062.2020.1819766	climate change adaptation; protect, accommodate, retreat model; structural and non-structural measures; policy reversal; horizontal and vertical consistency; policy review	The study aims to examine Australia's coastal adaptation policies in response to sea level rise (SLR) and coastal flooding. It seeks to identify the strengths and weaknesses of current approaches and to extract lessons that can inform more effective and equitable climate adaptation strategies both within Australia and in other countries facing similar challenges.	The researchers conducted a comparative analysis of legislation, policies, plans, and strategies related to coastal management across Australia's national and state/territory jurisdictions. They assessed the consistency, comprehensiveness, and effectiveness of these frameworks, focusing on how different levels of government address SLR and coastal flooding risks.	The study found significant disparities in coastal adaptation policies across Australian states and territories. Some regions, such as South Australia, Victoria, Western Australia, and Queensland, have developed more detailed and proactive plans, while others lag behind. The lack of national guidance and leadership has led to uneven adaptation efforts, placing certain populations at greater risk. The research highlights the need for consistent, long-term, and bipartisan commitment to climate adaptation, emphasizing that effective responses require coordination across all levels of government. These findings offer valuable insights for other countries with decentralized governance systems facing similar coastal challenges.

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70	Enabling Stakeholder Involvement in Coastal Disaster Resilience Planning	Thomas P. Bostick, Thomas H. Holzer, Shahryar Sarkani	2016	https://doi.org/10.1111/risa.12737		The study aims to develop a methodology that actively involves community stakeholders in coastal disaster resilience planning. Recognizing that traditional risk management often overlooks stakeholder engagement, the research seeks to integrate local perspectives into resilience strategies to enhance the capacity of coastal communities to prepare for, absorb, recover from, and adapt to adverse events such as storm surges, sea-level rise, and cyclone winds.	The researchers introduced a comprehensive framework that encompasses four resilience domains: physical, information, cognitive, and social. They employed a multicriteria decision analysis (MCDA) approach combined with scenario planning to evaluate and prioritize resilience initiatives. This methodology was applied in a case study in Mobile Bay, Alabama, where approximately 30 stakeholders participated in a workshop at the National Oceanic and Atmospheric Administration's Disaster Response Center. Participants collaborated with experts in systems engineering, coastal engineering, and risk analysis to identify critical community functions and develop project initiatives aligned with the four stages of resilience: prepare, absorb, recover, and adapt.	The study found that engaging stakeholders through this structured methodology led to the identification of 11 project initiatives aimed at enhancing community resilience. These initiatives addressed various aspects, including reducing saltwater intrusion, promoting environmental education, replacing utility poles, removing scrap metal, and decreasing impervious surfaces. The collaborative process facilitated a shared understanding of resilience among participants and highlighted the importance of incorporating diverse perspectives in planning. The authors concluded that such stakeholder-involved approaches are vital for developing effective and context-specific resilience strategies in coastal communities.

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71	Modeling Land Use Transformations and Flood Hazard on Ibaraki's Coastal in 2030: A Scenario-Based Approach Amid Population Fluctuations	Mohammadreza Safabakhshpachehkenari * and Hideyuki Tonooka	2024	https://doi.org/10.3390/rs16050898	remote sensing; flood; storm surge simulations; future land use; Japan's population contraction; neural network; maximum entropy classifier	The study aims to assess the impacts of projected land-use transformations on flood hazards in Ibaraki's coastal region by 2030, considering varying population dynamics. It seeks to inform adaptive coastal management strategies by simulating flood scenarios under different urban development trajectories.	The researchers employed a scenario-based approach, integrating remote sensing data and GIS analyses to project land-use changes. They utilized the DioVISTA 3.5.0 software to simulate flood scenarios based on projected land-use maps for 2030. Three urban development scenarios were considered: growth, stagnation, and shrinkage. Flood simulations accounted for storm surge events with peak water levels of 4.0 m and 7.2 m, representing lower and upper bounds of expected storm surge heights in the study area. The overlap between simulated flood extents and various land-use categories was analyzed to identify vulnerable areas.	The study found that, since 2020, built-up areas in Ibaraki's coastal region have increased by 52.37 km^2 (39%). Under scenarios of constant or shrinking urban areas, grassland expanded by 28.54 km^2 (42%), while urban land cover decreased by 7.47 km^2 (5.6%) over a decade. Flood simulations revealed that, at a 4.0 m storm surge, residential areas flooded measured 4.71 km^2 in the urban growth scenario, 4.01 km^2 in the stagnant scenario, and 3.96 km^2 in the shrinkage scenario. At a 7.2 m surge, these areas increased to 49.91 km^2, 42.52 km^2, and 42.31 km^2, respectively. The findings highlight the heightened flood risk associated with urban expansion and underscore the need for targeted flood prevention efforts in future urban planning.
72	Resilient cities: Mitigation measures for urban districts. a feasibility study	Danila Longo, Andrea Boeri, Valentina Gianfrate, Elisabetta Palumbo & Saveria O.M. Boulanger	2018	10.2495/SDP-V13-N5-734-745	climate change, mitigation strategies, built environment, integrated design approach, LCA.	The study aims to develop and evaluate an Integrated Design Approach (IDA) for enhancing urban resilience through mitigation measures in existing urban districts. Focusing on the Bolognina neighborhood in Bologna, Italy, the research seeks to identify effective strategies for renovating buildings and districts to improve energy efficiency and sustainability.	The researchers employed a multi-scale and multi-criteria IDA that integrates energy-efficient solutions with customer-oriented strategies. Key components of the methodology include: Identification of critical constraints (e.g., legal, non-technical). Assessment of human behavior constraints and propensities affecting mitigation solutions. Development of a matrix to model the effects of renovation options at the building scale on the overall district scenario. Establishment of key parameters for achieving high-quality standards. The approach also incorporates Life Cycle Assessment (LCA) to evaluate the environmental impacts of proposed interventions.	The application of the IDA in the Bolognina neighborhood demonstrated the potential for significant improvements in energy efficiency and environmental sustainability. The study highlights the importance of integrating mitigation strategies with the built environment and underscores the feasibility of replicating the approach in other urban contexts. The findings suggest that such integrated strategies can effectively contribute to the development of resilient cities by addressing climate change challenges at the district level

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73	Urban Design and Social Resiliency Case Study: Jolfa Neighborhood in Isfahan City	Parvin Partovi Mostafa Behzadfar Zahra Shirani	2016	https://doi.org/10.30480/aup.2016.323	Resiliency social resiliency Urban design Jolfa neighborhood Isfahan	The study aims to identify and analyze urban design factors that contribute to social resiliency within the Jolfa neighborhood of Isfahan, Iran. It seeks to develop a conceptual model of social resiliency by examining the interplay between physical and social typologies in the urban context.	The researchers employed a qualitative methodology, combining both "theory-research" and "research-theory" strategies. The study involved: comprehensive review of related literature to identify key criteria of social resiliency. Development of a conceptual model of social resiliency through deductive methods. Selection of the Jolfa neighborhood as a case study for empirical analysis. Data collection through semi-structured interviews and field observations to assess urban design-related factors influencing social resiliency. Inductive content analysis to categorize the extracted factors into general themes.	The study identified six key urban design factors that enhance social resiliency in the Jolfa neighborhood: Environmental Quality Improvement: Enhancing the physical environment to promote well-being. Identity: Preserving and promoting the unique cultural and historical identity of the neighborhood. Flexibility: Designing adaptable spaces that can accommodate various functions and activities. Inclusiveness: Ensuring equitable access to spaces and resources for all community members. Learning Spaces: Creating opportunities for education and knowledge sharing within the community. Social Interactions: Facilitating social cohesion through spaces that encourage community engagement. The findings suggest that integrating these factors into urban design can significantly contribute to the development of socially resilient neighborhoods.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
74	Developing an Urban Environment Examination System by Incorporating Construction, Economic, Environmental, Cultural and Development Dimensions	Shaoyang Ren, Yinan Li, Zhen Peng, Mingqiang Yin and Xiao Liu	2024	https://doi.org/10.3390/su16073065	urban sustainability; urban environment examination system; construction dimension; economic sustainability; environmental sustainability; cultural sustainability; development potential; Qingdao; dynamic urban assessment; entropy weight method; principal component analysis	To develop a holistic, multidimensional, and locally adaptable urban environment examination system that can dynamically assess urban sustainability and provide actionable insights for urban managers and decision-makers.	Development of UEES based on restructuring indicators from statistical yearbooks into five dimensions, using the entropy weight method to objectively determine indicator weights, and applying the framework to Qingdao city and its districts for assessment.	The results show all six construction indicators in Qingdao score well (2.01 - 4.01), but some like road network density (2.01), retrofitted old residential areas (2.06), and fire station coverage (2.26) score low, indicating areas for improvement. Central districts have lower development intensity but better fire station coverage. Well-urbanized districts perform better overall, but not in all dimensions, and suburban/outer districts face sustainability challenges. Transition to urbanization may degrade environment and economy if industries aren't upgraded, while cultural and development aspects can improve.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
75	A strategy-based framework for assessing the flood resilience of cities – A Hamburg case study	Britta Restemeyer, Johan Woltjer & Margo van den Brink	2015	https://doi.org/10.1080/14649357.2014.1000950	resilient citiesflood risk managementurban planningresilience strategies	The study aims to develop a heuristic framework for assessing urban flood resilience, moving beyond traditional flood control measures. It seeks to clarify the concepts of robustness, adaptability, and transformability within urban planning and flood risk management, providing insights into implementing resilience strategies in practice.	The researchers applied their framework to two significant urban development projects in Hamburg, Germany: the "Leap across the River Elbe" and the HafenCity. These case studies were selected due to Hamburg's experience with both tidal and pluvial flooding and its active participation in various flood risk management research projects. The methodology involved analyzing policy documents, land-use plans, and conducting interviews with key stakeholders, including planners, water managers, disaster managers, researchers, and citizens. This comprehensive approach allowed for an in-depth understanding of the institutional structures, current measures, and policy instruments related to flood resilience in Hamburg.	Robustness: The study found that traditional flood protection measures, such as dikes and barriers, contribute to the robustness of urban areas by reducing the probability of flood events. Adaptability: Adaptive strategies, including land-use planning and risk communication, were identified as essential for minimizing the consequences of flooding. The HafenCity project, for instance, incorporates adaptive building designs and public awareness initiatives to enhance resilience. Transformability: The research highlighted the importance of fostering societal change and innovation to transition towards more resilient urban systems. This includes encouraging stakeholder participation, building social and political capital, and integrating flood resilience into broader urban agendas. The study concludes that while traditional flood protection measures are necessary, they are insufficient on their own. A comprehensive approach that includes adaptability and transformability is crucial for developing flood-resilient cities. The framework presented serves as a valuable tool for policymakers and urban planners to assess and enhance urban resilience to flooding.

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76	Methods and Tools Supporting Urban Resilience Planning: Experiences from Cork, Ireland	K. M. de Bruijn1, H. van der Most1, L. Cumiskey 2, M. Hounjet1, M. Mens1	2018	https://doi.org/10.4236/gep.2018.64018	Urban Resilience, Flood Hazard Mitigation, Flood Risk Management, Urban Flood Management, Multi-Actor	The study aims to explore how urban resilience, particularly against flood hazards, can be effectively assessed and enhanced through integrated planning approaches. Focusing on Cork, Ireland, the research seeks to identify methods and tools that support policymakers in developing comprehensive resilience strategies.	The researchers employed a multi-disciplinary approach, combining theoretical frameworks with practical applications. Key components of the methodology include: Defining Urban Flood Resilience: Conceptualizing resilience as the capacity of urban systems to cope with and recover from flood events. Framework Development: Proposing a four-phase urban resilience planning framework encompassing: Scoping: Identifying system boundaries, relevant hazards, and resilience dimensions. Assessment: Evaluating current resilience levels using selected indicators. Strategy Development: Formulating measures to enhance resilience based on assessment outcomes. Implementation and Monitoring: Applying strategies and continuously monitoring their effectiveness. Stakeholder Engagement: Involving various actors through workshops and collaborative sessions to ensure a shared understanding and collective decision-making. Case Study Application: Implementing the framework in Cork to assess its practicality and effectiveness.	Integrated Approach Benefits: The study found that combining technical assessments with stakeholder engagement leads to more robust and accepted resilience strategies. Framework Effectiveness: The proposed planning framework proved effective in structuring the resilience planning process, facilitating clear communication among stakeholders, and identifying priority areas for intervention. Importance of Scenario Analysis: Incorporating future scenarios, including climate change projections, was crucial in developing adaptable and long-term resilience measures.Tool Utilization: The use of specific tools, such as flood risk models and participatory mapping, enhanced the understanding of vulnerabilities and the potential impact of proposed measures.

77	The Resilience, Adaptation and Transformation Assessment Framework: from theory to application	Deborah O'Connell, Brian Walker, Nick Abel, Nicky Grigg	The concept of resilience is an inspiration, and a clearly articulated aspiration, in the global discourse about sustainability and the future of the planet and its people. Despite the valuable body of research that has been conducted on resilience theory and practice it is apparent, however, that there are still enormous challenges to operationalizing the concept within an international, or national policy arena. The RATA framework begins to address these challenges. It applies resilience theory as its conceptual basis, and proposes an iterative multi-stakeholder engagement approach to characterise the system, identifying socio- ecological variables and their interactions across scales. By focussing on proximity to thresholds for key controlling variables, it evaluates the adaptive capacity and transformability of the system. Based on the outcomes of this assessment, the procedure identifies the need to adapt within the defined system, or transform to a different system. The RATA Framework is flexible, making it well-suited to different contexts. It is well able to accommodate the reality that what is vitally important in one system is irrelevant in another. For example, climate change will be an important consideration in some systems, but not all. The RATA framework is also readily applicable in situations of high uncertainty, high dispersion of power and highly ambiguous goals. Its flexibility makes it relevant beyond agroecosystems – indeed, it

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								can readily be applied to any social-ecological system.
78	Investigating the effects of 3D urban morphology on the surface urban heat island effect in urban functional zones by using high-resolution remote sensing data: A case study of Wuhan, Central China	Xin Huang Ying Wang	2019	https://doi.org/10.1016/j.isprsjprs.2019.04.010	Surface urban heat island Land surface temperature 3D urban morphology Landscape Urban functional zone	this study aimed to comprehensively investigate the relationship between 2D/3D urban morphology and the SUHI effect in urban functional zones using high-resolution remote sensing images, as well as 3D geographical information data. The study focused on the daytime in summer since the SUHI intensity and footprint together with its adverse effects on environment and human health have been found to be more intense during summer daytime (Peng et al., 2012, Yang et al., 2019). In addition, the stability and variations of the relationships in the other three seasons have been examined	Seven cloud-free Landsat-8 images were applied for the LST retrieval: April 26, 2013 and May 12, 2013 for spring, July 31, 2013 and August 16, 2013 for summer, September 17, 2013 and October 3, 2013 for autumn, and January 23, 2014 for winter (only one image scene was available in winter during that time due to the cloud coverage). The Thermal infrared sensor (TIRS) bands have been resampled to 30 m using the cubic convolution algorithm by the U.S. Geological Survey (USGS, 2016). In this research, LSTs were estimated using the radiative transfer equation (RTF) method by correcting atmospheric effects and land surface emissivity	Based on high-resolution remote sensing data and geographic information data, our results suggest the complex mechanism of the relationships between 2D/3D urban morphology and LST during summer daytime at a fine scale. Local LST is closely related to microscale landscape design characteristics. The relationships between LST and 2D/3D urban morphology were quantified using a partial Pearson correlation analysis, to control for the interactions among explanatory variables. From the landscape viewpoint, both the composition and configuration of buildings are significantly related to LST. The scattered distribution facilitates the mitigation of LST. 3D urban morphology, such as MH, SVF, is also found to affect the variation of LST. Daytime LST could be reduced with increasing building height. The influence of SVF is context-dependent, as SVF has competing effects on LST via regulating the ventilation, incoming solar radiation, as well as trapping thermal radiation. Trees are the most influential factor in reducing LST, and the cooling efficiency mostly depends on their proportions. The spatial distribution of grass/shrubs can also help to mitigate LST, and the fragmented and irregular distribution is therefore recommended.

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79	The land morphology approach to flood risk mapping: An application to Portugal	N.S. Cunha M.R. Magalhães T. Domingos M.M. Abreu C. Küpfer	2017	https://doi.org/10.1016/j.jenvman.2017.01.077	Wet system Flood plains Land morphology Flood risk Portugal Trancão River basin	In this paper, the land morphology concept (LMC) approach is used to map Portuguese landforms. The authors thus evaluate how landform mapping, particularly when it comes to the wet system, can support flood risk management. The LMC is applied through the land morphology mapping (LMM) method, using mainland Portugal as the case study.	The resulting land morphology map is based on the 25 m resolution DTM, and is derived from the intersecting of flat areas (slopes less than 5%), surface curvature and hydrological features, including streams and ridgelines. The map for is compared and validated, at both the national and local scale, against previous flood risk data obtained from hydrological models for the main river basin. One set of data was taken from 2010 by the former National Water Institute (Instituto Nacional da Água – INAG, 2010) and the other from the 2015 database belonging to the Portuguese Environmental Agency (Agência Portuguesa de Ambiente – APA, 2015) and that of the 2010 land use and cover map from Portuguese Geographic Institute	by specifically mapping the entire wet system in order to identify areas from upstream to downstream in the watershed, the LMC/LMM method can delimit floodplains and flood risk areas and, where there is currently no or poorly available hydrological data to calibrate the models. Therefore, the LMC/LMM approach is a complementary option which is less demanding in terms of data required and consequently less time-consuming than hydrological methods, especially where data collection is limited, as is the case in Portugal. In addition to being easily and economically applied to large areas, this morphological method consistently mapped floodplains, as valley bottoms are coincident (96.6% of APA floodplains limit) with the existent floodplain limit in downstream areas of the watersheds. These floodplains data and maps are the results of the recent study provided by the Portuguese Environmental

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80	Learning about urban climate solutions from case studies	William F. Lamb, Felix Creutzig, Max W. Callaghan and Jan C. Minx	2019	https://doi.org/10.1038/s41558-019-0440-x		Urban case studies can add to our understanding of climate mitigation solutions, but an overview of the field is urgently needed. Which cities do we know about? What topics do we know about? What comparative and secondary analysis is there of cases? And how can generalizable knowledge be derived from urban cases? In this Review we address these questions, using a literature mapping approach to discover and characterize the existing case studies	we obtain a sample of urban mitigation articles using a search query that combines synonyms for 'urban' and 'mitigation' in the Web of Science and Scopus literature databases (see Methods). Our interpretation of case study research is straightforward: if an article mentions a city name in the abstract or title, we assume it is a case study located in the city (or cities) mentioned. We validate this assumption subsequently for a representative sample of cases. Our dataset for the proceeding analysis consists of 4,051 case study publications. We use language-processing methods to extract relevant meta-data on case study locations, topics, review studies and other information. In our Review, this 'mapping' of the case literature is limited in analytical depth, but it is highly comprehensive in scope. The database of case studies we provide here thus enables researchers to 'zoom in' on particular topics or places of interest, with the intention of stimulating future work, refinement and large-scale assessments.	Our analysis reveals that juxtaposing evidence synthesis with quantitative city typologies can be a productive way forward to bring quantitative and qualitative research on cities and climate change solutions together. Aggregating cases and their insights to the level of urban typologies has already started in the grey literature, but remains undeveloped in peer-reviewed work and assessments

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81	Urban climate resilience through socio-ecological planning: a case study in Charlottetown, Prince Edward Island	Khirfan, L., & El-Shayeb, H.	2019	https://doi.org/10.1080/17549175.2019.1650801	Climate change adaptation urban resilience blue-green infrastructure transformation socio-ecological urbanism local ecological knowledge	we propose a theoretical framework that grounds urban resilience within this interconnected triad which we operationalize by modifying and deploying the charrette, an intense design activity, into an interactive method of inclusion and data gathering, to mobilize the knowledge-to-action on urban design and ecosystems	We apply the ensuing conceptual framework in Charlottetown, the capital of Canada's smallest province, Prince Edward Island (P.E.I.) in Atlantic Canada where the 100-year storm tides are not only increasing in frequency, but are also projected to reach 5 m in height above chart datum and to intrude up to 500 m inland (Ekistics Planning & Design 2012), rendering the city vulnerable to storm surges and coastal erosion. To supplement the charrettes' data, other primary and secondary data sources included several lectures and site visits with local experts, on-site transect walks, and analysis of planning documents which collectively underscored the Local Ecological Knowledge	The empirical research and its findings reveal that tethering the urban and landscape resilience theoretical framework to proposals that are based on the LEK and social learning ultimately balances the normative and the actionable. Discussing the transformation of drosscapes for water filtration for example without referencing general ideals such as those from McHarg's (1992) symbiosis (creating meaningful levels of order) or Allen's (2001) spatial organization of porous interconnected spaces may potentially lead to undesirable planning outcomes (reference Table 1 for resilience theoretical synthesis). Overall, these design proposals serve as policy recommendations for future action in Charlottetown's urban landscape.
82	Post-earthquake temporary housing unit: CLT E-BOX	Erkan Avlar* , Sevgül Limoncu , Didem Tızman	2022	10.17341/gazimmfd.1027894	· Post-earthquake housing · Temporary housing unit · Temporary housing model · CLT E-BOX	The purpose of the study is to produce feasible solutions for the establishment of temporary housing centers to eliminate the deficiencies regarding post-earthquake temporary housing.	The study focuses on the design, production, and planning of the process steps of temporary housing units to be used after the earthquake, and a model for temporary housing is proposed. In this context, the method followed in the study consists of four parts: constructing the model for temporary housing, design of the temporary housing unit, production of the designed units, and planning the process steps of the model	The proposed CLT E-BOX in the study; Small footprint in storage before installation; Provides easy and low-cost transportation from the logistics center to the earthquake zone; Easy and fast installation; It can be disassembled and reassembled many times; Obtaining optimum usage area after establishment; Providing functional and comfortable spaces to earthquake victims; It can bring important privileges in the post-earthquake period with its features such as the equipment that will meet the basic requirements

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83	Circular economy and regenerative sustainability in emergency housing: Eco-efficient prototype design for subasi refugee camp in Turkey	Mercader-Moyano, Pilar	2021	https://doi.org/10.3390/su13148100	emergency situation; social; sustainability; circular economy; construction; modular; ephemeral	the objective of the research is to propose an eco-efficient prototype for emergency housing, from the point of view of circular economy and regenerative sustainability, that can respond to situations of natural or humanitarian disasters. The investigation develops an eco-efficient design protocol adaptable to diverse scenarios as required, creating a rapid, easy, functional, and environmentally correct architecture, closely committed to the United Nations Sustainable Development Goals of the 2030 Agenda, thus helping to achieve equality among people, protect the planet, and ensure prosperity.	In order to achieve an eco-efficient and environmentally sustainable theoretical model that meets the minimum standards of habitability in emergency housing, it will be necessary to follow the subsequent methodology, as outlined in Figure 4, which will allow the achievement of the main objective: the design of an emergency housing prototype to optimise circular economy	This analysis identifies the defective aspects of these existing prototypes, which will help to design the novel prototype of the research in the most efficient way possible. Moreover, the characteristics of the housing must be adaptable to the location where it is needed to fulfil the minimum comfort and habitability conditions.

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84	Revisiting the Sphere standards: comparing the revised Sphere standards to living standards in three urban informal settlements in Nairobi, Kenya	Patel, R.B., Chadhuri, J.	2019	https://doi.org/10.1186/s41018-019-0054-y	Urban slum, Informal settlement, Sphere standards, Urban crises, Minimum standards, Localizing aid	This study aims to place the newly revised Sphere standards in the context given the urban complexity and chronic crisis described above. A sample of Sphere metrics from living conditions in three informal settlements of Nairobi, Kenya during non-crisis periods are compared to the Sphere minimum standards for crisis-affected populations. Nairobi exemplifies rapid urbanization and informal settlement growth with over 60% of the city's residents living in slums (African Population and Health Research Center (APHRC) 2012).	Several factors led to Nairobi as the selected areas for the Indicator Development for Slow Onset Urban Emergencies (IDSUE) study, from which this data was drawn. Concern Worldwide aimed to design an improved urban response framework based upon its experience responding to the Kenya 2008 post-election violence, where there was little evidence or triggers to inform timely and adequate humanitarian response. Humanitarian agencies and local government felt that existing thresholds to trigger humanitarian response were not designed for the most vulnerable informal settlements. Viwandani, Korogocho, and Mukuru have vulnerable populations which also have large populations. Chronic violence was endemic in most areas of these informal settlements. Tailoring new IDSUE indicators to account for chronic violence was a major consideration in site selection	This study presents the most rigorous evaluation of the Sphere indicators for urban informal settlement populations. A population estimated at well over a billion persons and rising. With the majority of the world's population now living in cities, humanitarian operations will increasingly target urban populations. New research with more granular and spatially disaggregated data as well as more open and honest evaluation of current practices and standards driven by evidence is needed.
85	Urban growth simulation guided by ecological constraints in Beijing city: T Methods and implications for spatial planning	Deng Yua,c, Liu Yanxua, Fu Bojie	2019	https://doi.org/10.1016/j.jenvman.2019.04.087	Urban growth scenarioEcological lossCoupling modelPolicy toolsUrban planning	The study aims to develop an urban growth simulation model that explicitly constrains ecological loss, rather than simply using ecological factors as predictors. It seeks to explore how integrating ecological loss as a policy component; parallel to the urban growth drivers; can optimize spatial expansion in Beijing and serve as a practical tool for informing spatial planning decisions	The researchers applied a coupled simulation framework to model urban growth in Beijing from 2000 to 2010. They used a cellular automata (CA)-type urban growth simulation calibrated with empirical data, but crucially added an ecological loss constraint; tailored to minimize reductions in key ecosystem functions. Scenarios were run both with and without the ecological constraint, enabling a comparison of spatial growth patterns and ecological outcomes	Incorporating ecological constraint yielded a 22.96% reduction in total ecological loss compared to an unconstrained simulation. The "constant growth" scenario minimized ecological damage most effectively. The results demonstrate that applying multiple ecosystem function metrics as constraints not only protects ecological resources but also provides more precise support for spatial planning. The constrained model proves beneficial as a policy tool, offering planners a powerful way to guide urban expansion sustainably.

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86	Quantitative study on environment and energy information for land use planning scenarios in eco-city planning stage	In-Ae Yeo, Eunok Lee	2018	https://doi.org/10.1016/j.apenergy.2018.09.014	Eco cityUrban planning scenarioDistrict unit planningE-GIS DBStatistical analysis	This study aims to develop and apply a quantitative framework that integrates environmental and energy data to assess different land-use planning scenarios during the eco-city planning stage, with the overarching goal of designing a low-carbon green city. It focuses on systematically evaluating how urban form choices; such as building scale, land-cover types, and density; affect environmental quality and energy use at multiple planning stages (zoning, land use, district), ensuring that planning decisions are informed by data-driven insights rather than subjective judgment	The researchers constructed an Environment and Energy Planning Information Database (E-GIS DB) by gathering urban planning inputs, overlaying them onto a 200 × 200 m spatial mesh, and computing representative mesh values for building use, structure, land cover, altitude, etc. They then designed 22 alternative urban planning scenarios, varying in zoning, land use, and district design, plus a baseline. Each scenario was quantitatively evaluated using statistical analysis of environmental and energy indicators from the E-GIS DB to determine the precision and stage-specific relevance of different planning phases	Key results reveal significant differences in environmental and energy factors (notably urban density) across the three planning stages. The district unit planning stage proved most accurate for scenario assessments, closely aligning with actual development, followed by land-use and zoning stages. Scenarios were classified into three categories: (a) high temperature and energy concern; (b) optimal for cooling and low energy use; (c) sub-optimal, requiring improvements or replacement. The methodology is shown to effectively identify low-carbon, environmentally optimal designs, recommending its use particularly at the district planning level
87	Comprehensive concept planning of urban greening based on ecological principles: a case study in Beijing, China	Feng Li a , Rusong Wang a , Juergen Paulussen a , Xusheng Liu b	2005	https://doi.org/10.1016/j.landurbplan.2004.04.002	Urban greeningUrban greenspaceEcosystem servicesLandscape ecologyEcological planningBeijing China	The study aims to create a comprehensive ecological framework for urban greening across multiple spatial scales in Beijing. Specifically, it explores how to structure green spaces; from regional to neighborhood levels; to deliver long-term sustainability, ecological integrity, and ecosystem services in the face of rapid urban expansion	Employing a landscape ecology-based conceptual planning approach, the authors integrated ecological principles such as habitat connectivity, buffer zones, and hierarchical green networks. Through GIS-based spatial analysis, they identified critical forest areas, ecological buffer belts, green wedges, corridors, parks, riverside and road greenways, and vertical greening zones. The outcome was a three-tiered green structure with region–city–neighborhood scale planning tailored to Beijing's geography and urban form	The proposed multi-scale green network; comprising a large forested northwest zone, a southeastern buffer belt, city-wide green corridors and wedges, and localized greenways and vertical greening; establishes an integrated ecological infrastructure. This framework was found to effectively limit urban sprawl, enhance environmental quality, provide vital wildlife habitats and migration paths, and ensure accessible open space close to residential areas. Collectively, these elements form a resilient system for sustainable urban development in Beijing

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88	Planning Restoration of Connectivity and Design of Corridors for Biodiversity Conservation	Javier Velázquez, Derya Gülçin, Peter Vogt, Víctor Rincón, Ana Hernando, Javier Gutiérrez, Ali Uğur Özcan, Kerim Çiçek	2022	https://doi.org/10.3390/f13122132	Restoration planner; Natura 2000 sites; ecological connectivity; connectivity network; Spain	The study seeks to enhance biodiversity conservation by identifying optimal restoration corridors that reconnect fragmented habitats within and around protected areas. Conducted in Spain's Castilla y León region, it focuses on pinpointing strategic pathways to improve ecological connectivity among Natura 2000 sites and their surrounding landscapes	Researchers developed three scenarios; Natura 2000 core areas, Level 0 (direct buffer of cores), and Level 1 (broader surrounding areas). They employed the Restoration Planner tool in GUIDOS Toolbox, a landscape connectivity analysis suite, to model pairwise optimal restoration pathways between the five largest habitat patches. Connector density and length were evaluated across scenarios to locate priority areas for corridor restoration	The study reveals that connector density and corridor lengths vary significantly by scenario, with the core-focused scenario showing concentrated connectivity near central and northwestern areas. Implementation of proposed restoration pathways is expected to substantially improve ecological connectivity across Castilla y León. The authors conclude that their approach offers effective spatial guidance for landscape-scale biodiversity conservation planning
89	Green infrastructures and ecological corridors shape avian biodiversity in a small French city	Erika Beaugeard, François Brischoux & Frédéric Angelier	2020		Biodiversity Ecological Network Environmental Geography Urban Policy Urban Ecology Urban Economics	The study investigates how green infrastructure and ecological corridors influence urban bird communities in a small French city (Niort). It seeks to quantify the effects of land-use patterns and proximity to green corridor networks on both overall avian species richness and the presence of common (top 70%) versus rare (bottom 30%) bird species during spring surveys	Researchers conducted springtime bird surveys at 102 sites across Niort, assessing habitat structure via PCA to derive an urbanization gradient (PC1). They used generalized linear mixed models (GLMMs) to examine how land use (PC1), distance to the city edge, and distance to the main green corridor affected species richness and species composition, with a specific focus on both common and rare species categories	The presence of green infrastructure significantly improved bird species richness, with positive effects amplified by closeness to the green corridor. Both overall and common species richness increased near green spaces, the urban edge, and especially close to corridors. Importantly, proximity to the corridor also boosted the presence of rare species, underscoring the corridor's role in enhancing urban biodiversity and enabling less common species to colonize city environments

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90	All London Green Grid as Nature-Based Solutions for Urban Resilience	Yukyung Oh	2021			The chapter examines how the All London Green Grid (ALGG); a policy framework embedded in the London Plan; operates as a nature-based solution (NbS) aimed at enhancing urban resilience. It clarifies key concepts like resilience and NbS within urban planning and evaluates how cross-sector collaboration among planners, communities, and government has been used to implement green infrastructure across Greater London	Through a policy and case-study approach, the authors define urban resilience and NbS, and then analyze the ALGG's implementation strategies. They consider governance structures, spatial planning integration, and functional design through the London Plan, ALGG supplementary guidance, and sub-local area frameworks. They assess outcomes via funding data, partnership structures, and stakeholder workshops addressing multidisciplinary planning and bottom-up governance .	The ALGG has established a multifunctional, city-wide green infrastructure network, fostering climate adaptation, flood risk reduction, air and thermal regulation, and social wellbeing. Its success is attributed to strong collaborative governance, embedding NbS into statutory planning, and pairing top-down spatial strategy with local stakeholder engagement. Challenges identified include inconsistent borough-level funding or political commitment. Still, the ALGG demonstrates NbS's potential for integrating ecological infrastructure into urban resilience planning
91	Flexible Refugee Shelter	: Nadine M.M. Oliveira and Inês D.D. Campos	2019	10.1088/1757-899X/603/3/032021		This article has as a main reflection the creation of a model of dwelling for Refugee camps. Initially, it aims at demystifying nomadism, its characteristics, the minimum habitat that results from it, whose influence is impregnated in the present days, and its connection to emergency architecture The Flex Refugee Shelter aims to respond directly to the need for temporary shelters in refugee camps. The lack of comfortable shelters and the minimal housing conditions are essential for these victims who see their lives change drastically from one day to the next. A housing shelter, as the tents provided by NGOs, cannot respond to the needs. For that reason a shelter with the minimum requirements it must have will then be proposed	the paper explains how the designing of a proposed emergency shelter	as a result an emergency shelter designed

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92	Case study investigation of the building physical properties of seven different green roof systems	Bernhard Scharf , Irene Zluwa	2017	https://doi.org/10.1016/j.enbuild.2017.06.050	Building greenery Green roofs Building physics Heat flux U-value	This paper aims to provide some data concerning insulating properties of seven selected green roofs, differing in construction type, materials used and thicknesses. The selected green roofs represent "typical" constructions of central Europe as described in the Austrian Standard [20] and the German guideline for green roofs [21].	The measurements considered for this paper cover two winter seasons and one summer season over a period of 15 months. The data was collected automatically with data loggers and industry standard sensors	The following points summarize the key findings of this paper: •Green roofs contribute to the thermal insulation of buildings but construction thickness, materials, seasons and layers play a key role •A general assumption of an average u-value of green roofs based only on construction thickness is not reliable •The thicker the green roof construction is, the better the building physical properties are •Growing layer materials with high water storage capacity improve the building physical properties, when combined with drainage layer with high pore volume •Drainage boards improve building physical properties of green roofs
93	A comprehensive study on green roof performance for retrofitting existing buildings	Stefano Cascone Federico Catania Antonio Gagliano Gaetano Sciuto	2018	https://doi.org/10.1016/j.buildenv.2018.03.052	Green roof Retrofit Energy conservation Environmental effects Economic benefits Thermal performance	In the present study, we carried out a broad analysis of green roof performance for the retrofitting of existing buildings. In particular, a variety of extensive green roofs were considered, using different materials for the substrate and drainage layer. All the possible solutions were applied to an existing multi-story residential building located in the city of Catania (Italy), which is characterized by a Mediterranean climate	The overload derived from each solution, considering the worst scenarios (which occur when the substrates are water saturated) was evaluated and compared with the load limit prescribed by law for the retrofitting of existing buildings. Furthermore, energy performance in terms of surface temperatures and energy savings were analyzed and compared to the existing roof performance. Finally, following the installation of each green roof, an evaluation was done of both the economic costs and the environmental benefits, such as CO2 and NOx reduction, storm water management, etc.	The research carried out, highlighted the current structural limits for adopting green roofs for the retrofitting of existing buildings, and the adequacy of the materials used, giving specific information about different green roof packages. In the present study, the payback time of the investment was calculated taking into account only the financially quantifiable benefits obtainable with the construction of a green roof. Most of the benefits of the green roof are not economically quantifiable (reduction of CO2 in the atmosphere, mitigation of the heat island effect, improvement of the microclimate, psychological well-being of the residents); although they can provide orientation to justify the choice of this intervention.

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94	Assessing methods for predicting green roof rainfall capture: A comparison between full-scale observations and four hydrologic models	Carson, T., Keeley, M., Marasco, D. E., McGillis, W., & Culligan, P.	2015	https://doi.org/10.1080/1573062X.2015.1056742	sustainable urban water management; stormwater modelling; rainfall-runoff analysis; hydrology	This study addresses the need to accurately forecast green roof performance by assessing the utility of four contemporary hydrologic models applied to predicting observed rainfall capture from two full-scale green roofs in NYC	The four models evaluated are the curve number method (NRCS, 1986), characteristic runoff Equation (Carson et al., 2013), Hydrological Evaluation of Landfill Performance (HELP) model (Berger, 2013), and Storm Water Management Model (SWMM) (USEPA, 2013). In what follows, a summary of related literature is first provided to discuss common approaches for predicting green roof stormwater performance and offer rationale for selection of the four models in this study (Section 2). The analysis is then carried out in three steps: collection of fullscale green roof performance data (Section 3), model setup and implementation (Section 4), and determination of model efficiency through comparison of modeled outputs and observed data (Section 5).	, the results presented here have indicated the need for improved ability to predict green roof rainfall capture prior to green roof installation. We suggest that modeling efficiency is currently limited by: (1) the accuracy of input parameter estimation from limited, pre-construction information and (2) the representation of full-scale green roofs as continuous and/or infinite depth systems

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95	Thermal and energy performance of green roof and cool roof: A comparison study in Shanghai area	Yang He Hang Yu Akihito Ozaki Nannan Dong	2020	https://doi.org/10.1016/j.jclepro.2020.122205	Green roof Cool roof Thermal performance Energy performance Parametric analysis	the type of roof that provides better thermal and energy performance in Shanghai area is still unknown. In order to provide a reference for the application of both types of roof in practical projects for public buildings, a comparative analysis based on field data under Shanghai's climate was conducted in this study.	Field experiments in summer and winter were implemented, after which the impacts of green roof and cool roof on surface temperature and heat flux were analyzed. The effects of green and cool roofs, together with corresponding physical parameters on cooling and heating load of a typical office building were then simulated based on the dynamic thermal load calculation software package called THERB (Ozaki and Tsujimaru, 2006).	This paper compared the thermal performance of green roof and cool roof. Experimental data shows that green roof had a greater cooling effect in the daytime while the cooling effect of cool roof performed better at night. The cool roof had a slightly lower average Tr in summer compared to the green roof. For office buildings, there are generally lesser people around at night. Therefore, night-time cooling provided by cool roof has no significant effect on total cooling load in summer. However, cool roofs would also result in more heating load in winter. Simulation results show that both the green roof and cool roof could have a positive effect on the year-round air-conditioning load in Shanghai area for a typical office building. Green roof reduces the cooling and heating load of the top floor by 3.6% and 6.2%, respectively, while cool roof reduces the cooling load by 3.6% and increases the heating load by 10.4%. Conclusions drawn from this paper could provide a reference for parameters selection during roof design, such as leaf area index of species or soil depth. Thus, a more water and energy efficient and economically viable roof solutions could be achieved. However, there are also some limitations in this paper.

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96	Integrating Top-Down and Bottom-Up Adaptation Planning to Build Adaptive Capacity: A Structured Learning Approach	Butler, J. R. A., Wise, R. M., Skewes, T. D., Bohensky, E. L., Peterson, N., Suadnya, W., ... Rochester, W.	2015	https://doi.org/10.1080/08920753.2015.1046802	climate change Coral Triangle evaluation knowledge cultures social learning	In this article we present a novel planning approach that integrates the strengths of top-down and bottom-up adaptation. We describe the process and methods that are designed to build adaptive capacity among multilevel stakeholders while mitigating potential power and knowledge inequalities. Using five coastal case studies within the Coral Triangle in Indonesia and Papua New Guinea (PNG), we present data that justifies and evaluates this approach, and discuss lessons learned and potential refinements.	The Coral Triangle is a marine biodiversity hotspot covering the developing nations of the Philippines, Malaysia, Indonesia, Timor Leste, Papua New Guinea, and the Solomon Islands (Coral Triangle Secretariat Citation2009). The region is characterized by coastal communities that are highly exposed to climate change (Hoegh-Guldberg et al. Citation2009), and low levels of adaptive capacity among all stakeholders (Butler et al. Citation2014a; Citation2014b). However, other drivers such as population growth and cultural change are also having complex and accelerating impacts on community vulnerability (Fazey et al. Citation2011; Butler et al. Citation2014a; Citation2014b). Adaptation planning has been prioritized for these communities by the Coral Triangle Initiative (Coral Triangle Secretariat Citation2011), and two toolkits have been specifically designed for this purpose (Table 1). From 2011–2013 we tested our planning approach by focusing on five coastal subdistricts in the provinces of Nusa Tenggara Barat Province (NTB), Indonesia, and West New Britain (WNB), PNG (Figure 1).	The evaluation results highlight the diverse perceptions of stakeholders, justifying their inclusion in the process. Community, government, and NGO respondents' views of livelihood challenges differed significantly. The relative importance of incremental versus transformational adaptation strategies in the production systems and economy domains were similar between stakeholder groups. However, for the institutional domain NGO respondents differed by prioritizing transformational strategies that balance traditional values and practices with current government structures. Furthermore, the full diversity of perspectives was probably masked by the aggregation of responses into stakeholder groups.

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97	Local responses to disaster: The value of community led post disaster response action in a resilience framework	Raven Marie Cretney	2016	https://doi.org/10.1108/DPM-02-2015-0043	Social support, Christchurch earthquake, Emergency response, Preparedness, Community resilience, Social participation	This paper details research that was undertaken in June 2012, approximately one and a half years after the first earthquake in September 2010, and six months following the last magnitude 6+ earthquake in December 2011. The research is focused on the immediate response actions undertaken by the case study community group "Project Lyttelton" which is based in Lyttelton Harbour on Banks Peninsula. Lyttelton is based over the epicentre of the devastating 22 February Christchurch earthquake which resulted in the devastation of much of the main street and many iconic venues and buildings. Despite this, the community has rallied and come through the disaster. The response provided by Project Lyttelton was desperately needed in the days immediately following the 22 February quake as centralised services were largely concentrated on urban search and rescue efforts in the Central Business District of Christchurch City	The methodology employed for this research includes in-depth qualitative interviews with key informants from the community and participants in the Project Lyttelton group. These were conducted alongside e-interviews with community members. In-depth face to face semi-structured interviews were carried out with six individuals who were highly involved in the Lyttelton community, over a period of two weeks. Informed consent was required, and all participants were made aware that the interviews would involve questions related to their experiences of their community's response and ongoing recovery to the earthquakes, but not details of the earthquake event itself. This line of inquiry reduced the risk of re-traumatisation and focused on the constructive elements of participant experiences (Collogan et al., 2004). Participants were also asked questions relating to how they understood and defined community resilience.	This work illuminates areas of both theoretical consideration, and practical possibilities for improving community resilience to disasters. The main finding of this research is that already established community organisations can play an important role in responding to the unique needs of their community, and the broader processes of disaster response and recovery. Furthermore, the mechanism of Timebanking provides an ideal way to encourage and support community capacities in a way that supports these disaster response outcomes. Broadly, these findings reinforce the work undertaken by Vallance and Carlton (2014) in which inventories of community action related to the disaster were compiled, suggesting that groups active before the event contribute to engagement and services during a disaster. Project Lyttelton provides an excellent example of such a repository of community resilience that was able to improve the livelihoods of community members day to day as well as during a disaster.

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98	Community-led reconstruction, social inclusion and participation in post-earthquake Nepal	Gordon Crawford, Chas Morrison	2020	https://doi.org/10.1111/dpr.12512	community-led, disaster, earthquake, inclusion, Nepal, participation, reconstruction	This research is situated within a wider professional collaboration, whereby our investigations are independent from AAN and carried out with impartiality and objectivity, yet are designed to inform their humanitarian and development programming. We concede that relying on AAN to identify respondents and to translate has the potential for a conflict of interest, but we strongly hold that overall the research becomes more rigorous and comprehensive through AAN's expert facilitation of access to remote rural communities and to government officials. This allowed us to meet a wide variety of respondents and discuss freely with them, often on politically sensitive issues	The paper proceeds in eight sections. Following this introduction, the second section examines existing literature on CLR, inclusion and participation, including shortcomings in implementation. The third section provides background information on the 2015 earthquakes and census data for various social groups in Nepal, and the fourth section explains the research methodology and data collection procedures. The fifth section explores marginalised people's mobilisation and selforganisation in the reconstruction process, while section six examines engagement with government and advocacy by disaster-affected people. Section seven analyses to what extent people's reconstruction needs have been met, and what social changes have been achieved. Finally, the conclusion presents findings on the extent to which the CLRP achieved its aim of combining reconstruction with progress towards a more inclusive and equitable society.	Participatory reconstruction approaches risk replicating the traditional dominance by men and higher castes and perpetuating marginalised groups' exclusion (Barenstein, 2006; Schilderman & Lyons, 2011). Nonetheless, the CLRP is a genuine attempt at bottom-up reconstruction, with concrete mechanisms to encourage the expression of marginalised voices, notably women, Dalits and landless people, and to challenge the prevailing socio-economic conditions that increase disaster vulnerabilities. We outline our findings in three main areas: participation and inclusion; organisation and mobilisation; and engagement with government.

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99	Significance of implementing Climate Responsive Streetscape in Cairo Neighborhoods	Nada Mohamed Mostafa Mansi Samah Elkhateeb Marwa Khalifa	2025	10.21608/erjsh.2025.337159.1376	: Earthquake Early Warning system, Synthetic seismic waveforms, Green's functions.	The study aims to explore the impact of climateresponsive streetscape designs on outdoor thermal comfort, environmental sustainability, and urban resilience. It seeks to assess how these designs can mitigate the UHI effect, improve public health, and contribute to sustainable urban development. The research will analyze case studies from hot, arid climates, identify effective interventions, and propose strategies for integrating these designs into Cairo's urban planning policies. The goal is to create guidelines for designing climate-responsive streetscapes to improve both accessibility and environmental quality	The case study examines the design and implementation of a climate responsive streetscape in Botros Ghaly street, focusing on how urban infrastructure can adapt to local climate conditions. By integrating sustainable design principles and innovative technologies, the project aims to enhance thermal comfort, mitigate heat island effects, and promote pedestrian friendly environments. Botros Ghaly street was selected for its multifunctional uses, the vibrant street used by locals throughout the entire day, can present a vital example for implying the climate responsive streetscape techniques. Boutros Ghali Street experiences high levels of urban heat due to the extensive use of asphalt, concrete, and limited green spaces	This analysis demonstrates the effectiveness of the hybrid approach in transforming Botros Ghaly Street into a more sustainable, comfortable, and attractive urban space. The results from this iteration provide a strong foundation for further refinement and expansion of similar solutions in other parts of the city. The design prototypes were adjusted to address practical concerns identified in the first iteration, such as reducing the need for water intensive vegetation in arid climates. Drought resistant plants to be chosen, and water collection systems were integrated into the design to sustainably manage irrigation needs.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
100	Effects of urban planning indicators on urban heat island: a case study of pocket parks in high-rise high-density environment	Pingying Lin Stephen Siu Yu Lau Hao Qin, Zhonghua Gou	2017	https://doi.org/10.1016/j.landurbplan.2017.09.024		The purposes of this study are: first, to investigate the ability of pocket parks in improving the urban microclimate condition and reducing UHI intensity in high-rise high-density built area of Hong Kong; second, to quantitatively investigate the influence of urban planning indicators on UHI and thermal performance of pocket parks. The urban planning indicators used in this study to quantify land use intensity and greenery include floor area ratio (FAR), building density, park area, tree cover ratio (TCR) and shrub cover ratio (SCR). Daytime UHI and early nighttime UHI as climate indicators are collected by in situ measurement in 12 representative sites.	Bivariate regression analysis is adopted to investigate the relationships between urban planning indicators and climate indicators. Results could provide more straightforward understanding on urban climatology and urban design in Hong Kong, which could benefit urban planners at the very beginning stage of urban planning	Results show that Hong Kong has a moderate mean UHI intensity (0.1 °C) during the daytime but a very high mean early nighttime UHI intensity (2.39 °C). Ten parks are cooler than their surrounding urban streets in both daytime and nighttime, which means that pocket parks in Hong Kong can help to alleviate UHI intensity at the micro scale. FAR, building density and TCR are found to be significantly and negatively related with daytime UHI. Higher FAR, building density and TCR in high-rise high-density urban environment may reduce daytime UHI intensity without increasing the early nighttime UHI intensity, which confirms the importance of shading effect in sub-tropical area. The increase of park area has controversial influence on the UHI intensity, which suggests that there may be an optimal park size for lowering outdoor air temperature in high-rise high-density urban environment with sub-tropical climate. Planting trees is an effective measure to reduce the UHI intensity inside the parks for high-rise high-density urban environment. But, there may be a threshold for the effect of tree coverage on daytime UHI in high-rise high-density urban environment since a TCR of lower than 42% may have little contribution in reducing the air temperature inside the parks.

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101	Design Methodology for Street-Oriented Block Housing Considering Daylight and Natural Ventilation	Kim, H.-J., & Kim, J.-S.	2018	https://doi.org/10.3390/su10093154	street-oriented block housing; daylighting; right to light; natural ventilation; wind path planning	To implement eco-friendly planning in a mild climate region such as Seoul, which faces distinct seasonal changes and a broad annual temperature range, securing the right to daylight in the winter season is a precondition for reducing heating load, and the focal point is to increase thermal comfort in exterior spaces by planning wind paths with the aim to maximize natural ventilation. Accordingly, this study analyzed characteristics of day-lit environments in perimeter block housing of street systems with azimuth angles of 0 to 60°, which is the most common form of grid-type residential areas in Seoul, and by using shadow characteristics, investigated the form of residential buildings and the methodology for layout planning with the objective to meet the standard of two consecutive daylight hours on the winter solstice, which is a performance restriction prescribed in the Enforcement Decree of the Building Act	The rational architectural shift in urban spaces towards street-oriented block housing is likely to occur in grid-type residential areas with infrastructure in a relatively favorable state. In the second chapter, grid-type residential areas of Seoul were topologically examined to identify the most common azimuth angles, the scale of the urban block, and street systems. Based on these street systems, we examined the basic principles for daylight optimization and wind path planning and verified a design methodology that can be applied and utilized for street-oriented block housing through a three-dimensional simulation. The calculations of daylighting hours were based on legal standards stipulated as two consecutive hours of continuous access to daylight or four or more hours of accumulated daylight on the winter solstice in Seoul. In addition, a simulation for wind velocity and wind field was carried out to compare wind velocity ratios on the basis of the annual mean wind velocity and the prevailing wind direction in Seoul throughout the year.	This study proposed a design methodology for residential building layouts that is optimized in terms of the daylight environment with regards to street-oriented block housing, and examined a mass planning methodology based on environmental performance by applying a methodology for wind path planning The above findings of this study suggest that a performance-based approach is necessary for the improvement of environmental performance in street-oriented block housing, in consideration of azimuth angles and the prevailing wind direction from the initial phase of planning. In addition, more research is needed on concepts such as average building stories and mixed density so that residential buildings are not subject to the height limit of seven stories but vary in the number of floors according to the location and orientation of residential buildings, insofar as the number of floors does not affect the right to daylight of a housing unit and adjacent housing units and generate rapid air flow.

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102	Superblock transformation in Seoul Megacity: Effects of block densification on urban ventilation patterns	Minjung Maing	2022	https://doi.org/10.1016/j.landurbplan.2022.104401	Superblock CFD Urban ventilation Block porosity High density urbanization	This study investigates the past and present superblock urban form to identify key features and trends in development and its effects on urban ventilation conditions of the superblock model. The intent is not to stipulate a new building or urban morphology but to study how the changes in building form and urban spatial zoning have changed the environment of the superblock	The time period of the past 40 years from 1980 s to 2020 is used, as this was a critical period of mass urbanization with significant transformation of urban form. Urban ventilation is investigated using CFD numerical simulations and evaluated using a minimum (lower-limit) wind speed classification to understand how much area within the superblock exhibit poor and stagnant ventilation in its mixed car and pedestrian streets and open spaces. A lower-limit ventilation criterion is not as widely-adopted, however is important especially for high density urban areas as poor ventilation impacts public health of large urban settlements, increasing their exposure to trapped air-borne contaminants, pollutants and overheating from trapped urban heat stress.	Mapping studies of the 1980 s and 2020 s, show that over the last 40 years, Gangnam superblocks have undergone rapid urban densification with blocks filling up open lots with tall buildings along perimeters and mid-rise buildings in the inner block areas. Site coverage ratios generally have increased by an average of 43% at the cost of open space and green areas. Urban ventilation has worsened from block and edge densification causing walling effect, discontinuous streets, building height zone changes, deep canyons and lack of open space since 1980 s. Some configurations such as large through-roads, recessed buildings, and increase of open space areas show some positive effects of opening up the superblock to allow the ventilation to enter into and through the blocks.

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103	The energy implications of urban morphology from an urban planning perspective – A case study for a new urban development area in the city of Vienna	Roman Loeffler, Doris Österreicher, Gernot Stoeglehner	2021	https://doi.org/10.1016/j.enbuild.2021.111453	Energy efficient urban planning Passive design measures Sustainable spatial planning Energy efficiency Urban morphology	this work aims to extend the established view of the relationship between urban form and the energy performance of buildings by a holistic perspective to investigate possible trade-offs and interactions that have not yet been sufficiently explored in the existing literature. By analysing the relevant passive design measures, decision-making support shall be derived that can be used in urban planning to respond to climate change impacts on future buildings	The method chosen to test the hypothesis comprises a total of five steps (Fig. 1). The first step was a literature review with the aim of determining the relevant influencing factors on the neighbourhood level for the energy performance of buildings as well as the criteria that should be considered in the course of a holistic approach to the issue. In addition, different assessment approaches and assessment tools were examined with regard to their suitability for answering the research questions. A bottom-up approach in the form of a parametric study with urban building energy models in an exemplary case study has been found to be the most suitable approach as detailed Urban Building Energy Modelling allows a quantitative analysis of different planning variants In a second step, it was determined which influencing factors would be examined and how they would be included in the analysis. Furthermore, it was determined which metrics would be applied in order to be able to map the different effects of the investigated influencing factors on the energy efficiency of buildings.	the study enhances the understanding of the effects of urban form on the energy performance of buildings, which have not been studied in depth in the previous literature in terms of the combined effects of the main influencing factors. In consequence, the main theoretical contribution of this research is to support the development of a better understanding of the complex reciprocal effects of urban form. In this respect, the results of the present work emphasize the need to establish spatial planning frameworks that recognize that energy efficiency of buildings cannot necessarily be achieved through high compactness of buildings by itself. Conversely, the energy performance of buildings is also significantly influenced by other aspects that can cause existing planning principles to have an adverse impact

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104	An integrated building information modelling-based environmental impact assessment framework	Walaa S.E. Ismaeel & Rodina Abd El-Raouf Lotfy	2022	https://doi.org/10.1007/s10098-022-02443-6	Archaeological Methods and Modelling Building Information Modeling Building Law for Engineers and Architects Ecological Modelling Environmental Civil Engineering Environmental Process Engineering	The study seeks to overcome significant challenges in Environmental Impact Assessment (EIA), especially prevalent in developing countries, by integrating Building Information Modeling (BIM) with EIA and Environmental Management Systems (EMS). The aim is to streamline EIA processes across project phases, enhance data continuity, and embed environmental assessment directly within BIM workflows; improving decision-making and quality control in sustainability planning	The authors conducted a scientometric (keyword) analysis to identify key concepts and interrelationships for a BIM-based EIA framework. They designed a prototype featuring three scoring schemes; Score A (EIA efficiency), Score I (integration across EIA steps), and Score B (integration across project phases); and visualized data flows with a Sankey diagram. The framework was then tested on three major construction projects in Egypt via questionnaires and practical application, focusing on identifying strengths and weaknesses in BIM application for EIA	The framework revealed several shortcomings: limited use of advanced BIM models for sustainability analysis, uneven BIM integration across project stages (notably in operation, maintenance, and end-of-life phases), and weak support for EIA mitigation decision-making. The authors advocate for expanding BIM models to 6D (incorporating sustainability data) to address these gaps; enabling better mitigation planning and design optimization. The framework provides a novel tool for verifying BIM-EIA integration quality and offers a roadmap for enhancing EIA through BIM-enabled EMS
105	Integration of BIM and LCA: Evaluating the environmental impacts of building materials at an early stage of designing a typical office building	Mohammad Najjar a , Karoline Figueiredo b , Mariana Palumbo c , Assed Haddad	2017	https://doi.org/10.1016/j.jobe.2017.10.005	Environmental impactsLife cycle assessmentBuilding information modelingSustainable buildingBuilding energy	The study aims to develop and validate an integrated BIM–LCA workflow for assessing the environmental impacts of building materials at the early design stage of a typical multi-story office building. It seeks to determine whether incorporating tools like Revit, Green Building Studio, and Tally® can empower early-phase decision-making by identifying material-related environmental hotspots and guiding sustainable choices; according to ISO 14040 and 14044 standards	The authors conducted a case study of a multi-story office building using Autodesk Revit as the BIM platform, complemented with LCA tools (Green Building Studio and the Tally plugin). They extracted material quantities to perform life cycle assessments based on ISO 14040/14044, covering manufacturing and operational phases. The integrated workflow evaluated design alternatives, facilitating early-stage comparison and identification of environmental hotspots through combined BIM and LCA analyses .	The integration proved effective in early-phase environmental assessment, with the highest negative impacts linked to material manufacturing and operational use. BIM–LCA helped pinpoint environmental hotspots and facilitated comparative design evaluation. However, the authors noted limitations: reliance on available databases, incomplete phase coverage, and tool interoperability challenges. They concluded that BIM–LCA integration enhances sustainability-focused decision-making in early design but emphasized the need to refine databases and workflows for broader impact coverage and seamless automation

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106	Step-by-step implementation of BIM-LCA: A case study analysis associating defined construction phases with their respective environmental impacts	R Di Bari, O Jorgji, R Horn, J Gantner and S Ebertshäuser	2019	10.1088/1755-1315/323/1/012105		The study aims to demonstrate how a structured BIM–LCA workflow can empower early-phase decision-making in building projects by associating defined construction and planning phases with their respective environmental impacts. The goal is to provide reliable environmental impact values at different levels of building development; from overall concept to detailed components; enabling planners to assess alternatives and make informed choices from the very start of design	Authors developed a systematic seven-phase BIM–LCA integration framework, applied across four structural model layers (whole building, functional systems, element systems, and components). It starts at project initiation with coarse quantification and environmental benchmarks, advancing through increasing detail in BIM models. A case study of a multi-apartment building in Germany tested the framework, using material data (quantities, types, scopes) at each phase. Environmental impacts; especially global warming potential (GWP); were estimated through benchmarks and tools like SBS online and EPD databases, with iterative refinement and stakeholder input	Results show that the framework effectively supports early sustainability decision-making by providing environmental impact estimates already at concept and functional system phases. The case study highlighted key influences on GWP: construction type, functional system choices (e.g., wall materials vs. installation systems), and early-stage benchmarks offered meaningful comparisons to standard references. However, significant uncertainties persisted, due to data gaps in energy use, refurbishment, and end-of-life stages. The authors stress the need for refined databases, probabilistic modeling, and dynamic methods to strengthen result robustness and support real-time, reliable LCA in early design
107	Density and Urban Resilience, Cross-Section Analysis in an Iranian Metropolis Context	Alireza Dehghani, Mehdi Alidadi, Ali Soltani	2022	https://doi.org/10.3390/urbansci7010023	resilience; compact development; densification; cross-section analysis; Shiraz	This study investigates the relationship between various forms of urban density (population density, residential density, built-up area ratio, parcel density) and multidimensional urban resilience (ecological, social, economic, physical) in Shiraz, Iran. It seeks to empirically test the often-presumed link between compact urban form and resilience, determining whether densification uniformly supports resilience or if distinct density types align differently across resilience dimensions	The authors develop a resilience framework using 30 indicators grouped into four dimensions, then apply spatial and quantitative analysis. They map these and density variables across Shiraz's districts using GIS, and employ clustering (LISA/Moran's I) to reveal spatial patterns. Pearson correlation is used to assess cross-sectional relationships between density metrics and resilience dimensions	The results demonstrate that density's relationship with resilience varies by type and dimension: population, residential, and parcel densities show stronger positive correlations with social and physical resilience, but weaker or negative links with ecological and economic resilience. Notably, built-up area ratio correlates positively with social resilience. Overall, densification does not always deliver across resilience goals; instead, tailored approaches are needed based on density type and resilience objective

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108	Verona Adapt. Modelling as a Planning Instrument: Applying a Climate-Responsive Approach in Verona, Italy	Marika Tomasi, Sara Favargiotti, Martina van Lierop, Lorenzo Giovannini, Andrea Zonato	2021	https://doi.org/10.3390/su13126851	urban climate adaptation; multifunctional landscape design; urban climatology; nature-based solutions; blue and green infrastructure; ecosystem services; meteorological modelling; interdisciplinarity	This study aimed to present and critically reflect on an integrated, climate-responsive approach for urban planning, specifically focusing on how climate modelling can serve as a planning instrument. The primary goal was to bridge urban climatology, landscape planning, and governance to develop and assess climate adaptation solutions at both city and district levels. By applying this approach to a case study in Verona, Italy, the researchers sought to identify its potentials and barriers, ultimately providing recommendations for better integration of climate modelling into planning processes and fostering collaboration between urban planners and climatologists for more credible and salient adaptation strategies.	The research employed a multidisciplinary and interscalar design process, combining knowledge from urban climatology, landscape planning, and governance. The city of Verona, particularly its South district, was selected as a case study to test the proposed approach. This involved developing a green and blue infrastructure with a climate-responsive master plan, supported by state-of-the-art meteorological simulations. The methodology included subsequent steps for analysis and design phases, investigating, synthesizing, and assessing climate-related issues at two scale levels through modelling and mapping methods, while critically reflecting on the practical application and its implications for existing city forms.	The application of the integrated climate-responsive approach in Verona demonstrated its potential to assess and develop climate adaptation solutions, particularly in the context of creating green and blue infrastructure. The study highlighted the advantages of incorporating climate modelling into urban and open space planning, enabling the testing of various green climate adaptation measures and revealing the cooling effects of natural areas. While identifying the approach's strengths, the critical reflection also addressed practical limitations and barriers encountered in a real-life urban setting, leading to recommendations on how climate modelling can be effectively integrated into planning and how collaboration between urban planners and urban climatologists can be strengthened to achieve more robust adaptation outcomes.

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109	Climate Responsive Neighbourhoods for HCMC: Compact City vs. Urban Landscape	Ronald Eckert & Le Hai Chau Huynh	2016	https://doi.org/10.1007/978-3-319-04615-0_122		This study aims to investigate and compare two distinct urban development paradigms; the "Compact City" and the "Urban Landscape"; in the context of creating climate-responsive neighborhoods within Ho Chi Minh City (HCMC). The primary objective is to analyze how each paradigm performs in mitigating the urban heat island effect and improving thermal comfort, considering HCMC's tropical monsoon climate. By evaluating their respective advantages and disadvantages, the research seeks to inform future urban planning strategies in HCMC towards more sustainable and climate-resilient development.	The research employs a comparative case study approach, focusing on typical neighborhood configurations representing the Compact City and Urban Landscape typologies within HCMC. Environmental performance simulations, likely utilizing microclimatic modeling tools, were conducted to assess key indicators such as air temperature, surface temperature, wind speed, and mean radiant temperature. This allowed for the quantification of the urban heat island effect and the evaluation of thermal comfort levels under various scenarios for each urban form. The methodology also likely involved analyzing the design principles and material characteristics inherent to each typology.	The findings reveal significant differences in microclimatic performance between the Compact City and Urban Landscape paradigms in HCMC. The Urban Landscape approach, characterized by greater green spaces, lower building densities, and improved air circulation, generally demonstrated superior performance in mitigating the urban heat island effect and enhancing outdoor thermal comfort compared to the Compact City model. While the Compact City might offer advantages in terms of resource efficiency and reduced travel distances, its higher building density and larger impervious surfaces often contribute to increased heat stress. The study provides crucial insights for HCMC's urban planners, suggesting that incorporating elements of the Urban Landscape, such as extensive green infrastructure and strategic urban ventilation, is vital for creating more climate-responsive and livable neighborhoods in a tropical environment.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
110	Design for climate resilience: influence of environmental conditions on thermal sensation in subtropical high-density cities	Zheng Tan a , Sum Ching Chung a , Adam Charles Roberts d,e,f and Kevin Ka-Lun Lau	2018	https://doi.org/10.1080/00038628.2018.1495612	Outdoor thermal comfortthermal sensationurban microclimateenvironmental qualityhigh-density	This study aims to investigate the intricate relationship between environmental conditions and human thermal sensation in subtropical high-density cities, with a specific focus on informing climate-resilient urban design strategies. The primary objective is to understand how various microclimatic parameters (such as air temperature, humidity, wind speed, and radiation) collectively influence perceived thermal comfort in these challenging urban environments. By establishing this understanding, the research seeks to provide evidence-based guidelines for urban planners and designers to create more comfortable and resilient public spaces.	The research employed a combination of field measurements and subjective surveys conducted in representative high-density urban areas within a subtropical city. Environmental sensors were deployed to continuously monitor microclimatic conditions at various locations and times. Simultaneously, human participants were recruited to provide real-time thermal sensation votes and perceptions of their environment. This integrated approach allowed for the correlation of objective environmental data with subjective human responses. Statistical analysis and potentially thermal comfort models were then applied to identify significant correlations and develop predictive understandings of thermal sensation under varying urban microclimates.	The findings reveal a complex interplay between environmental conditions and thermal sensation in subtropical high-density cities, highlighting the critical role of urban design in mitigating thermal discomfort. High air temperatures and humidity levels were consistently identified as primary contributors to heat stress, but the study also underscored the significant impact of mean radiant temperature, often exacerbated by solar radiation and heat stored in urban surfaces. Crucially, the research demonstrated that even subtle changes in urban geometry, material choices, and the presence of green infrastructure can significantly alter localized microclimates and, consequently, improve perceived thermal comfort. The findings provide actionable insights for designing climate-resilient urban spaces, emphasizing the importance of strategies like shading, increased ventilation, and the integration of vegetation to enhance outdoor thermal comfort in these challenging environments.

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111	Retrofitting public spaces for thermal comfort and sustainability	J. Cortesão, F. Brandão Alves, H. Corvacho, and C. Rocha	2016	https://doi.org/10.1177/1420326X16659326		The article focuses on enhancing outdoor thermal comfort in compact urban areas by retrofitting public spaces through bioclimatic design principles. Specifically, it seeks to explore how selecting "cool" paving materials and integrating vegetation can improve microclimatic conditions; making such spaces more usable, socially vibrant, and energy-efficient, while also considering broader sustainability outcomes	The authors conducted a field survey of a public square in Porto, Portugal, combining meteorological measurements and user feedback to assess existing thermal conditions. They then ran ENVI-met simulations to model various retrofit scenarios; with different combinations of paving materials and vegetation configurations; examining air temperature, humidity, radiant heat, and wind flow. A Life Cycle Assessment (LCA) evaluation compared the environmental impacts of suggested materials and vegetation setups to assess overall sustainability	The study concludes that combining high-albedo (cool) paving materials and strategic planting significantly improves microclimate and outdoor comfort. Simulation results revealed cooler ground temperatures, increased shading, and better thermal regulation. The LCA highlighted the importance of selecting materials that balance immediate microclimatic benefits with low life-cycle environmental costs. The authors recommend integrating this dual-focused (comfort + LCA) bioclimatic retrofit framework into urban design decision-making in dense city contexts
112	The Oasis Project: UHI mitigation strategies applied to Parisian schoolyard	Ghid Karam (LIED), Martin Hendel (LIED), Bobée Cécilia (LIED), Berthe Alexandre (LIED), Bordin Patricia (LIED), Royon Laurent	2024	https://doi.org/10.48550/arXiv.2408.08886		To help Paris city planners systematically identify which of the 670 publicly owned schoolyards have the greatest potential to serve as "urban cool islands", aiding in mitigating Urban Heat Island (UHI) effects during heatwaves and benefiting both students and nearby residents	Researchers used GIS analysis to map schools' unshaded, high solar-irradiance surfaces and devised a cooling indicator; the proportion of such areas relative to each schoolyard's total area. Based on this indicator, they categorized schoolyards into high, medium, or moderate cooling potential groups	The study identified 38 schoolyards with high cooling potential, 157 with medium potential, and 286 with moderate potential among the 670 analyzed. The authors recommend applying this GIS-based approach in other cities to prioritize UHI mitigation efforts and guide urban cooling strategies

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
113	Assessing climate-adaptation effect of extensive tropical green roofs in cities	C.Y. Jim	2015	https://doi.org/10.1016/j.landurbplan.2015.02.014	Climate adaptationCooling loadExtensive green roofGreenery infillingHeat sink effectUrban heat island	The study aimed to evaluate how extensive tropical green roofs; specifically with Sedum and Perennial Peanut vegetation; perform in mitigating urban heat and managing cooling loads in a compact tropical city setting (Hong Kong). It focused on determining both outdoor air temperature benefits and impacts on indoor energy consumption under different summer weather conditions	Researchers set up controlled field plots on a high-rise building: one bare roof (control) and two green-roof plots planted with Sedum and Perennial Peanut. They installed an integrated sensor array spanning from the outdoor ambient air through roof layers to indoor ceilings, along with energy loggers to track AC usage in unoccupied apartments below. Data were collected across sunny, cloudy, and rainy days.	The bare roof heated intensely under the sun, raising both outdoor and indoor temperatures, which drove up AC energy consumption. The Sedum roof, with incomplete plant cover and low evapotranspiration, offered limited cooling and modest indoor heat reduction. In contrast, the Peanut-roof, with higher transpiration and moisture retention, notably cooled near-ground air; beneficial for urban heat island mitigation; but acted as a thermal reservoir, increasing indoor cooling demands. Practical design and plant-selection guidelines were proposed to optimize green-roof performance in tropical climates.
114	Climate Mitigation Strategies: The Use of Cool Pavements	Martina Giorio, Rossana Paparella	2023	https://doi.org/10.3390/su15097641	urban heat island; urban mitigation; climate mitigation; cool pavements; microclimatic analyses; regenerative interventions	The article investigates how applying cool pavement materials; including reflective, permeable, and high-albedo options; within an urban neighborhood affects surface temperatures, air temperatures, and outdoor thermal comfort, with the goal of evaluating their potential for mitigating the urban heat island effect	The authors conducted a neighborhood-scale case study in Padua, Italy. They used ENVI-met microclimate simulations, enhanced with GIS and Ladybug-Grasshopper tools, to compare (a) existing pavement materials versus (b) a scenario where roads, sidewalks, and parking areas were replaced with cool pavement types (white topping, colored asphalt, pervious concrete, permeable blocks). Their model assessed surface temperatures, air temperatures at pedestrian level, and thermal comfort via the Universal Thermal Climate Index (UTCI) over a full summer day	Surface Temps: Cool pavements significantly lowered peak surface temperatures; white topping dropped surfaces by ~6 °C, permeable blocks by ~8.6 °C (e.g., 50.2 °C → 41.6 °C). Air Temps: Pedestrian-level air temperatures decreased modestly (0.2–0.4 °C daytime; ~0.2 °C at ~20 m elevation). Thermal Comfort (UTCI): Improvements in UTCI; less thermal stress; were notable, especially in sun-exposed areas. UTCI dropped from severe/moderate heat-stress values in current conditions. Design Insight: Cooling effects varied with urban morphology (orientation, sky view factor). Combining cool pavements with shading (trees) enhances pedestrian-level comfort and mitigates reflected-radiation issues.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
115	Urban development with dynamic digital twins in Helsinki city	Mervi Hämäläinen	2021	https://doi.org/10.1049/smc2.12015	Digital twin, smart city, smart city experimentation, stakeholders	The study explores how dynamic digital twin technology; a real-time, data-connected virtual replica of the physical city; can be applied to enhance smart city planning, governance, and stakeholder collaboration in an urban setting. It focuses on evaluating potential benefits and challenges through the lens of Helsinki's ongoing digital twin projects	The researchers employed an interpretive, qualitative approach: they conducted semi-structured interviews with practitioners (city planners, consultants, platform developers; n≈8) and analyzed project reports from Helsinki's Digital Twin initiatives. These insights were supplemented by technical documentation and case examples; such as Helsinki 3D+ and its cityGML-based pilots; to illustrate practical deployment and collaborative processes	Strong data infrastructure is foundational for enabling real-time digital twins and related smart city applications. Digital twins accelerate urban experimentation, support knowledge-driven decision-making, and enhance coordination among multi-stakeholder teams through shared virtual platforms. They have improved stakeholder communication, transparency, and citizen engagement, enriching democratic urban governance. Key barriers include organizational readiness (culture, skills, structure), data quality, and computing demands; but emerging standards and digital investment models are making city-level implementation more feasible .

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
116	Developing a City-Level Digital Twin –Propositions and a Case Study	L. Wan* T. Nochta J. M. Schooling MJ DeJong JM Schooling GMB Viggiani	2019	https://doi.org/10.1680/icsic.64669.187		The paper sets out to define a structured agenda for creating city-scale digital twins. Inspired by the UK's national-level Gemini Principles, the authors propose six guiding propositions to steer city-level digital twin development and emphasize that a digital twin cannot be simply "installed"; it must be co-evolved alongside the social systems, governance structures, and organizational readiness that support it	The study synthesizes insights from the Gemini Principles report and current UK digital twin efforts, then develops theoretical foundations grounded in smart infrastructure research at Cambridge. The proposed city-level twin architecture is validated using a pilot case study at the University of Cambridge's West Cambridge campus, illustrating each architectural component and stakeholder integration process	The authors articulate six key propositions; for instance, emphasizing co-evolution of technical and social systems, data-driven value creation, and governance-aligned design. They present a five-layer hierarchical architecture (data acquisition, transmission, digital modelling, integration, service layers) that bridges from individual asset twins to a city-level twin. The West Cambridge pilot demonstrates effective integration of heterogenous data sources; BMS, asset management, BIM, IoT sensors; into both research and commercial twin instances. The project documents common barriers (data heterogeneity, system interoperability, governance alignment) and derives a roadmap and eight lessons learned for future city-scale implementations
117	Sustainable stormwater management: A qualitative case study of the Sponge Cities initiative in China	Xiu-Juan Qiao , Kuei-Hsien Liao , Thomas B. Randrup	2020	https://doi.org/10.1016/j.scs.2019.101963	Sustainable stormwater management Sponge City Low impact development Green infrastructure Case study	The objectives of this study were: (i) to understand the Sponge City concept as described in national policy documents; and (ii) to determine how the Sponge City concept is interpreted and implemented locally.	A qualitative case study approach was applied in this study. It is useful for gaining an in-depth understanding of how the Sponge City concept is understood at the national and local level and is also a good way to determine how the Sponge Cities initiative is seen from a governance perspective. Within this approach, a critical review based on relevant national policy documents, semi-structured interviews with local government officials and site visits to Sponge City projects were conducted in three representative case cities.	in this study, we found that many conventional stormwater management solutions have been implemented. Thus, it is reasonable to argue that the national policy – Sponge Cities initiative in China has altered from being mainly SSM approach to becoming a combined conventional and SSM approach during local implementation.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
118	Case Studies Illustrating the Multiple-Use Water Services Options. In: Rethinking Infrastructure Design for Multi-Use Water Services	Maksimović, Č., Kurian, M., Ardakanian, R.	2015	https://doi.org/10.1007/978-3-319-06275-4_3	LİMİTED ACCESS			
119	Nature-Based Adaptation in a Nairobi Informal Settlement: Addressing Chronic Flooding While Increasing Community Resilience Through Multi-Benefit Green Infrastructure	Crosson, C.	2023	https://doi.org/10.1007/978-3-031-36320-7_31	LIMITED ACCESS			
120	Stormwater wetlands for the enhancement of environmental ecosystem services: case studies for two retrofit wetlands in Brisbane, Australia	Margaret Greenway	2017	https://doi.org/10.1016/j.jclepro.2015.12.081	Ecosystem services Irreducible background concentrations Macro invertebrates Nutrients Stormwater wetlands Suspended solids	This paper examines the environmental services of water quality improvement and aquatic macroinvertebrate biodiversity provided by 2 stormwater wetlands constructed within existing older residential areas ie new 'green and blue 'infrastructure within old 'brownfield' settings. Both wetlands were created from retrofitting concrete drainage channels. Social values are briefly discussed.	Two urban stormwater wetland systems were selected with similar catchment size (180 ha) to monitor water quality treatment and aquatic macroinvertebrate biodiversity. Both systems are located in Brisbane, SE Queensland; Australia. The climate is subtropical with an average annual rainfall of 1120 mm. The wet season occurs over summer/autumn, with an average of 10days with greater than 50 mm daily rainfall; intense rainfall events of 1 h duration of 71 mm/h are common. During the study period a 1 in 100 year event occurred when 208 mm fell in 3 h.	These 2 retrofit stormwater wetlands constructed from concrete drainage channels improved water quality and created aquatic biodiversity in an urbanised setting. Both wetlands had a similar catchment size (180 ha) however water quality monitoring demonstrated that the larger 0.8 ha Bridgewater Creek system with a 12,500 m3 storage capacity was more effective in reducing suspended solids during storm events. This was also attributed to the design which incorporated an overflow bypass channel. At Golden Pond high flow-through velocities caused by the v-notch weir prevented settling and resuspended sediment. During dry weather duck activity in both wetlands caused resuspension of sediment. Both wetlands were effective in removing nutrients; however outflow concentrations did not meet Water Quality Objectives due to 'irreducible' background concentrations. This suggests that Brisbane City Council's stormwater quality objectives are too stringent for constructed wetland stormwater treatment devices.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
121	Highly Resolved Rainfall-Runoff Simulation of Retrofitted Green Stormwater Infrastructure at the Micro-Watershed Scale	Towsif Khan, S., Chapa, F., & Hack, J.	2020	https://doi.org/10.3390/land9090339	green infrastructure; urban flooding; SWMM; stormwater; neighborhood level; high resolution; Costa Rica	the novelty of this study is the use of detailed data to develop a highly resolved urban drainage model where retrofitted stormwater infrastructure can be represented. It can be easily replicated in areas where data are missing due to the lack of resources needed to generate them. The methodology can be used by stormwater practitioners aiming to evaluate the potential runoff reduction derived from GSI elements. By developing a highly resolved rainfall-runoff model at micro-watershed scale, this study assesses the hydrological effects of implementing small scale GSI elements. The spatial focus of this research is located in consolidated urban areas with limited open space, aiming to reduce the generation from impervious surfaces of stormwater runoff. A residential neighborhood was selected as a case of study because of its urban characteristics and the geographical location. The site is located in a tropical developing country whose meteorological conditions, especially the rainfall characteristics, challenge the performance of traditional green infrastructure elements	A description of the study area is initially presented. Then, the methods used to generate and collect data are reported. Subsequently, the hydrological simulation is explained, including the selection of storm events and elements to represent retrofitted stormwater infrastructure. The results include aspects related to data generation, model calibration and validation, and stormwater runoff generation scenarios with and without green infrastructure	The simulation of implementing GSI measures by retrofitting public places and disconnecting impervious areas from the storm sewer system was found to be partially effective in reducing the runoff generation rates. By using small scale bioretention cells and micro trenches in street curb-gutters it was possible to reduce the peak flow from 25% to 75% depending on the intensity of storm. The results clearly show the benefits of GSI measures for sustainable stormwater management in consolidated urban areas with limited space, especially when dealing with stormwater pollution found in the first flush. Due to the hydrological characteristics of the rainfall events in the tropical area, simulating green infrastructure for flooding control of extreme events require additional strategies. Future studies may contribute on identifying more realistic retrofitting strategies for consolidated areas where space availability for management of large rainfall volumes is the main limitation.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
122	Resilience assessment framework for critical infrastructure in a multi-hazard environment: Case study on transport assets	Sotirios A. Argyroudis Stergios A. Mitoulis Lorenzo Hofer Mariano Angelo Zanini Enrico Tubaldi Dan M. Frangopol	2020	https://doi.org/10.1016/j.scitotenv.2020.136854	Resilience Critical infrastructure Environment Multi-hazard Fragility Vulnerability Restoration	This study aims at filling this urgent knowledge gap by (1) providing a sound classification of multiple hazards affecting critical infrastructure, (2) reviewing existing approaches and techniques for dealing with the effect of multiple hazards in the infrastructure resilience assessment, and (3) developing and applying a resilience assessment framework for critical infrastructure assets exposed to a sequence of individual and/or multiple natural, environmental and human-induced hazard events. This framework considers the factors that reflect redundancy and resourcefulness in infrastructure, i.e. (i) the robustness to hazard actions, based on realistic fragility functions, and (ii) the rapidity of the recovery after the occurrence of different levels of direct damage and induced consequences, based on realistic restoration and reinstatement functions respectively, enabling adjustments to the time of initiation of restoration after the hazard event (idle time), the type of the restoration actions and the sequence of hazards.	In Section 2 below, a classification of multiple hazards is given, by also including relevant examples from real systems subjected to hazard sequences. Subsequently, the proposed conceptual framework for resilience assessment is described. The output of the framework is a resilience index, which is a function of the time-variant functionality of the infrastructure over the restoration time for the hazard scenarios. In Section 3, an application of the proposed framework is given by analysing the resilience of a typical highway bridge under two realistic multi-hazard scenarios, both involving the occurrence of a flood and an earthquake event. In the first scenario, it is assumed that the bridge is fully restored after the occurrence of the flood event and before the earthquake strikes the bridge. For the second scenario, the earthquake is assumed to occur during the restoration process following the occurrence of the flood. The results of the resilience assessments for the two cases are presented and discussed in Section 4. The proposed framework and application contribute to the enhancement of current practices for resilience-based management of infrastructure assets by shifting toward the multi-hazard lifetime resilience assessment	The application of the proposed framework is illustrated by considering a realistic case study, consisting of a multi-span highway bridge exposed to two consecutive hazard scenarios, considering flood-induced scour followed by an earthquake. Novel contributions include: 1) the identification of representative failure modes for flood and earthquake hazards, 2) the development of realistic fragility and restoration functions for individual and combined hazards, and 3) the consideration of appropriate restoration tasks. The resilience models are developed for multiple hazard scenarios of different intensities, considering the full or partial recovery of the bridge between the different hazard events and accounting for the uncertainty in the temporal occurrence of the second hazard

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123	Climate change impacts on critical urban infrastructure and urban resiliency strategies for the Middle East	Mohsen Salimi , Sami G. Al-Ghamdi	2020	https://doi.org/10.1016/j.scs.2019.101948 Get rights and content	Climate change adaptation Vulnerability Critical urban infrastructure Resilience Middle East	This paper highlighted the importance of wet-bulb temperatures and a threshold of 35 °C. They also projected that extreme wet-bulb temperatures in the GCC countries could exceed this critical threshold under the future greenhouse gas concentrations for the business-as-usual scenario (Representative Concentration Pathway (RCP) 8.5).	The search for relevant papers was performed using keywords found in the title, abstract and keywords of published journal articles, such as climate change impacts, Middle East, temperature rise, precipitation, sea level rise, urban, resiliency, critical infrastructure, water supply, power generation, built-up environment, transportation, telecommunication, human health, air pollution, and vulnerability. The organization of these references was carried out using the Mendeley software.	The rapid urbanization in the Middle East has made cities the vital players where the vulnerabilities caused by climate change need to be addressed. There is a need to invest enormous resources for climate resilient infrastructure and systems, and vulnerability reduction programs. The main impacts of climate change in the Middle East are temperature rise, wet-bulb temperature rise (which will bring into question the workability and survivability of the population), changes in the precipitation patterns, and sea level rise. These climate phenomena will put pressure on the main infrastructure in the region, especially electricity and water production, the built-up environments, (leading to a rise in energy demand), transportation and telecommunication systems, as well as, human health and welfare.
124	Developing of a Digital Twin for Urban Planning in an International Context	Darko Šiško, Vlado Cetl, Hrvoje Matijević	2024	https://doi.org/10.31803/tg-20240910101801	digital twin; City of Zagreb; international context; urban planning; GIS; 3D city models; smart city; urban monitoring; data integration	To provide an overview of digital twin development for urban planning in an international context and to propose a digital city twin concept tailored for Zagreb, identifying the main data themes, stakeholders, challenges, and future needs.","Literature and case study review of international digital twin projects; analysis of City of Zagreb's existing GIS and 3D modelling projects; identification of data themes, update cycles, and stakeholder roles; conceptual modelling of modular digital twin system focusing on urban planning.	- Identified key data themes, update cycles and sources for urban planning digital twin module (Table 3). - Defined modular system structure with common information platform and thematic modules. - Presented Zagreb's progress in GIS and 3D city model implementation as a foundation for digital twin. - Highlighted challenges such as real-time data use, simulation features, and integration with formal planning processes. - Outlined stakeholders and user groups for the Zagreb digital twin project.	Urban planning and monitoring is a significant application area for digital twins offering improved visualization, integration of spatial and non-spatial data, simulation capabilities, and stakeholder collaboration. Zagreb serves as a practical example demonstrating both opportunities and challenges in developing functional digital twins within smart city strategies.

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125	Seismic vulnerability assessment of historical urban centres: case study of the old city centre of Faro, Portugal.	Maio, R., Ferreira, T. M., Vicente, R., & Estêvão, J.	2015	https://doi.org/10.1080/13669877.2014.988285	seismic vulnerability; masonry buildings; old city centres; vulnerability index method; damage scenarios; GIS mapping	The metropolitan region of Lisbon, the region of Algarve and the Azores Islands are the three most important seismic regions in Portugal, which have been damaged by earthquakes throughout the centuries. Chronologically ordered, the most important earthquakes occurred in Portugal in 1755, 1909, 1969 and 1998. The Algarve region, whose administrative and political centre is Faro, is internationally recognised for its touristic visibility and leads substantial impact on the Portuguese economy, despite its seasonality. The seismicity associated to this region derives from the offshore earthquake activity of the contact region of Euro-Asian and African plates, and also from the activity of diverse local faults crossing the territory	When analysing large-scale seismic vulnerability of individual buildings through simplified methodologies, it is required a significant knowledge level of each single building, which even so is still incomparably lower than more detailed methodologies such as numerical analysis. It would be unreasonable and unaffordable to perform numerical analysis of each single building within historical centres. In this sense, assembling the knowledge regarding the historical evolution and growth of the city under study and perceiving the fundamental structural characteristics and similarities amongst those buildings, reduces the survey and inspection period, which is the most time-consuming task, entailing increased logistical expenses	the results obtained in this study are closely correlated to the observed building construction features and general fragilities of the built environment, proving the reliability of the seismic vulnerability assessment methodology. Although the old city of Faro is located in a moderate seismic hazard region, the level of damage associated with an eventual moderate seismic event can be, as shown along the work herein presented, significantly high. The level of damage estimated for this urban area is an indicator of building's low resistance to seismic actions, due to several factors that are systematically observed in Portugal's building stock, the lack of primary maintenance and adequate retrofitting interventions, which subsequently lead to the progressive abandonment and demolition of those old masonry buildings

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
126	Towards Redundancy in Urban Landscapes: Enhancing Adaptive Capacity Through Design	Rob Roggema	2021	10.11648/j.urp.20210601.12	Redundancy, Urban Design, Climate Adaptation, Resilient Cities, Research by Design, Western Sydney	The aim of the research presented in this article is to detect design principles to enhance the adaptive capacity of cities. This is undertaken by investigating existing precedents in sustainable urban plans and neighborhoods and insert these abstracted design principles in the design for future urban projects	For this research the Third City is used as case study area. The way the research is carried out is through Research by Design, which 'generates critical inquiry through design work that may include realized projects, proposals, possible realities or alternatives' [16]. Design studios, as well as professional practice and design-led research projects are seen as methods belonging to Research by Design [17]. In this case, two studios in the Master of Architecture, taught in 2017, Research by Design was used to investigate the spatial potentials to include redundancy in urban designs. In an iterative process, design propositions were developed based on design inquiry of precedents, deriving spatial principles to design with and judge the potential outcomes on a set of criteria.	In this article the focus lies on creating redundancy in the urban design, which looks mainly at ecology, water and food systems, but less so at mobility. Mobility is a factor that determines the urban appearance heavily, as inhabitants experience their direct urban environment as participants in traffic, public transport and as users of active transport
127	Artificial intelligence assisted intelligent planning framework for environmental restoration of terrestrial ecosystems	Xinzhe Yin a Jinghua Li Seifedine Nimer Kadry Ivan Sanz-Prieto	2021	https://doi.org/10.1016/j.eiar.2020.106493	Environmental restoration Terrestrial ecosystems Artificial intelligence Biological retreat configuration Machine learning	land environment regeneration needs both environmental and socio-economic expertise to recognize the factors and processes for destruction and often examines strategies and approaches to preserve and regenerate the damaged environment. The final goal is to protect the infrastructure of the terrestrial environment and to ensure sustainable sustainability of the society and economy	The rest of this article is arranged in the following way. The related research activities are described in Section 2. In Section 3, Biological Retreat Configuration (BRC) using AI and machine learning has been defined. Section 4 provides real-time studies and an overview of the measure. Part 5 includes a description of the research and outlines potential analysis for the future	The present study uses the link between source and claim of EUS to define machine learning, minimal accumulated resistance models, and circuit theory to evaluate the three-dimensional magnitude of environmental streams, environmental pathways, and strategic points. The research findings offer fresh perspectives into the use of LCR methods for the production of BRC, particularly in urban areas.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
128	A novel hybrid artificial intelligence approach for flood susceptibility assessment	Kamran Chapi Vijay P. Singh Ataollah Shirzadi Himan Shahabi Dieu Tien Bui Binh Thai Pham Khabat Khosravi	2017	https://doi.org/10.1016/j.envsoft.2017.06.012	Flood susceptibility Bagging-LMT Bayesian logistic regression Logistic model tree Iran	This study therefore aims to propose a new hybrid intelligence model, based on bagging ensemble and logistic model tree, namely "Bagging-LMT" model, for flood susceptibility modeling and identifying areas prone to flooding with a case study of the Haraz watershed, northern Iran. The Logistic Model Tree (LMT) classifier is one of the recent machine learning methods and is a hybrid of Decision Tree (DT) classifier and Logistic Regression (LR) function. Bagging ensemble is an ensemble technique that can improve the accuracy of prediction of a base classifier.	The proposed model is evaluated using training and validation datasets, sensitivity, specificity, accuracy, Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and Area Under the Receiver Operating Characteristic (ROC) curve (AUROC). Additionally, the proposed model is compared with four state-of-the-art benchmark soft computing machine learning methods: logistic model tree (LMT), logistic regression (LR), Bayesian logistic regression (BLR), and random forest (RF).	The model proposed in this study is a new hybrid intelligent model (Bagging-LMT) for flood susceptibility mapping which is a combination of bagging ensemble technique and the logistic model tree classifier Ensemble technique. The model was applied to the Haraz watershed, the Mazandaran province, Iran. It was constructed using 141 (training datasets) and validated with 60 (validation datasets) flood locations and eleven conditioning factors, including slope angle, elevation, curvature, NDVI, stream power index (SPI), topographic wetness index (TWI), lithology, land use, rainfall, stream density and distance to stream. The information gain ratio (IGR) was used for identifying the most important conditioning factors for modeling using the training dataset. The prediction ability and degree-of-fit of the Bagging-LMT model were examined using precision, sensitivity, specificity, accuracy, Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Kappa and area under the receiver operating characteristic curve (AUROC) criteria.

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129	Utilizing Remote Sensing for Sponge City Development: Enhancing Flood Management and Urban Resilience in Karachi	Asifa Iqbal, Lubaina Soni, Ammad Waheed Qazi, Humaira Nazir	2025	https://doi.org/10.3390/rs17111818	Flood, Risk management, Sponge city	this research aims to assess the flood risk in Karachi, Pakistan, arising from fast urban growth and the environmental issues that come with it. By utilizing an SC framework and employing remote sensing and Geographic Information Systems (GIS) techniques, this study seeks to identify vulnerable areas to flooding and propose NBSs that will contribute to sustainable urban planning and climate adaptation.	The methodology of this study integrates remote sensing (RS), Geographic Information Systems (GIS), Multi-Criteria Decision Analysis (MCDA) using the Analytical Hierarchy Process (AHP), and hydrological modeling to assess flood risk and propose sponge city solutions in Karachi. 1. Data Collection and Preprocessing: Satellite imagery and digital elevation models (DEMs) were used to analyze land cover, elevation, slope, and drainage patterns. Data resolution and temporal relevance were considered to ensure accuracy. Identification of Flood-Conducive Factors: Factors such as elevation, slope, rainfall distribution, land use/land cover, drainage density, proximity to rivers, roads, and flood history were analyzed using GIS layers. Flood Risk Assessment Framework Development: The AHP was employed to assign weights to these factors based on expert judgment and literature. A pairwise comparison matrix was constructed, normalized, and validated for consistency (CR=0.0097). The weighted overlay of factors produced a comprehensive flood risk map identifying vulnerable areas.	The flood risk maps developed in the research identified areas in Karachi that are highly vulnerable to flooding, particularly in regions such as DHA, Korangi, and Gulistan-e-Jauhar. These zones are especially susceptible due to their topography and land use characteristics, making them prone to waterlogging during heavy rains.The study also pinpointed key factors influencing flood susceptibility, including low elevation, gentle slopes, intense rainfall, dense drainage networks, and increased impervious surfaces like roads and buildings. These elements collectively contribute to higher surface runoff and flood risk. Furthermore, the use of the Analytic Hierarchy Process (AHP) for multi-criteria analysis proved effective in producing a reliable flood risk map that aligns well with known flood-prone areas. This validates the methodology as a useful tool for spatial risk assessment. Based on these findings, targeted urban interventions are recommended, such as installing permeable pavements, green roofs, wetlands, and bioswales in high-risk zones. These nature-based solutions can enhance water absorption, reduce surface runoff, and mitigate flooding impacts.

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130	Collaborative and Sustainable Strategies Through Geodesign: The Case Study of Bacoli	Maria Somma, Michele Campagna, Tess Canfield, Maria Cerreta, Giuliano Poli, Carl Steinitz	2022	https://doi.org/10.1007/978-3-031-10545-6_15	Geodesign, decision-making process, spatial planning, collaborative design, port areas	The research aims to show and discuss the results of a geodesign workshop referring to the Municipality of Bacoli, in the South of Italy, nearby the City of Naples. The development strategies are described for the study area, which were pursued through a two day, iterative, online and in-person workshop that has involved different stakeholders. The geodesign workshop was supported by the online GIS-based platform Geodesignhub.com, allowing for geo-referenced analysis and design, and facilitating communication and negotiation among the stakeholders involved in the decision-making process.	The geodesign workshop for Bacoli was organised in November 2021 by the Second Level Master in "Sustainable Planning and Design of Port Areas" of the University of Naples Federico II. The workshop began with an introduction to the study area, the goals of development scenarios, and the presentation of ten evaluation maps developed by the coordination teams as a digital collective knowledge base from which to begin the design. The evaluation maps represent the landscape systems' spatial representation related to vegetation, hydrology, cultural and historical landscape resources, accessibility and transportation, commerce, tourist services, urban mix, and reclamation.	The proposed scenario for the city of Bacoli to 2030 fully reflects the three targets established in the preparatory phases. The diagram frequency (Fig. 9) has facilitated the comparison of the scenarios proposed by the two merged teams of stakeholders (TCM (Tourism, Culture, Metropolitan teams) and GDF (Green, Developers, Farmers team)). It allowed the similarities in design and policy to emerge with a straightforward negotiation process.

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131	Blueprint conceptualization for a river basin's digital twin	Debasish Pal; Hannu Marttila; Pertti Ala-Aho; Eliisa Lotsari; Anna-Kaisa Ronkanen; Carlos Gonzales-Inca; Danny Croghan; Marie Korppoo; Maria Kämäri; Erik van Rooijen; Linnea Blåfield; Jari Silander; Aziza Baubekova; Joy Bhattacharjee; Ali Torabi Haghighi; Cintia Bertacchi Uvo; Harri Kaartinen; Mehdi Rasti; Björn Klöve; Petteri Alho	2025	https://doi.org/10.2166/nh.2025.111	Data management, Decision-making, digital twin, hybrid modeling, river basin management	The aim of this research is to explore and propose a comprehensive blueprint for developing a digital twin of a river basin. It seeks to create a dynamic, virtual replica of river basin systems by integrating real-time monitoring, data analytics, predictive modeling, and advanced computational tools. The ultimate goal is to enhance river basin management by optimizing operational efficiency, identifying uncertainties, bridging knowledge gaps, and supporting decision-making processes; thereby enabling more sustainable and adaptive management of water resources in the face of environmental, social, and economic challenges.	The methodology for developing the river basin digital twin begins with its conceptualization as a dynamic, holistic virtual replica aimed at optimizing operational efficiency, identifying uncertainties, bridging knowledge gaps, and enhancing decision-making processes. It is built upon a six-dimensional structural framework that includes physical river basin features, backend infrastructure, data, modeling, services, and connectivity, forming the core architecture supporting its functionality and scalability. The implementation follows a three-phase progression; Unit, System, and System of Systems (SoS); each representing increasing levels of complexity and integration, designed to address different decision-making scales and types of uncertainties, from localized routine decisions to comprehensive, long-term planning that contends with social and political variables. During these phases, stakeholders define objectives aligned with long-term sustainability goals, decompose them into actionable tasks, and systematically monitor and calibrate models with real-time data, ensuring seamless data flow and interoperability. The approach emphasizes continuous validation and scenario analysis to handle inherent uncertainties using hybrid modeling techniques that combine physics-based, data-driven, and emerging models. Furthermore, attention is given to establishing governance frameworks, standardizing data protocols, and fostering stakeholder collaboration to ensure the digital twin's	The main outcome of this research is the development of a comprehensive framework and roadmap for the creation of a river basin digital twin. The study proposes a six-dimensional structural framework that forms the foundation for such a digital replica, encompassing physical systems, infrastructure, data, modeling, services, and connectivity. This framework facilitates the seamless integration and effective functioning of each component. In terms of implementation, the project introduces a three-phase progression model: Unit, System, and System of Systems (SoS). These stages ensure the digital twin can operate at different decision-making levels and manage various uncertainties. Consequently, solutions can be tailored to a wide range of management needs, from routine local decisions to large-scale regional planning. Additionally, a maturity spectrum has been outlined to illustrate the evolving capabilities of digital twins; from basic fact-based systems to autonomous, self-governing entities capable of proactive management. This spectrum provides a clear pathway for the development and enhancement of digital twin systems over time.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
							sustainability, adaptability, and effective integration into river basin management processes.	
132	The urban mine of the Netherlands: The material basis for a circular economy	Ester van der Voet, Janneke van Oorschot, Teun Verhagen, Lauran van Oers, Vincent van Straalen, Vivian Tunn, Kiki Kersten, Roel Delahaye	2025	https://doi.org/10.1111/jiec.70030	Circular economy, Industrial ecology, Materials, Urban mine	The aim of this study is to assess the potential and size of the urban mine in the Netherlands, which consists of materials contained within products and infrastructures currently in use. By conducting a comprehensive inventory across various application categories and materials, the study seeks to create a foundational database that can support the development of a circular economy. It aims to demonstrate the feasibility of standardizing the assessment of urban mines, thereby providing valuable insights into the scale of resources available for reuse and recycling. Ultimately, the study endeavors to show how leveraging the urban mine can serve as a strategic resource to reduce reliance on geological mining, mitigate environmental impacts, and facilitate sustainable development through improved resource management within society.	The methodology of this study involves a systematic approach to mapping the in-use stocks of materials within the Netherlands' urban environment. The researchers focused on nine major application sectors, deliberately excluding linear resource uses like food and packaging, which are less relevant to the urban mine concept. They gathered detailed data from various sources, including direct contacts with infrastructure managers such as electricity, gas, water, and transportation authorities, to obtain precise information on existing stocks. For applications like consumer products and industrial machinery, they relied on national statistical data, such as flow figures and estimated lifespans, to infer stock quantities. To determine the material composition, the researchers compiled material intensity data; amounts of specific materials per unit of application; drawing from literature, product databases, and specialized inventories like the Ecoinvent database. They then multiplied the volume of each application by its material content to estimate the total stock of different materials in the urban environment. This process resulted in a detailed database that captures both the scale and material makeup of the Dutch urban mine, forming the groundwork for analyzing resource potential and supporting circular economy strategies.	The study revealed that the total in-use materials within the Netherlands' urban environment amount to approximately 7.79 billion tons, equating to roughly 450 tons per inhabitant. The inventory highlighted that construction minerals, primarily sand and gravel, and construction materials such as concrete, constitute the largest stocks, predominantly stored in infrastructure like roads, waterways, and coastal defenses. The second largest stock is found in buildings, which contain a diverse range of materials including minerals, metals, and biobased materials. Data collection efforts showed significant variation and gaps, especially regarding the specific material composition of consumer products, which proved challenging due to their variability. The detailed database compiled from this research provides a comprehensive overview of the size, distribution, and material composition of the Dutch urban mine, emphasizing the potential of reused resources and the importance of further data refinement to support circular economy policies.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
133	Evaluating the effectiveness of circular economy initiatives in reducing urban waste and promoting sustainable development: A case study of Greece	Spinthiropoulos Konstantinos Stavros Kalogiannidis Fotios Chatzitheodoridis Dimitrios Kalfas Ioanna Parri	2025	https://10.31893/multirev.2025316	circular economy waste management in urban areas material recovery facilities (MRFs) waste generation industrial symbiosis sustainable development	The primary aim of this study is to evaluate the effectiveness of circular economy initiatives in reducing urban waste and fostering sustainable development in Greece. Specifically, it focuses on assessing four key areas: material recovery facilities (MRFs), product-as-a-service (PaaS) business models, industrial symbiosis (IS), and extended producer responsibility (EPR) policies. By examining these interventions, the study seeks to determine their roles in diverting waste from landfills, improving resource efficiency, and supporting sustainable industrial practices within Greek cities. Ultimately, the research aims to identify best practices, address main challenges, and provide actionable recommendations for policymakers and industry stakeholders to enhance waste management strategies and promote economic and environmental sustainability in the region.	The study employed a cross-sectional, quantitative research methodology to evaluate circular economy interventions in Greece. Data was collected through structured questionnaires distributed to a sample of 175 environmentalists and urban planners using a stratified sampling approach to ensure representativeness. The questionnaires incorporated both closed and open-ended questions, allowing participants to rate the effectiveness of initiatives such as material recovery facilities (MRFs), product-as-a-service (PaaS) models, industrial symbiosis, and extended producer responsibility (EPR) policies, primarily using Likert scales. The data collected were analyzed using descriptive statistics, Pearson's correlation, and multiple regression analyses to assess the relationships between interventions and waste management outcomes. Key indicators such as waste reduction percentages, resource utilization, and policy feasibility were evaluated, with the data processed through the Statistical Package for Social Science (SPSS).	he results indicate that circular economy initiatives in Greece have been largely effective in improving urban waste management and promoting sustainable development. Material recovery facilities (MRFs) were regarded as highly effective by a significant portion of respondents, with 41.7% considering them very effective in reducing landfill waste and enhancing recycling processes. Support for product-as-a-service (PaaS) models was also strong, with 42.9% of participants expressing high confidence in their ability to improve resource efficiency and minimize waste. Industrial symbiosis received favorable perceptions, with 48.0% deeming it highly beneficial, highlighting its role in fostering collaboration between industries to optimize resource use. Additionally, EPR policies were viewed as impactful, with 38.9% believing they significantly improved waste management through producer accountability. Regression analysis demonstrated that these four interventions collectively explained about 90.1% of the variance in waste management outcomes, confirming their significant positive influence.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
134	Experimenting urban living lab methodology on circular economy co-design activities in some Italian urban territories	Carolina Innella, Grazia Barberio, Claudia Brunori, Francesca Cappellaro, Anna Rita Ceddia, Rocco Civita , Salvatore Dimatteo, Marco Ferraris, Rocco Pentassuglia & Luigi Sciubba	2024	https://doi.org/10.3389/frsc.2024.1406834	Urban Living Lab, Circular Economy, Co-design, Community Participation	The aim of this study is to describe and assess the application of a specific ULL (Urban Living Lab) methodological framework designed to enhance stakeholder engagement and facilitate the co-design of circular economy (CE) projects at the urban level. Through the implementation of this approach in four distinct Italian urban territories; Anguillara Sabazia, Bologna, Taranto, and Venosa; the research seeks to demonstrate the effectiveness of the ULL methodology in fostering collaborative processes that lead to the generation of viable CE project proposals tailored to each local context. Additionally, the study aims to highlight how this methodological framework can stimulate cultural capital, strengthen community ties, and increase collective awareness regarding sustainable urban development, ultimately supporting the transition toward a circular economy in diverse territorial settings.	The methodology employed in this study is based on a structured ULL (Urban Living Lab) framework that consists of four main phases: scouting and territorial analysis, listening and exploration, participation, and execution. The process begins with a thorough assessment of the territorial context and stakeholder mapping to understand the local landscape and identify key actors. This is followed by the listening and exploration phase, where surveys and data collection activities are conducted to gauge stakeholder needs and perspectives on circular economy topics. In the participation phase, interactive meetings and workshops involve local citizens, associations, and institutions to co-design CE ideas and project proposals. Finally, the execution phase focuses on implementing these co-developed projects through active collaboration among stakeholders, with an emphasis on fostering engagement, building relationships, and translating ideas into tangible initiatives. Across four diverse Italian urban contexts, this flexible yet systematic approach proved effective in activating community participation, generating innovative CE solutions, and adapting to different socio-economic and geographical characteristics.	n Anguillara Sabazia, Bologna, Taranto, and Venosa, the process successfully mapped critical issues, identified stakeholders' needs, and facilitated collaborative development of proposals such as repair laboratories, waste management initiatives, sustainable tourism strategies, and food redistribution programs. The participatory approach led to increased community involvement, strengthened partnerships among public administration, private entities, and civil society, and generated concrete project ideas aligned with local priorities. Overall, the outcomes demonstrate that the methodology effectively activated participatory processes, promoted collective awareness, and produced promising solutions capable of supporting urban transitions toward sustainability and circularity in diverse territorial contexts.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
135	A Digital Urban Twin Enabling Interactive Pollution Predictions and Enhanced Planning	Dennis Teutscher, Fedor Bukreeva, Adrian Kummerlander, Stephan Simonisa, Peter Bachler, Ashkan Rezaee, Mariusz Hermansdorfer, Mathias J. Krause	2025	https://doi.org/10.1016/j.buildenv.2025.113093	digital twin, computational fluid dynamics, lattice Boltzmann method, urban, pollution, particulate matter, porous media, OpenStreetMap	Digital twin (DT) technology is increasingly used in urban planning, leveraging real-time data integration for environmental monitoring. This paper presents an urban-focused DT that combines computational fluid dynamics simulations with live meteorological data to analyze pollution dispersion. Addressing the health impacts of pollutants like particulate matter and nitrogen dioxide, the DT provides real-time updates on air quality, wind speed, and direction.	Using OpenStreetMap's XML-based data, the model distinguishes between porous elements like trees and solid structures, enhancing urban flow analysis. The framework employs the lattice Boltzmann method (LBM) within the open-source software OpenLB to simulate pollution transport. Nitrogen dioxide and particulate matter concentrations are estimated based on traffic and building emissions, enabling hot-spot identification. The DT was used from November 7 to 23, 2024, with hourly updates, capturing pollution trends influenced by wind patterns.	he results demonstrate that the proposed digital twin effectively captures urban airflow and pollution dispersion dynamics, with simulations showing strong agreement with experimental wind tunnel data. The model successfully reflects how wind patterns influence pollutant distribution, highlighting the formation of hot-spots in areas with reduced ventilation, such as street canyons and stagnation zones. During the analyzed period from November 7 to November 13, 2024, changes in wind direction significantly altered pollution hotspots, confirming the strong correlation between meteorological conditions and pollutant concentration patterns. The integration of real-time meteorological data allowed for dynamic updates of airflow and pollution levels, providing insights into transient pollution phenomena. Moreover, incorporating detailed urban geometry from OpenStreetMap, including porous elements like trees, improved the accuracy of pollutant transport modeling, especially in representing how vegetation impacts airflow and pollutant dispersion. Overall, the results affirm the potential of this digital twin framework to support real-time air quality monitoring, urban planning, and mitigation strategies tailored to evolving environmental conditions.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
136	A geodesign decision support environment for integrating management of resource flows in spatial planning	Gustavo Arciniegas , Rusné Šileryté, Marcin Dąbrowski , Alexander Wandl, Balázs Dukai , Max Bohnet & Jens-Martin Gutsche	2019	https://doi.org/10.17645/up.v4i3.2173	Amsterdam; circular economy; decision support tools; geodesign; recycling; urban living labs; waste management	This article argues that collaboration between actors within an iterative geodesign process with feedback loops plays a central role alongside innovation and the implementation of new technology, which can be facilitated through a living lab approach. The integration between geodesign, the living lab approach, GIS, MFA and LCA into a single support environment allows for the following innovations: (1) MFA in a geographical context: via a new method of Activity-Based Spatial Material Flow Analysis (AS-MFA; Resource Management in Peri-Urban Areas [REPAiR], 2017) by geo-locating activities and actors involved in resource flows; (2) Visualization of resource flows: via AS-MFA data analysis and visualization tools in order to gain insights into the current status quo at early stages of the solution creation process rather than only at the stage of evaluation; (3) Simulation of proposed changes: applying the solutions as simulations of changes in the overall mapped resource flow network; (4) LCA for impact assessment: using the AS-MFA data to describe the LCA baseline scenario and the simulated resource flow network of proposed strategies.	To address the question of whether and how geodesign can be used to improve waste and resource management, this article proposes a geodesign-based tool for supporting a collaborative process of developing decision-making on strategies for a given territory with close stakeholder involvement. In addition, the GDSE integrates spatial data on material flows and related actors, which are presented in a visual and accessible way and ensures a sound and accessible evidence base in the participatory process. ecoinnovative strategies to advance CE in peri-urban areas. Geodesign can provide a helpful framework for improving waste and resource. management, which is evident by the observations and outcomes of the PULL workshops, and the positive reactions of the participants in the surveys. In fact, geodesign allows for a structured and comprehensive organization of the process and diagnosis of challenges, design and selection of solutions, and decision-making on strategies for a given territory with close stakeholder involvement. In addition, the GDSE integrates spatial data on material flows and related actors, which are presented in a visual and accessible way and ensures a sound and accessible evidence base in the participatory process.	

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
137	A GIS-based approach for estimating community transportation exposure and capacity in the context of disaster resilience	Firas Gerges, Hani Nassif, Thomas Herrington , Michel C. Boufadel	2022	https://doi.org/10.1016/j.horiz.2022.100030	Resilience, Transportation infrastructure, Climate change, Mobility, Connectivity	Enhancing the resilience of transportation infrastructure is vital for reliable and sustainable functionalities, and subsequently, to more resilient communities. There are indices and frameworks that assess and evaluate transportation resilience and performance, ranging from component-based, to network and system metrics. The existing approaches, however, usually overlook location and capacity of critical transportation components. These two characteristics possess significant effects on the resilience and performance of the transportation sector. Moreover, the stress type and its magnitude should be incorporated in the resilience assessment. In this work, we leverage a recent resilience quantification framework to compute the Exposure and Capacity-based Transportation Resilience Index (EC-TRI), describing the resilience of the transportation infrastructure, focusing on the location and capacity of certain assets.	They aim to evaluate an absolute index that describes the resiliencelevel of the transportation infrastructure within a community. We buildsuch index upon certain transportation characteristics that are criti-cal during disasters. In this context, we regard resilience as the de-gree to which a system can prepare for, respond to, and recover fol-lowing a disaster (Gerges et al., 2022). We follow the methodology ofGerges et al. (2022) to evaluate our resilience index as a percentage,illustrating how resilient is the transportation infrastructure in a certainlocation (community). Following such methodology, we introduce a per-fect score for each attribute used in the quantification, that describes thevalue of said attribute, in a best-case scenario, allowing the normaliza-tion of attribute values to percentages. Perfect score depicts “good” val-ues relative to the local priorities and strategies, and not necessarily themaximum possible values. An attribute with a value greater or equalsto its perfect score is assigned the value 100%. Moreover, resilience de-pends on the type and level of the stress, the community into consid-erations, and the priorities of local practitioners and decision makers.Subsequently, we provide EC-TRI as a dynamic tool to practitioners,providing a room to adjust multiple variables that could be relative tocommunities.	They argue for the adoption of this index as a complement to existing frameworks, and we develop a web-based GIS framework to evaluate EC-TRI for communities within New Jersey (NJ). The novelty of EC-TRI lies in its consideration for the stress level, the exposure and capacity characteristics of transportation assets, as well as in its practicality and scalability. Users can leverage EC-TRI to locate the weak and vulnerable components within the transportation network, and to provide a community-based assessment of the resilience level of the transportation infrastructure. In addition, they provide EC-TRI as a highly scalable GIS framework, providing users with the ability to adjust the quantification components as per local needs and priorities.

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138	A NEW MODEL IN DISASTER MANAGEMENT: TURKISH NATIONAL RISK SHIELD MODEL	Tuğrul Çamaş & A. Menaf Turan	2023	https://webdosya.csb.gov.tr/db/cis/csidergisi/csidergisi4/files/basic-html/page253.html	Disaster Management, Ministry of Environment, Urbanization and Climate Change, February 6 Kahramanmaraş Earthquakes, Turkish National Risk Shield Model	The aim of this article is to evaluate the Turkish National Risk Shield Model, which was developed as a new model in disaster management, with all its aspects.	After the February 6 earthquakes, a new one was added to these searches and the Turkish National Risk Shield Model, consisting of 13 boards, was put into practice. With the model that determines fighting not only earthquakes but all disasters as the main purpose, studies are carried out on the recovery of 11 provinces affected by the earthquake, on the one hand, suggestions and measures to be implemented throughout Turkey are developed on the other hand. In the study, the model in question was examined in detail.	The Turkish National Risk Shield Model is considered as a model that contributes to Turkey's fight against disasters as a participatory and inclusive model, since it includes innovative, scientific and stakeholder views.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
139	A Parametric BIM Framework to Conceptual Structural Design for Assessing the Embodied Environmental Impact	Kitti Ajtayné Károlyfi & János Szép	2023	https://doi.org/10.3390/su151511990	parametric design; building information modeling (BIM); conceptual design; structural approximation; embodied environmental impact	This study aims to develop a method that allows the efficient generation and evaluation of structural design alternatives in the conceptual design phase from a sustainability point of view. To achieve this, a steel frame structure was created as a case study using Rhinoceros 3D and Grasshopper. The model consists of load-bearing structures, secondary structural elements, and façade elements. Structural design approximations were embodied in the model as rules to define the cross section of the frame according to the span. The appropriateness of the structural dimensions was checked with the help of the Grasshopper–ConSteel live connection using the Pangolin plug-in. The embodied environmental impact of 48 different geometries was then investigated based on the database of ÖKOBAUDAT [10]. Although the entire geometry is parametric, the examined variables were the span, the number of frames, and the distance between the frames. This study focuses on the embodied environmental impact; therefore, the product stage (A1–A3 module) of the lifecycle was considered on seven environmental impact categories, i.e., global warming potential (GWP), photochemical ozone creation potential (POCP), ozone depletion potential (ODP), acidification potential (AP), eutrophication potential (EP), abiotic depletion potential for non-fossil resources (ADPE), and abiotic depletion potential for fossil resources (ADPF).	Rhinoceros and Grasshopper were used to develop the parametric script, which includes the generation of geometrical variations, the automatic definition of initial cross sections for the load-bearing elements based on in-built structural design approximations, the datasets for embodied environmental impact of the used building materials, the generation of life cycle inventory (LCI), the automatic calculation of life cycle assessment (LCA) results based on the geometry, and the conversion of the parametric model into building information model.	The method was demonstrated using a case study of 48 different alternative solutions for an unheated warehouse made of steel frames. Based on the results, the areas with the greatest energy impact were identified. The case study analysis also illustrated that the applied cross section may have a significant effect on the impact categories. The results draw attention to the complexity of LCA calculations even in the case of a simple structure containing a limited number of variables, where parametric design can serve as an effective tool for a comprehensive environmental impact assessment.

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140	A Participatory Planning Framework using Urban Digital Twins Supporting the Co-Creation of Flexible, Positive Energy Districts	Ernst Gebetsroither-Geringer, Rushikesh Padsala, Ali Hainoun, Giorgio Agugiaro, Stanislaw Biernat, Amando Reber, Barbara Smetschka, Weixiao Gao, Daniel Horak, Basak Falay,Volker Coors	2025	https://archive.corp.at/cdrom2025/papers2025/CORP2025_115.pdf	Citizens Participation, Modelling and Simulation, Urban planning, Positive Energy Districts, Digital Twin	The urban socio-ecological transformation requires pathways for an urban energy transition, including the establishment of Positive Energy Districts (PEDs). Technical solutions and simulation tools for urban energy systems are needed for the planning, management and implementation of PEDs. In addition, the involvement of all societal stakeholders is needed to achieve the EU's ambitious target of 100 PEDs by 2025. 1 To this end, innovative research, information and communication strategies must be developed.The transnational funded research project DigiTwins4PEDs 2 focuses on developing an Urban Digital Twin as a dynamic digital representation of urban energy systems using advanced modelling tools.	The transnational project applies innovative methods and develops implementation strategies supported by a participatory process involving key stakeholders and citizens in co-design, co-creation and co-learning stages of research. Through the framework of living labs in four different case studies, citizens are continuously engaged throughout the project so that citizen-driven actions towards Positive Energy Districts can be considered and implemented more efficiently. New tools and methods are developed and adapted using Urban Digital Twins based on the CityGML data format to enhance public participation in advancing clean energy transition. These toolsenable citizens to actively engage in shaping the future energy transition of their communities and thus supporting informed decision-making. The developed and implemented urban digital twin framework is tested in different urban case study areas (Vienna, Stuttgart, Rotterdam, Wroclaw)within an innovative public participatory process to address the multifaceted aspects crucial for establishing PEDs together with the citizens.	The research project DigiTwins4PEDs develops an urban digital twin framework tested in different urban case study areas (Vienna, Stuttgart, Rotterdam, Wroclaw). Based on the 3D CityGML data format, the UDT integrates two urban energy simulation tools SimStadt and MAPED. To have a structured and standardised way of data sharing amongst the two simulation models, Energy ADE implemented in 3DCityDB PostgresSQL is used. The developed platform can be used in participatory processes to address the multifaceted aspects crucial for establishing PEDs together with the citizens.The concept and first prototypepresented above already show the potentials,e.g. how it can be used to explore behaviour stories for realizing the energy system transition, to change e.g. from pure energy consumer to become a prosumer. The first experiences also show that the UDT needs a facilitator (operator) to maximise its potential. Furthermore, that it is essential to integrate it in already existing citizens' engagement tools (platforms like Wien mitgestalten8) to be successful and accepted by the citizens and urban administration. Combining different Energy System Simulation tools, capable of simulating from the building level up to the district, enables us to show the broader picture for the district as well as give citizens (tenants and building owners) andpublic authorities the information to support their decisions and develop jointly sustainable scenarios for the future.The project sofar developed the Energy ADE 2.0, which is one of

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								the major outputs of the projectneeded to enable this from a technical perspective.During the next phase of the projectwe will further improve the concept and test the prototype applied in the planned interventions in the four involved case study. The developed data-workflows in the different cities necessary to prepare the input data for the simulation tools are essential to learn how the framework can be used in other cities with their available data.For the stakeholders involved from the cities,this isan important aspect to keep the effort at minimum, whenever the UDT framework should be transferred after the project.

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141	A Procedural Modeling Approach for Ecosystem Services and Geodesign Visualization in Old Town Pocatello, Idaho	Xingyue Yang & Donna Delparte	2022	https://doi.org/10.3390/land11081228	geodesign; procedural 3D modeling; ecosystem services; urban design; impervious surfaces; GIS; visualization	This paper demonstrates a complete workflow for generating a rule-based 3D city model in Old Town Pocatello, Idaho, USA and provides city planners and stakeholders with the tools to visualize and interact with planning scenarios on multiple platforms. We created a 3D procedural model with landscapes and streetscapes for the Old Town section of a mid-sized city in the western United States (Pocatello, Idaho) using CityEngine software. This city model was integrated into a gaming engine (Unity) to create an interactive 3D application where users can visualize and interact in Old Town Pocatello by virtually driving a car with a joystick on Android devices and walk around with a mouse and keyboard with the HTC Vive system. Additionally, we proposed a green scenario and analyzed the valuation and trade-offs of ES based on increasing green spaces and reducing impervious layers in Old Town that were scripted to allow users to visualize and assess the valuation impact between before and after simulations.	he methodology for developing the procedural modeling approach in Old Town Pocatello involved a comprehensive workflow integrating data preparation, 3D city model generation, and visualization. Initially, geospatial GIS layers; including green spaces, parking lots, railyards, building footprints, sidewalks, and impervious surfaces; were digitized based on high-resolution NAIP imagery using ArcGIS Pro. Attribute tables were populated with relevant information such as area types, sizes, and classifications of parking lots and green spaces. Elevation data for buildings and trees were extracted from LiDAR-derived Digital Surface Models (DSM) and Digital Elevation Models (DEM), with height calculations obtained through surface change models. These datasets were verified and corrected through quality assurance processes. Subsequently, the prepared vector and raster data were imported into CityEngine, where a procedural modeling approach utilizing grammar-based rules (CGA rules) was employed to automatically generate detailed 3D cityscape models efficiently, enabling rapid scenario development. Finally, the models were integrated into Unity, a gaming engine, to create interactive visualization applications compatible across multiple platforms, facilitating real-time urban planning simulations and assessment of ecosystem service impacts. This integrated workflow leverages GIS, procedural modeling, and interactive visualization to	The study's findings demonstrate that the procedural modeling approach effectively creates detailed and accurate 3D cityscape models that aid urban planning and visualization. The workflow allowed for rapid generation of models with detailed land cover, building, and green space data, enabling realistic visualization of present and proposed urban scenarios in Old Town Pocatello. The models facilitated the assessment of ecosystem services by illustrating spatial distributions of impervious surfaces, green spaces, and other land uses. This approach supports city planners and stakeholders in exploring the impacts of different development scenarios on ecosystem functions and urban sustainability. Additionally, integrating these models into interactive platforms like Unity enhanced engagement, allowing users to visualize and evaluate urban changes in real time. Overall, the method proved to be a cost-effective, scalable, and versatile tool that advances sustainable urban planning through detailed visualization of physical features and ecosystem service considerations.

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							support sustainable urban development planning.	
142	Climate Resilience of Coastal Cities Using Geographic Information Systems (GIS)	Mikhail Lunyakov, Hassan Mohamed Ali, Yerragudipadu Subbarayudu, Sukhman Ghumman, Manbir Singh Bisht, Aman Mittal, Rajeev Sharma, Deepak Kumar Tiwari, Bh. Prashanthi	2024	https://doi.org/10.1051/e3sconf/202458101014	Climate resilience, Coastal cities, GIS, Sea level rise, Flooding, Adaptation, Urban planning, Vulnerability assessment	To analyze climate resilience and vulnerability of coastal cities to sea-level rise and flooding using GIS, and to propose adaptation strategies.	Data collected includes climate projections from NASA/IPCC, urban infrastructure (OpenStreetMap, municipal data), socio-economic indicators (census, World Bank), elevation, and hydrological data (USGS, national surveys). Vulnerability assessment performed via GIS multi-criteria analysis combining hazard and socio-economic layers. Flood simulations under multiple sea-level rise scenarios (0.5m, 1m, 1.5m). Adaptation scenarios tested with GIS modeling (zoning reforms, flood defenses, nature-based solutions). Tools include ArcGIS, QGIS, Python with GeoPandas and Pandas for spatial and statistical analyses.	Miami projected to have 15% urban flooding at 1m sea-level rise, low-income neighborhoods most vulnerable. Mumbai faces >30% flooding at 1.5m rise, especially in slums. Manila faces >25% flood risk at 1m rise, disproportionately affecting informal settlements. Adaptation measures like zoning reforms reduce exposure; flood defenses can cut flood areas by up to 50%; mangrove/wetland restoration reduces impacts by 30%. Socio-economic resilience is lowest in informal settlements due to limited resources. Targeted interventions like improving drainage and climate-resilient housing recommended.

143	Green Re-vision: A Framework For The Resilient Cities Project	Hakan Alphan, Çiğdem Coşkun Hepcan, Süha Berberoğlu, Ahmet Çilek, Yüksel Ünlükaplan	2019	https://direnclikent2019.izmir.bel.tr/YuklenenDosyalar/Dokumanlar/AFRAMEWORKFORRESILIENTCITIESTOCLIMATECHANGEGREENREVISIONGUIDEBOOK.pdf	Climate Model, Land Cover/Land Use Change, Ecosystem Services, Urban Green Infrastructure System	The aim of the project "Green Re-vision: A Framework of The Resilient Cities" is to create a resilient urban area in a context of climate change by using, enhancing and supporting the potential of green infrastructure. We plan to reach this overarching goal through three specific objectives and the consequent results: a) to develop a framework that makes the city more resilient to the impacts of climate change, b) to increase the technical capacity to enhance the capacity building of target groups and shareholders on climate change action and c) to increase public awareness on climate change by disseminating knowledge and experience.	The project employed an interdisciplinary methodology combining climate modeling, geospatial analysis, ecosystem service quantification, and participatory planning tools to assess and enhance urban climate resilience through nature-based solutions. 1. Climate Modeling and Scenario Analysis Regional climate projections were developed using downscaled outputs from global circulation models, particularly under the IPCC's CMIP5 framework, utilizing RCP 4.5 and RCP 8.5 scenarios. These projections provided long-term estimations (2050–2100) for key climate variables such as temperature, precipitation, and soil moisture, enabling a localized understanding of future climate risks in İzmir. 2. Geographic Information Systems (GIS) and Remote Sensing GIS-based spatial analysis and remote sensing techniques were used to map existing green infrastructure and assess land use/land cover (LULC) dynamics. Vegetation indices such as the Normalized Difference Vegetation Index (NDVI) were employed to evaluate vegetation health and spatial distribution. High-resolution satellite imagery supported the delineation and connectivity analysis of green spaces within the urban fabric. 3. Ecosystem Services Assessment Service values were estimated using spatially explicit ecological models and standardized coefficients based on land cover typologies and vegetation density. Quantitative	Within the context of the project, the climate model was formed for the moderately optimistic and the most pessimistic climate scenarios for the period between the years 2050 and 2100 in İzmir. The ranges of the variables average temperature, total precipitation, evaporation, average soil moisture, average wind velocity and radiation were mapped. Besides in Balçova, chosen as the pilot area, the changes that occured on the land cover between the years 1955-2015 and 2015-2017 were mapped, a land cover/ land use exchange model was prepared and urban green infrastructure system was mapped. In the pilot area Balçova district, the run-off retention, carbon sequestration and air purification ecosystem services were calculated.The project outputs were presented to the public at an international conference titled 'Adapting to Climate Change: Green-Focused Adaptation for Resilient Cities.'

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							assessment of ecosystem services was conducted to evaluate the performance of green infrastructure in providing key regulatory functions, including: Carbon sequestration Stormwater retention capacity Air pollution removal 4. Vulnerability and Risk Mapping Spatial vulnerability mapping was carried out by integrating climatic, topographic, land use, and socio-demographic variables. This allowed for the identification of climate-sensitive areas, particularly in terms of heat stress and flood risk, with Balçova district serving as the pilot area. 5. Stakeholder Engagement and Participatory Methods Workshops, stakeholder consultations, and expert training sessions were organized to incorporate local knowledge, facilitate cross-sectoral dialogue, and ensure the applicability of proposed strategies. Participatory methods enhanced the legitimacy and contextual relevance of adaptation recommendations. 6. Development of a Practice-Oriented Adaptation Guide Findings from the above methods were synthesized into a comprehensive adaptation guide. The guide includes spatial strategies, design principles, and policy recommendations aimed at mainstreaming nature-based solutions into urban planning and climate adaptation efforts.	

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144	Central City Recovery Plan	Canterbury Earthquake Recovery Authority	2012	https://ccc.govt.nz/assets/Documents/The-Council/Plans-Strategies-Policies-Bylaws/Plans/central-city/christchurch-central-recovery-plan-march-2014.PDF	Post-Disaster Reconstruction, Earthquake Management, Urban Planning, Resilient Cities, Infrastructure Restoration, Green Spaces	The objective of the Central City Recovery Plan is to facilitate the rapid, effective, and sustainable reconstruction of Christchurch's central business district following the 2011 earthquakes. The plan aims to enhance urban resilience, strengthen infrastructure, revitalize economic and social activities, and create a safe, livable, and environmentally sustainable city center that meets community needs. Additionally, it seeks to reduce disaster risks and improve the city center's capacity to withstand future hazards.	The Central City Recovery Plan employed a multi-phase, integrated approach to guide the reconstruction and revitalization of Christchurch's central business district following the 2011 earthquakes. 1.Damage Assessment and Data Collection: Comprehensive analysis of physical and social damages was conducted, including assessments of infrastructure, buildings, transportation networks, and public spaces, supported by detailed data compilation. 2.Community and Stakeholder Engagement: Extensive consultations with local residents, businesses, public agencies, and other stakeholders were undertaken to identify needs and priorities, fostering community ownership through participatory planning. 3.Integrated Urban Design and Planning: A holistic urban renewal plan was developed, integrating infrastructure repair, new construction, creation of green spaces, and enhancement of transportation networks. 4.Sustainability and Resilience Principles: The plan incorporated resilient building standards, environmental sustainability criteria, and social inclusivity as core guiding principles. 5.Implementation and Monitoring: Following the planning phase, implementation commenced with ongoing progress monitoring and adaptive management to ensure objectives were met effectively.	The Central City Recovery Plan successfully guided the reconstruction and revitalization of Christchurch's central business district after the 2011 earthquakes. Key infrastructure, including transportation networks, utilities, and public spaces, was restored and modernized, improving overall urban functionality. The integration of resilient design principles enhanced the city's ability to withstand future seismic events and other hazards. Community engagement processes fostered strong local ownership and social cohesion, contributing to a vibrant and inclusive urban environment. Economic activities in the city center have gradually recovered, supported by improved accessibility and revitalized commercial zones. The plan's emphasis on sustainability and green spaces has led to enhanced environmental quality and livability. Overall, the plan serves as a model for effective post-disaster urban recovery that balances infrastructural, social, economic, and environmental objectives.

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145	Flood Risk Management Plans (FRMPs)	2010	https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX%3A52019SC0059	Flood Risk Management, Flood Prevention, Flood Risk Assessment, Flood Mapping, Early Warning Systems, Floodplain Management, Climate Change Adaptation, Sustainable Water Management, Emergency Response Planning	Developed under EU Floods Directive; map flood hazards, identify priority zones, propose structural and non-structural flood risk measures; stakeholder engagement; linked to River Basin Management Plans; guide investments and EU fund allocation.	The development and implementation of Flood Risk Management Plans (FRMPs) follow a systematic and multidisciplinary approach comprising several key steps: 1.Data Collection and Analysis: Comprehensive gathering of hydrological and meteorological data, including precipitation, river discharge, and water levels. Historical flood events are reviewed alongside land use, topography, population distribution, and infrastructure information to inform risk assessments. 2.Flood Hazard and Risk Mapping: Identification and spatial delineation of flood-prone areas using hydrological and hydraulic modeling techniques. Different flood scenarios are simulated to produce hazard maps, which are then overlaid with vulnerability data to assess flood risk. 3. Risk Assessment: Evaluation of potential impacts on human health, property, economic activities, and ecosystems. This step integrates social, economic, and environmental dimensions to prioritize areas and populations at risk. 4.Planning of Prevention and Mitigation Measures: Formulation of structural measures (e.g., levees, dams, pumping stations) and non-structural measures (e.g., green infrastructure, floodplain restoration, land-use planning). Early warning systems and emergency preparedness plans are developed to enhance resilience. 5.Stakeholder Engagement: Inclusive participation of local authorities, public agencies, communities, and	The implementation of Flood Risk Management Plans (FRMPs) has resulted in considerable advancements in mitigating flood risks and enhancing community resilience. Through precise flood hazard mapping, vulnerable areas have been accurately identified, allowing for more effective allocation of resources and targeted interventions. Structural measures, including levees, retention basins, and upgraded drainage systems, have significantly reduced damage to infrastructure and properties. Additionally, the integration of advanced monitoring and early warning systems has improved preparedness by providing timely alerts, thereby facilitating quicker emergency responses and evacuation procedures. The active engagement of stakeholders; including local authorities, communities, and private sectors; has fostered greater awareness and cooperation, which are critical for successful implementation. Furthermore, the adaptive management approach, involving regular reviews and updates of the plans to incorporate new data and climate change projections, has ensured their ongoing relevance and effectiveness. Collectively, these outcomes demonstrate that FRMPs serve as a vital framework for sustainable flood risk governance, balancing technical, environmental, and social dimensions.

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							private sector stakeholders to ensure transparency, local knowledge integration, and effective plan implementation. 6.Implementation, Monitoring, and Review: Execution of the planned measures followed by continuous monitoring and evaluation of their effectiveness. FRMPs are periodically updated to reflect new data, changing environmental conditions, and emerging risks.	

146	Strategy for Protection Against Negative Impacts of Floods and Erosion Using Nature-Based Measures	2016	https://www.vuv.cz/en/strategy-for-protection-against-negative-effects-of-floods/about-the-project/	Nature-Based Solutions, Flood Protection, Erosion Control, Ecosystem Restoration, Wetland Restoration, Green Infrastructure, Climate Change Adaptation, Sustainable Flood Management, Environmental Sustainability, River Rehabilitation, Flood Risk Reduction	Focus on ecosystem-based solutions: wetland restoration, reforestation, reconnecting rivers with floodplains; addresses soil erosion; emphasizes multi-sector cooperation; supports EU green infrastructure and biodiversity goals; influences funding priorities.	The strategy employs a multidisciplinary approach centered on the application of nature-based solutions to reduce flood and erosion risks. The methodology includes: 1.Assessment of Flood and Erosion Risks: Collection and analysis of hydrological, geomorphological, and ecological data to identify vulnerable areas prone to flooding and soil erosion. 2.Identification and Prioritization of Nature-Based Measures: Selection of suitable interventions such as wetland restoration, reforestation, riparian buffer zones, and green infrastructure based on site-specific conditions and potential effectiveness. 3.Stakeholder Engagement and Collaboration: Involvement of local communities, governmental agencies, environmental organizations, and experts to ensure participatory planning and knowledge integration. 4.Implementation Planning: Development of detailed action plans outlining the design, construction, and maintenance of nature-based interventions alongside complementary traditional engineering works where necessary. 5.Monitoring and Evaluation: Establishment of monitoring programs to assess ecological, hydrological, and socio-economic outcomes, allowing adaptive management and iterative improvements. 6.Integration with Climate Change Adaptation Strategies: Incorporation of climate projections and resilience-building measures to	The implementation of nature-based measures outlined in the 2016 strategy has demonstrated significant benefits in mitigating flood and erosion risks. Restoration of wetlands and riparian zones has improved natural water retention capacities, reducing peak flood flows and slowing surface runoff. Green infrastructure projects have enhanced soil stabilization, thereby decreasing erosion rates in vulnerable catchments. Stakeholder engagement initiatives have fostered greater community awareness and participation, leading to more effective and locally supported interventions. Monitoring data indicate improvements in biodiversity and ecosystem services, contributing to both environmental health and socio-economic resilience. Additionally, integrating these measures within climate adaptation frameworks has strengthened the long-term sustainability of flood and erosion management efforts. Overall, the strategy has provided a cost-effective and environmentally sustainable alternative to conventional engineering approaches, aligning with broader goals of ecological restoration and climate resilience.

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							ensure long-term effectiveness and sustainability.	

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147	Strategy on Adaptation to Climate Change in the Czech Republic	Ministry of the Environment of the Czech Republic	2015	https://www.preventionweb.net/files/58333_oeokadaptationstrategy20171003.pdf	Adaptation to climate change, Nature-based solutions, Flood management, Drought management, Ecosystem-based adaptation, Sustainable land use, Water resources management, Biodiversity, Environmental sustainability	National long-term approach addressing climate impacts including floods; identifies vulnerable sectors; promotes flood forecasting, sustainable urban drainage, natural retention, intersectoral cooperation; updated with latest science and international commitments.	The Strategy on Adaptation to Climate Change in the Czech Republic is based on an interdisciplinary and evidence-driven approach. It was developed through a combination of national vulnerability assessments, climate impact analyses, and stakeholder engagement processes. The methodology consists of the following key components: 1.Climate Impact and Vulnerability Assessment: Comprehensive analysis of climate-related risks; such as floods, droughts, heatwaves, erosion, and biodiversity loss; was conducted using meteorological, hydrological, and ecological data to identify vulnerable regions and sectors. 2.Sectoral Risk Analysis: The strategy includes detailed assessments of climate change impacts on critical sectors, including agriculture, forestry, water management, health, energy, transportation, and urban development. This helped prioritize adaptation measures for each sector. 3.Definition of Adaptation Measures: Both structural (e.g., infrastructure upgrades) and non-structural nature-based solutions (e.g., wetland restoration, afforestation, green infrastructure) were identified, based on their feasibility, effectiveness, and sustainability. 4.Stakeholder Involvement: The strategy was developed with active participation from government ministries, regional authorities, scientists, NGOs, and private sector representatives. This ensured a participatory, inclusive, and transparent planning process.	The implementation of the Strategy on Adaptation to Climate Change in the Czech Republic has produced measurable progress in enhancing national resilience to climate-related risks. Key achievements include the successful integration of adaptation priorities into sectoral policies and national development plans, particularly in water management, agriculture, forestry, and urban planning. Nature-based solutions such as wetland restoration, forest regeneration, and green infrastructure have been adopted in multiple regions, contributing to improved flood regulation, drought mitigation, and erosion control. Enhanced coordination among ministries and local governments has led to more coherent and region-specific adaptation measures. Public awareness and stakeholder participation have also increased through targeted education and outreach programs. The development of monitoring frameworks has enabled the evaluation of adaptation outcomes and informed the updating of measures based on new scientific data and climate scenarios. Overall, the strategy has laid the foundation for a more climate-resilient society by promoting adaptive governance, cross-sectoral collaboration, and sustainable land and water management practices.

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							5.Policy Integration and Implementation: The proposed adaptation actions were embedded into existing national development plans, environmental policies, and sectoral strategies to ensure coherence and facilitate practical implementation. 6.Monitoring, Evaluation, and Updating: A continuous monitoring and evaluation framework was established to track progress and effectiveness, allowing for periodic updates based on new scientific findings, data, and climate projections.	

148	National Action Plan on Adaptation to Climate Change	Miroslav Havránek, Tereza Kochová, Jakub Skála, Edita Koblížková, Jan Mertl, Jan Pokorný, Jiří Přech	2020	https://cenia.gov.cz/wp-content/uploads/2020/09/Hkonc_EvaluaceNAPAZK_MEHOSTRADO.pdf	Climate change adaptation, National action plan, Nature-based solutions, Sustainable development, Risk management, Water resources management	The aim of the National Action Plan on Adaptation to Climate Change is to enhance the resilience and adaptive capacity of the country's social, economic, and environmental systems to current and projected climate change impacts. The plan seeks to identify and implement prioritized adaptation measures across key sectors, integrate climate adaptation into existing policies and planning frameworks, and foster multi-stakeholder collaboration. By doing so, it aims to reduce climate-related risks, safeguard ecosystem services, and contribute to sustainable development goals while ensuring the well-being of present and future generations.	The National Action Plan on Adaptation to Climate Change was developed through an interdisciplinary and participatory approach, incorporating the following methods: 1.Climate Impact and Vulnerability Assessment: Analysis of meteorological and ecological data was conducted to evaluate current and projected impacts of climate change across different sectors and regions. 2.Sectoral Risk Assessment: Key sectors such as agriculture, water resources, forestry, health, energy, and infrastructure were assessed to identify and prioritize climate-related risks. 3.Stakeholder Engagement: Workshops and consultations involving government agencies, local authorities, NGOs, academia, and private sector representatives were organized to ensure a multi-stakeholder planning process. 4.Identification of Adaptation Measures: Both structural solutions (e.g., infrastructure improvements, technological innovations) and nature-based approaches were evaluated to select feasible adaptation strategies. 5.Policy and Planning Integration: Adaptation measures were aligned with existing national development plans and sectoral strategies to ensure coherence and practical implementation. 6.Monitoring and Evaluation Mechanisms: Systems were established to monitor the implementation progress, evaluate effectiveness, and facilitate updates to the plan as needed.	The implementation of the National Action Plan on Adaptation to Climate Change has led to significant progress in strengthening the country's resilience to climate-related hazards. Key outcomes include the successful integration of adaptation strategies into national and sectoral policies, particularly within agriculture, water management, forestry, and public health sectors. Nature-based solutions, such as wetland restoration, reforestation, and green infrastructure projects, have been effectively deployed to mitigate flood risks, combat droughts, and reduce soil erosion. Enhanced coordination among government agencies and increased stakeholder involvement have resulted in more coherent and context-specific adaptation actions across different regions. Public awareness campaigns and educational programs have improved community engagement and support for adaptation measures. Monitoring and evaluation frameworks have been established, enabling continuous assessment of adaptation effectiveness and facilitating iterative improvements based on emerging scientific data and climate projections. Overall, the plan has provided a comprehensive and adaptive approach to climate change resilience, promoting sustainable development and safeguarding ecosystem services.

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149	State Environmental Policy of the Czech Republic 2030 with outlook to 2050	Vladislav Smrž, Anna Pasková, Jaroslav Kepka, Markéta Linxová, Lucie Hanišová, Helena Vaňková.	2021	https://www.czechia.eu/wp-content/uploads/2021/12/State-Environmental-Policy-of-the-Czech-Republic-2030-with-a-view-to-2050.pdf	Environmental policy, Sustainable environmental management, Climate change adaptation and mitigation, Biodiversity, Waste management, Renewable energy, Sustainable development, Ecosystem protection	The aim of the State Environmental Policy of the Czech Republic 2030 with Outlook to 2050 is to ensure the country's environmental sustainability by promoting efficient and effective use of natural resources and achieving long-term climate change mitigation and adaptation goals. The policy seeks to improve air, water, and soil quality, protect biodiversity, and enhance ecosystem resilience to safeguard public health and quality of life. Additionally, it aims to integrate environmental considerations into economic and social development processes, promote the adoption of green technologies, and facilitate the transition to carbon neutrality. Through these efforts, the policy supports compliance with national and international environmental standards and contributes to the achievement of sustainable development objectives.	The development of the State Environmental Policy of the Czech Republic 2030 with Outlook to 2050 was based on a comprehensive, evidence-based approach incorporating multidisciplinary scientific research, stakeholder consultations, and policy analysis. The methodology involved the following key steps: 1.Environmental Assessment: Detailed evaluation of current environmental conditions and trends, including air and water quality, biodiversity status, land use, and climate change impacts, was conducted using national and European data sources. 2.Risk and Vulnerability Analysis: Identification of critical environmental risks and vulnerable ecosystems and populations helped prioritize focus areas for intervention. 3.Stakeholder Engagement: Inclusive consultations were held with government agencies, local authorities, scientific institutions, private sector representatives, and civil society to ensure diverse perspectives and promote collaborative decision-making. 4.Policy Review and Benchmarking: Existing national and EU environmental policies and international commitments were analyzed to align the strategy with broader frameworks and standards. 5.Scenario Development and Modelling: Future scenarios were modeled to assess potential environmental outcomes under different policy and development pathways up to 2050. 6.Implementation Framework	The implementation of the State Environmental Policy of the Czech Republic 2030 with Outlook to 2050 has led to notable advancements in environmental protection and sustainable resource management. Improvements have been observed in air and water quality indicators, supported by stricter regulatory frameworks and increased monitoring capacities. Biodiversity conservation efforts have resulted in the stabilization and partial recovery of several endangered species and habitats. The promotion of renewable energy and green technologies has contributed to a gradual reduction in greenhouse gas emissions, aligning the country with EU climate targets. Cross-sectoral integration of environmental objectives into economic and social policies has enhanced policy coherence and effectiveness. Stakeholder engagement and public awareness initiatives have fostered greater community participation and support for environmental measures. The establishment of adaptive governance and continuous monitoring systems has enabled timely responses to emerging environmental challenges, ensuring the policy remains dynamic and responsive.

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							Design: Mechanisms for integrating environmental objectives into sectoral policies, establishing monitoring and evaluation systems, and facilitating adaptive governance were formulated.	

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150	City of Prague Climate Change Adaptation Strategy	Mgr. Tereza Líbová, Ing. Kateřina Schön, Ing. Tereza Zubrová	2020	https://adaptacepraha.cz/wp-content/uploads/2020/12/Implementacni_plan_20_24_web_ENG.pdf	Adaptation to climate change, Urban resilience, Green infrastructure, Flood management, Energy efficiency, Water management, Biodiversity, Sustainable urban development	The aim of the City of Prague Climate Change Adaptation Strategy is to enhance the city's resilience to the adverse effects of climate change and support sustainable urban development. The strategy focuses on developing adaptation measures in priority areas such as urban infrastructure, water resources, public health, and biodiversity. It adopts a multi-sectoral and participatory approach to reduce climate risks and increase public awareness. Through these efforts, the strategy seeks to protect the city's livability and strengthen its capacity to adapt to changing climate conditions.	The development of the City of Prague Climate Change Adaptation Strategy involved a comprehensive, multi-disciplinary approach integrating scientific assessments, stakeholder engagement, and policy analysis. Key methodological steps included: 1.Vulnerability and Risk Assessment: Identification and evaluation of the city's vulnerabilities to climate-related hazards such as heatwaves, flooding, and droughts using climate models and historical data. 2.Stakeholder Consultation: Engaging local government agencies, community groups, academic institutions, and private sector representatives through workshops, surveys, and public forums to gather diverse perspectives and foster collaboration. 3.Scenario Analysis and Modelling: Development of future climate scenarios to assess potential impacts and evaluate the effectiveness of proposed adaptation measures. 4.Integration with Urban Planning: Aligning adaptation strategies with existing urban development plans, infrastructure projects, and environmental policies to ensure coherence and feasibility. 5.Monitoring and Evaluation Framework: Establishment of indicators and processes for ongoing assessment of strategy implementation and adaptation outcomes.	The implementation of the City of Prague Climate Change Adaptation Strategy has led to measurable improvements in the city's resilience to climate-related risks. Key outcomes include the enhancement of green infrastructure, such as the expansion of urban parks and green corridors, which contribute to mitigating urban heat island effects and improving biodiversity. Flood management systems have been upgraded with improved drainage networks and floodplain restoration projects, reducing the vulnerability of critical urban areas. Public health initiatives focusing on heatwave preparedness and air quality monitoring have increased community awareness and reduced climate-related health risks. Energy efficiency measures have been integrated into municipal buildings and infrastructure, contributing to the city's sustainability goals. Stakeholder engagement processes have fostered stronger collaboration across government departments and civil society, enhancing the coordination and effectiveness of adaptation actions. Monitoring and evaluation frameworks have been established, allowing for continuous assessment and iterative improvements of adaptation measures. Overall, the strategy has provided a robust and flexible framework that supports Prague's sustainable urban development and climate resilience.

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151	The Critical Role of Open Space in Earthquake Recovery: A Case Study	P.Allan & M.Bryant	2010	https://db.nzsee.org.nz/2010/Paper34.pdf	Earthquake recovery, urban design, urban morphology, community adaptation	The aim of this study is to understand how the open space network within a city contributes to adaptive responses that facilitate earthquake recovery. Specifically, the research seeks to explore how features of open space; such as structure, function, distribution, proportion, and design; either assist or hinder post-earthquake recovery. Additionally, the study aims to identify earthquake-resilient characteristics that also enhance urban design quality, thereby promoting the integration of urban resilience strategies into city planning and design	The methodology of this research comprises two interrelated stages: 1. Resilience Vocabulary: a typomorphological analysis: This phase involves assessing the relevance and compatibility of resilience attributes described by Walker and Salt with urban design theory. The researchers analyze case studies of earthquake-damaged cities to identify which aspects of their urban form exhibit these resilience characteristics. 2. Primary Sources: response and recovery: This stage involves corroborating findings with primary source evidence; such as government documents, personal accounts, photographs, and reconnaissance reports; to examine adaptive behaviors during and after earthquakes. These sources are evaluated based on recovery functions including gathering and shelter, distribution of goods and services, re-establishment of commerce, temporary inhabitation, memorialization, and waste disposal.	The main results of the study highlight the significant role of open space in enhancing urban resilience and facilitating recovery in earthquake-affected cities: - Correlation between urban form and resilience: The analysis of San Francisco's urban morphology reveals that characteristics such as wide streets, a network of parks, and open spaces with high tolerances and diversity may have contributed to its capacity to recover more effectively from the 1906 earthquake and fire. - Open space as a facilitator of adaptive behaviors: Primary sources demonstrate that open spaces provided crucial functions during recovery, including sites for resource distribution, shelter, and community gathering, supporting community regeneration in the immediate and medium-term aftermath of the disaster. - Urban design and resilience attributes alignment: There is a cautious optimism that identifying specific open space characteristics can improve urban resilience, contribute to everyday urban life quality, and serve as vital life support mechanisms during disasters, thus reinforcing the integration of spatial and recovery planning. - Open space as a 'second city': The concept proposed is that open spaces should be viewed as an integral part of urban infrastructure, equipped with latent capacity to act as agents of recovery while also enhancing daily urban life.

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152	A GIS-based Suitability Analysis of Xiamen's Green Space in Park for Earthquake Disaster Prevention and Refuge	Yuan Li, Yuanmeng Liu, Junfeng Jiao	2013	https://www.academia.edu/27933582/A_GIS_based_Suitability_Analysis_of_Xiamens_Green_Space_in_Park_for_Earthquake_Disaster_Prevention_and_Refuge	Green Space in Park; Earthquake Disaster Prevention and Refuge; Suitability Assessment; GIS; Xiamen	The primary goal of this study is to evaluate the suitability of green spaces in Xiamen's parks to function as earthquake disaster prevention and refuge shelters. The aim is to ensure that these spaces can be effectively utilized during emergencies by assessing their accessibility, availability, and security.	The researchers developed a comprehensive assessment system combining GIS-based spatial analysis with analytical methods such as Grey correlation and entropy analysis. They established evaluation indices, including factors like open space capacity, proximity to danger points, terrain gradient, and infrastructure connections. Using GIS, they generated spatial data such as shortest paths between shelters and hospitals, buffers around dangerous points, and terrain gradients. The Grey correlation and entropy methods were then employed to analyze the data and assess the suitability levels of each green space, categorizing them into excellent, good, or moderate refuge areas based on calculated decision values.	The study identified that out of the assessed parks, ten received an excellent suitability rating, six as good, and five as moderate for earthquake refuge purposes. The findings highlight specific parks' strengths and limitations, such as their proximity to earthquake-prone zones, accessibility, capacity, and surrounding infrastructure, providing a scientific basis to optimize urban planning for disaster preparedness. The research concludes that availability should be prioritized, followed by security and accessibility, with recommendations for improving the usability of green spaces as emergency shelters.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
153	Open space and their attributes, uses and restorative qualities in an earthquake emergency scenario: The case of Concepción, Chile	Paula Villagra-Islas & Susana Alves	2016	http://dx.doi.org/10.1016/j.ufug.2016.06.017	Earthquake-prone environments, Open space	This study examines the relationship between landscape attributes and landscape use in Concepción, Chile, an earthquake-prone city.	In this study, landscape attributes referred to physical aspects of landscapes e.g. trees, seats, water, openness, and landscape uses referred to landscape utility e.g. for walking, for water collection. Multiple sorting procedures were used for data collection, because it makes possible the mapping of the concepts and processes used by communities to evaluate and act in particular environments. Community group meetings were undertaken during 2012, and consisted of assessing photographs of the city of Concepción	Landscape categories in the non-emergency scenario vary in relation to the level of urban design intervention ranging from urban landscapes to natural areas, which define their different uses. Biplots obtained during the Categorical Principal Component Analysis indicate that Dim 1 varies along landscape categories 'Landscapes with predominance of nature-related features, open space design intervention and accessibility' (C4) and 'Landscapes with nature-related features and no accessibility' (C7) allocated in each pole of this dimension, which are represented by photographs 39 and 57 respectively. Correlation results suggest that the 'Aesthetic of care' dimension is positively correlated with all restorative dimensions, with a highest correlation to 'Coherence

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
154	Measuring spatial accessibility to refuge green space after earthquakes: A case study of Nanjing, China	Wei Liu,Hao Xu ,Jing Wu,Wei Li,Huimin Hu	2022	https://doi.org/10.1371/journal.pone.0270035	Earthquake emergency shelter, Refuge green space (RGS)	The aim of this study is to evaluate the spatial accessibility of refuge green spaces (RGSs) in Nanjing, China, using the Gaussian two-step floating catchment area (G2SFCA) method across different evacuation time scenarios. The research seeks to identify spatial disparities and mismatches between RGS accessibility and population density in order to provide strategic insights for optimizing emergency shelter planning in rapidly urbanizing historic cities vulnerable to earthquakes	he methodology of the study involves several key steps. First, kernel density estimation (KDE) was employed to analyze the spatial distribution of existing refuge green spaces (RGSs) in Nanjing, capturing heterogeneity in their locations. Next, the Gaussian two-step floating catchment area (G2SFCA) method was applied to assess the spatial accessibility of RGSs under four evacuation time scenarios (10, 20, 30, and 60 minutes), accounting for distance attenuation and actual travel distances. Finally, spatial analysis tools such as the Lorenz curve, Gini coefficient, and bivariate local Moran's I were used to examine the relationship between RGS accessibility and population density, identifying areas of spatial mismatch and clustering pattern	The results revealed significant variations in RGS accessibility across Nanjing under different evacuation scenarios. As evacuation time increased from 10 to 60 minutes, overall accessibility improved, and inaccessible areas decreased, with the mean accessibility scores rising from approximately 2.567 to 0.955. However, accessibility remained uneven, with high-accessibility zones mainly distributed in the northern and southern parts of the city, while urban centers remained underserved. Spatial mismatch analyses showed that areas with high population density but low RGS accessibility heavily overlapped with city centers. Despite improvements with longer evacuation times, current RGSs could not fully satisfy emergency shelter demands, highlighting the need for strategic planning in RGS distribution, especially in underserved, densely populated regions

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
155	Facility against tsunamis and green infrastructure; a case study of post-disaster reconstruction after the Great East Japan Earthquake	Takahide Kurosawa	2021	https://doi.org/10.1080/21664250.2021.1877916	Biodiversity conservation, coastal protection, green space for disaster prevention, sea wall, the Great East Japan Earthquake and Tsunami	The study aims to evaluate the integration of green and hybrid infrastructure concepts in post-disaster reconstruction efforts after the Great East Japan Earthquake (GEJE), particularly focusing on infrastructure against tsunamis and biodiversity conservation. It seeks to understand how these approaches have been applied, their effectiveness in delivering ecosystem services, and lessons learned to inform future resilient coastal management.	The research involves a comprehensive review and categorization of the reconstruction and biodiversity conservation efforts across affected coastal areas. It examines administrative documents, policy guidelines, and field cases, analyzing reconstructed facilities such as seawalls, coastal forests, and green spaces. The study assesses the extent to which green infrastructure and Eco-DRR concepts have been incorporated, using case studies, site surveys, and policy analysis to evaluate design intentions, modifications, and the ecological impacts of reconstruction activities.	Traditional gray infrastructure (e.g., seawalls) was largely reconstructed following early plans, often with increased heights and extent, primarily serving flood and tsunami protection. Green infrastructure, such as coastal protection forests and green spaces, were reconstructed or created, but often resulted in ecological damage, such as the loss of unique ecosystems and wetlands. Attempts to incorporate biodiversity considerations; like setting back seawalls, designating conservation areas, planting trees on seawalls, or laying coastal sand; have been made, but these efforts were often isolated and lacked strategic network planning. Despite government promotion of Eco-DRR and green infrastructure, these concepts were scarcely reflected in actual reconstruction projects, highlighting a gap between policy and practice. Overall, reconstructed coastal facilities tend to serve disaster mitigation functions but have limited ecological service provision, emphasizing the need for more integrated, ecosystem-based planning to promote resilient and sustainable coastal environments.

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156	PLANNING OF URBAN GREEN SPACES AS EVACUATION AREA IN EARTHQUAKE DISASTER	GENTRIA ARDIPUTRI PARAMITA	2015	https://essay.utwente.nl/84699/	urban green space, evacuation area, SMCE, AHP	The aim of this MSc thesis is to develop and apply a GIS-based multi-criteria decision analysis (MCDA) approach to identify suitable urban green spaces in Bandung for use as evacuation areas during earthquakes.	The methodology involves collecting spatial and non-spatial data, establishing criteria and constraints for evacuation site suitability, constructing a criteria tree, standardizing the data to a common scale, and weighting criteria based on expert input through pairwise questionnaires. The Spatial Multi Criteria Evaluation (SMCE) module within ILWIS GIS software is then used to overlay and analyze the criteria, producing suitability maps for urban parks.	The main results indicate that the GIS-based MCDA effectively assessed the suitability of urban green spaces, enabling identification of optimal parks for evacuation purposes. The study also discusses interventions to make less suitable areas viable, supporting better evacuation planning and disaster resilience in Bandung. Overall, the approach offers a systematic, data-driven framework for urban disaster preparedness
157	Resilient Cities From Geodesign Perspective: The Case of Şanlıurfa Province	Fred Barış ERNST & İbrahim YENİGÜN	2023	https://dergipark.org.tr/tr/download/article-file/3119859	geodesign, earthquake, flood, Şanlıurfa	The aim of the paper is to demonstrate how Geodesign can be utilized to develop resilient and sustainable urban areas in Şanlıurfa, especially considering natural hazards such as earthquakes and floods. The study emphasizes integrating Geodesign principles with advanced GIS and visualization tools to facilitate participatory planning, enhance decision-making, and improve disaster preparedness.	The research applies the Geodesign framework, particularly following Steinitz's (2012) process, which involves assessing the current urban and environmental conditions, engaging various stakeholders through workshops and virtual reality experiences, and developing planning scenarios. These scenarios incorporate GIS-based analyses, material flow, life cycle assessments, and 3D/VR visualizations to explore potential future developments and resilience measures.	The main results highlight the potential of Geodesign to create collaborative, data-driven urban plans that enhance the capacity of Şanlıurfa to withstand and recover from natural disasters. The studies demonstrate how integrating different software tools, involving local stakeholders, and visualizing future scenarios can improve awareness, decision-making, and the implementation of resilient urban strategies in the region. The research underscores that adopting Geodesign approaches is essential for effective, responsive urban planning in disaster-prone areas.

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158	Planting Stormwater Solutions: A methodology for siting nature-based solutions for pollution capture, habitat enhancement, and multiple health benefits	Kelsey Jessup *, Sophie S. Parker, John M. Randall, Brian S. Cohen, Rowan Roderick-Jones, Shona Ganguly, Jill Sourial	2021	https://doi.org/10.1016/j.ufug.2021.127300	Stormwater management, Urban heat, Biodiversity, Public health, Water quality	(1) Where should we prioritize siting vegetated NBS based on biodiversity benefits? (2) Where should we prioritize siting vegetated NBS based on SPH benefits? (3) Where should we prioritize siting vegetated NBS based on water quality benefits? (4) Where do benefits converge or diverge?	Developed a spatially explicit analytical methodology named Planting Stormwater Solutions utilizing landcover datasets, spatial analysis in Esri ArcMap, and combined scoring algorithms specific to Los Angeles to assess and prioritize lands for vegetated NBS siting focused on three benefits: biodiversity, social and public health (SPH), and water quality. Raster layers were created for variables such as Tree Canopy, Tall Shrubs, Grass/Shrubs, Other Paved, Bare Soil, Roads/Railroads, Buildings. Indicators such as Opportunity to Add or Expand Habitat, Benefit of Adding Habitat, Benefit of Expanding Habitat were developed and categorized using Natural Breaks for prioritization. Combined metrics for SPH used economic hardship and race as proxies. Pollutant loading was assessed based on best available EMC and land use data, acknowledging limitations.	- Greatest biodiversity benefits occur along waterways. - Greatest SPH benefits realized in and around heavily developed urban areas, especially low-income communities of color with lower tree cover and higher heat exposure. - Greatest water quality benefits from NBS sited in areas with high density of commercial and industrial land uses. - Identified overlaps where co-benefits may be optimized, but also potential conflicts (e.g., wetlands in high pollutant load areas may concentrate contaminants harmful to wildlife).

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
159	The planning of green infrastructure using a three-level approach	Daiga Skujāne, Aiga Spage	2022	https://www.researchgate.net/publication/369609254_The_planning_of_green_infrastructure_using_a_three-level_approach	GI, green network, spatial planning, three-level planning	To define the main principles in the planning of green infrastructure (GI) in Latvia, applying a three-level approach reflecting different territorial scales (regional, rural/urbanized areas, site level), using Aizpute town and surroundings as a case study.	Analysis of existing planning documents from European countries and Latvia; mapping of existing GI elements and connections; assessment of public accessibility; identification of GI deficit zones; schematic planning of connection corridors; examination of ecological, social, cultural, and economic aspects; and regulatory document analysis.	- GI planning principles and mechanisms differ by scale (national, regional, county, urban, site) - National level needs additional regulatory documents, conceptual plans, and GI element mapping - Regional level includes more detailed mapping but not excessive detail - County level contains detailed maps and recommendations - Urban scale includes creation of green networks connecting major green areas and smaller parks - Case study of Aizpute revealed many blue and green elements but missing connections - Methodology applied to mark existing and possible connection corridors - Identified rivers as potential GI structural connections in accessibility deficit areas - Recognized need to balance agricultural activity with ecological connectivity - Importance of protective green zones around water bodies to prevent pollution through land treatment
160	Can Geodesign Be Used to Facilitate Boundary Management for Planning and Implementation of Nature-Based Solutions?	Sabine Gottwald, Ron Janssen, Colin Raymond	2020	https://doi.org/10.1017/9781108553827.010	Geodesign; Nature-Based Solutions; Boundary Management; Spatial Planning; Stakeholder Engagement	To examine the potential and lessons learned from applying geodesign tools and workshops to facilitate boundary management in NBS planning and implementation.	Case study analysis of three geodesign workshops, employing interactive digital mapping tools (Touch Table), scenario planning, and participatory stakeholder engagement with on-the-fly impact modelling. Qualitative analysis of workshop processes and outcomes.	Geodesign workshops supported translation of complex scientific and local knowledge into spatial strategies; enabled communication and mediation among stakeholders; produced spatial scenario maps synthesizing diverse inputs; highlighted integration challenges such as value assessments and scale preferences. Five key lessons for effective application were identified.

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161	Beyond Data, Towards Sustainability: a Sydney Case Study On Urban Digital Twins	Ammar Sohail, Bojie Shen, Muhammad Aamir Cheema, Mohammed Eunus Ali, Anwaar Ulhaq, Muhammad Ali Babar, Asama Qureshi	2025	https://doi.org/10.1007/s41064-025-00337-y	Urban digital twin, Sustainability, Automated insights, Traffic risk analysis	To present a case study of an urban digital twin of Sydney integrating diverse data sources, explore its applications in urban sustainability, and demonstrate data-driven approaches, including machine learning, for predicting traffic crash risks using environmental data.	Design and develop an urban digital twin integrating multifaceted datasets (weather, crime, greenhouse gas emissions, traffic volume, air quality, traffic incidents). Implement visualization tools for spatial analysis and automatic insight extraction. Employ standard machine learning techniques with data preprocessing (feature selection, handling class imbalance via SMOTE-Tomek) to predict traffic crash risks based on environmental data.	The urban digital twin integrates multi-source data with varying update frequencies (live datasets via API and published CSVs), applies data cleansing, aggregates data for consistency, and uses statistical and spatial analysis tools to generate insights. Machine learning models trained on an 80:20 stratified dataset address class imbalance via SMOTE-Tomek. Results indicate accurate prediction of traffic risks, enabling proactive prevention strategies by allocating resources to high-risk areas.
162	Urban Stormwater Management: A Sustainable Approach	Lina Karamoutsou, Elisavet Veliou, Eivind Bigum Kvernberg, Aris Psilovikos	2024	https://doi.org/10.3390/w16152089	climate change; stormwater; urban; water management; Oslo	To communicate Oslo's success in implementing sustainable stormwater management in urban areas and to provide knowledge to urban planners and policymakers regarding potential outcomes of sustainable stormwater management	Case study of Oslo using publicly available reports, documents from Water and Wastewater Agency of Oslo Municipality and literature review.	Oslo has developed a holistic sustainable stormwater management approach including green-blue infrastructure, citizen involvement, innovative solutions, and a three-step Sustainable Stormwater System (S3SS) method comprising infiltration (10 mm rainfall), retention (5-year climate-adjusted rainfall), and diversion (100-year climate-adjusted rainfall) strategies. The city also uses open streams, safe floodways in streets and roads, and blue-green infrastructure to increase resilience.,Oslo's approach serves as a representative model for global cities aiming to reduce negative impacts of urbanization and climate change on stormwater management. It emphasizes the role of committed city authorities, multifunctional green solutions, and infrastructure design, adapted to local geology and climate conditions.

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163	Enhancing metro accessibility in Riyadh: Reviewing neighborhood planning to integrate walkable, pedestrian-friendly urban environment design	Aïssa Rezzoug, Muhammed Imran, Omar Almutairi	2025	https://doi.org/10.21741/9781644903414-57	Riyadh Metro, Pedestrian Infrastructure, Accessibility, Sustainability, Urban Planning, Sidewalk and Pavement Design, Pedestrian Comfort, Shade Trees, Urban Greening	Identify challenges and opportunities related to improving pedestrian accessibility to Riyadh Metro stations to promote sustainable urban transport and enhance rider comfort in extreme climate conditions.	Literature review on pedestrian infrastructure and ridership, detailed case study of a metro station intersection in Riyadh covering surrounding districts, field observations of pedestrian infrastructure deficiencies and opportunities.	Identification of critical pedestrian access barriers like extreme heat, inadequate sidewalks, and shading; proposed widening sidewalks, planting shade trees, safe crossings, and policy recommendations; linkage with Saudi Green Initiative and Green Riyadh Project.
164	Model construction and simulation analysis of ecological corridors in landscape environment planning	Lu Dong, Xiangyi Du	2025	https://doi.org/10.2478/amns-2025-0218	Ecological corridor; Circuit theory; Landscape environment planning; Shortest circuit algorithm; Minimum impedance path; Ecological sources; Optimization	To develop and simulate optimized ecological corridor network structural models for landscape environment planning, improving ecological connectivity and supporting green development.	- Identification of ecological sources using circuit theory. - Construction of resistance surface model using Linkage Mapper. - Application of shortest circuit and minimum impedance path algorithms. - Graph theory metrics for network performance evaluation.	- Identified 21 ecological source patches >4 km^2. - Increased ecological corridors from 4 to 12. - Network closure index increased by 32.57%. - Line point rate increased by 19.38%. - Network connectivity increased by 9.15%. - Enhanced ecological network connectivity and functionality.
165	Environmental impacts and BIM: a Portuguese heritage case study	Gabriel Tomasetto Sugiyama, Maria Fernanda Rodrigues and Hugo Rodrigues	2024	DOI:10.1108/IJBPA-10-2023-0160	Heritage, Retrofit, Building Information Modelling (BIM), Sustainable construction, Life Cycle Assessment	The paper aims to compare environmental impacts of different rehabilitation solutions for a Portuguese vernacular building, focusing on less impactful materials and preserving heritage assets.	The methodology involves the production of a HBIM model through photogrammetry and point clouds, and LCA conducted via the Tally plugin integrated in Autodesk Revit. Two design options were created: one with sustainable, locally sourced natural materials, and a baseline solution using common contemporary materials for comparison.	Survey via drone photography; photogrammetry and point cloud modeling creating HBIM model with LoD 3; Life Cycle Assessment (LCA) using Tally plugin for Revit with GaBi database; comparison of rehabilitation solutions based on material selection.

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166	Summer Diurnal LST Variability Across Local Climate Zones Using ECOSTRESS Data in Lecce and Milan	Gianluca Pappaccogli, Antonio Esposito and Riccardo Buccolier	2025	https://doi.org/10.3390/atmos16040377	Land Surface Temperature, Local Climate Zones, ECOSTRESS, Urban Heat Island, Remote Sensing, GIS, Urban Climate	To evaluate the accuracy and applicability of LCZ classifications in urban climate research in Mediterranean cities and to examine diurnal variability of LST across LCZs using high-resolution ECOSTRESS data.	Use of ECOSTRESS satellite data to analyze diurnal LST variations; comparison between GIS-based LCZ map and WUDAPT European LCZ map; collection of high-resolution morphological and land use data using GIS; statistical analysis using Kruskal–Wallis test.	Milan showed pronounced nighttime overheating in dense urban LCZs, while Lecce exhibited clearer daytime thermal gradients with historic zones cooler. Differences in LCZ maps influenced spatial LST patterns. GIS-based classification showed higher accuracy. ECOSTRESS data provided valuable spatial resolution but had temporal limitations.
167	An AI-Driven and Digital Twin-Based Framework for Climate-Resilient and Sustainable Infrastructure Management in Palm Jumeirah: A Case Study Integrating Remote Sensing, Numerical Modeling, and Green Project Practices	Rasoul Ghafari, Seyed Reza Samaei	2025	https://www.researchgate.net/publication/390535965	Sea-level rise, saltwater intrusion, thermal stress, coastal infrastructure degradation, AI, Digital Twin, Remote Sensing, Numerical Modeling, Green Project Management	To develop and demonstrate an integrated, foresight-driven framework combining digital twin systems, AI, remote sensing, and numerical modeling for climate resilience and sustainability management of coastal megaproject infrastructure (Palm Jumeirah case study)	Hybrid methodology integrating four core technological pillars: 1) Digital Twin systems combining BIM, GIS, and IoT sensors for real-time monitoring; 2) Remote sensing data acquisition (Sentinel-2 satellite imagery, UAV imagery); 3) Climate and environmental data integration from Copernicus and UAE meteorological data; 4) Numerical modeling via Finite Element Method simulations (ABAQUS, OpenSees); additionally, AI models (Random Forest regression and LSTM neural networks) for degradation forecasting and failure prediction.	- 2.4 m shoreline retreat and 0.12-point NDVI decline detected through remote sensing over 5 years; - FEM simulations showed 28% increase in seawall base shear and up to 22 mm thermal expansion in bridge decks under sea-level rise scenarios; - Random Forest regression model achieved R^2=0.91 for structural degradation forecasting; - LSTM models predicted failure probabilities >0.63 in high stress zones under RCP 8.5 scenarios; - Digital twin platform enabled real-time risk mapping, maintenance optimization, and predictive scenario simulation.

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168	Flood Susceptibility Analysis with Integrated Geographic Information System and Analytical Hierarchy Process: A Multi-Criteria Framework for Risk Assessment and Mitigation	Sujan Shrestha, Dewasis Dahal, Bishal Poudel, Mandip Banjara and Ajay Kalra	2025	https://doi.org/10.3390/w17070937	Flood susceptibility, GIS, AHP	To analyze flood conditioning factors and identify flood-susceptible regions in Davidson County for flood risk assessment.	Integrated GIS and AHP approach for flood susceptibility assessment. Ten flood conditioning factors considered representing hydrological, hydraulic, topographical, and geomorphological aspects. Factor weights calculated using Saaty's nine-point scale. Weighted overlay method in GIS used to generate susceptibility map.,Soil type weighted highest (29%), followed by land use/land cover (21%), topographic wetness index (15%), and slope (11%). Flood susceptibility map created with five risk categories: very low, low, moderate, high, very high. Majority areas low to moderate risk. Validation done by comparison with FEMA flood hazard map.	Provides valuable flood zoning for planning mitigation to reduce loss of life and property. Demonstrates accurate flood susceptibility mapping integrating GIS and AHP. Useful for stakeholders in flood management.
169	Utilizing Satellite Remote Sensing and Geographic Information Systems for Assessing Urban Heat Island Effects as Urban Planning Tools for Emerging Economies	G. A. Acosta-Fernandez, N. M. Castrejon-Esparza, S. Morales-Inzunza, K.E. Martinez-Torres, L.A. Vargas-Robles, M.E. Gonzalez-Trevizo	2023	https://www.researchgate.net/publication/389945815	Surface Urban Heat Island, Land Surface Temperature, Urban planning, Heat vulnerability, Remote sensing	To use spectral images from Landsat 8 to compare and assess urban land cover and Surface Urban Heat Island effects in Ensenada, Mexico, specifically to compare typical summer days in 2019 and 2023.","The study used Landsat 8 satellite spectral images to generate Land Surface Temperature (LST) and Surface Urban Heat Island (SUHI) maps for 2019 and 2023. The Basic Geostatistical Area (AGEB) as defined by INEGI was used as the spatial analysis unit. Emissivity calculations for different surfaces (vegetation, soil, mixed areas) and atmospheric factors such as aerosol optical depth were considered. Jenks' natural breaks data classification technique was applied to normalize skewed SUHI data and classify intensity into five classes following Zhang's categories.	- 42.37% of AGEBs (114 out of 269) showed a rise in surface temperature from 2019 to 2023. - Temperature rise averaged 1.5 °C in severe temperature areas.\n- Increase primarily in central and southern parts of the city (0.06 to 4.35 °C) - Reduction in NDVI by 24.16% impacted 65 AGEBs.\n- Northeastern region showed decline in temperature (1 to 6 °C). - Urban heat island intensity highest in center and northern areas (>0.71), significant effects in southern zone (0.61 to 0.70). - Cool island identified in southwest area with intensity 0 to 0.40	Highlights the critical impact of urbanization on local climate and human vulnerability to heat. Emphasizes the importance of including green infrastructure in urban planning as a mitigation strategy. Demonstrates effectiveness of satellite remote sensing and GIS tools in monitoring urban heat and guiding sustainable development policies in emerging economies.

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170	Evaluation of an urban drainage system and its resilience using remote sensing and GIS	Guru Chythanya Guptha, Sabyasachi Swain, Nadhir Al-Ansari, Ajay Kumar Taloor, Deen Dayal	2021	https://doi.org/10.1016/j.rsase.2021.100601	Urban drainage system, Resilience, IMERG, Remote sensing, GIS	(a) model the UDS of a city in SWMM using the state-of-the-art remote sensing datasets, and (b) assess the functional and structural resilience of the UDS	Used state-of-the-art remote sensing datasets: half-hourly IMERG precipitation data (2000-2019), ALOS PALSAR DEM, Sentinel-2 LULC imagery, and drainage network data. SWMM (Storm Water Management Model) used for urban flood modeling; trend analysis methods (Modified Mann-Kendall and Sen's Slope) applied on rainfall data; sensitivity analysis performed on model parameters","High correlation between IMERG and IMD data justified using IMERG for urban flooding studies; rainfall indices showed positive trends challenging UDS management; Con-Mann parameter most influential; functional resilience of UDS calculated as 0.793 but deteriorates under increased climatic or urbanization stress; classification of structural resilience of conduits conducted	Helps in sustainable urban drainage system management under climate change and urbanization stress; can guide policymakers and engineers in improving urban flood resilience; demonstrates use of remote sensing and GIS to overcome data issues in developing countries especially India
171	Smart Green Planning for Urban Environments: The City Digital Twin of Imola	Mansoureh Gholami, Daniele Torreggiani, Alberto Barbaresi, Patrizia Tassinari	2024	https://doi.org/10.1007/978-3-031-35664-3_10	Digital twin, Smart green planning, Urban transformation, Microclimate, Real-time simulation, Urban microclimate, Trees, Thermal comfort	To develop an urban microclimate digital twin that provides real-time simulation of cooling effects of trees and other green infrastructure to improve thermal comfort and support urban planning in Imola.	Development of a digital twin using real-time weather forecasting data (via API), regeneration of epw weather files, coupling tools (Honeybee linking EnergyPlus, Radiance, Daysim), 3D modeling and microclimate simulations, validation with measured data sets.	The digital twin provides thermal maps, evaluates green planning scenarios, demonstrates reliable real-time microclimate forecasting, and acts as a platform for community engagement and urban green infrastructure enhancement.

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172	Toward Positive Energy Districts by Urban–Industrial Energy Exchange	Erfan Shafiee Roudbari, Ramanuni Parakkal Menon, Ivan Kantor, Ursula Eicker	2023	https://doi.org/10.3390/designs7030073	urban industrial symbiosis; positive energy district; energy system design; energy exchange; heat recovery	To answer how industries take part in achieving a Positive Energy District (PED) and to evaluate Urban Industrial Symbiosis (UIS) capacity to realize a PED.	The methodology evaluates recovering excess heat from industries and exchanging it with nearby buildings, involving heat transmission networks and installation of new units. Data are gathered, new energy systems designed for heat reuse with Scope 1 emission reduction, systems sized and optimized, and financial and environmental analysis conducted.	Scenario analysis based on unit selection such as direct heating from the factory, heat pumps, electric boilers; comparison of current and proposed systems; financial evaluation including NPV and discounted payback period; evaluation of emission reductions.
173	Jiading New City Green Ecological Urban Planning and Practice ; A Case Study of Yuanxiang Lake Central Activity Zone	Guoshu Yang, Hongyan Pan and Hua Sun	2025	https://doi.org/10.1051/e3sconf/202561703010	Green ecological urban planning, Low-carbon city, Green Gene Chain, Smart infrastructure, Sponge city, Low-carbon buildings	To advance Jiading New City into a model three-star green ecological city, promoting low-carbon construction, smart transportation, and ecological livability during the 14th Five-Year Plan.	Indicator system development including green ecological indicators with control and guiding criteria, phased implementation and evaluation, use of planning control platforms, detailed construction regulations, and third-party assessments. Application of "Low-Carbon Chain," "Health Chain," "Resilience Chain," "Vitality Chain," and "Intelligence Chain" planning strategies.	Establishment of a comprehensive green ecological planning system; aiming for >35% urban green space rate, 31.5 m^2 per capita park green area, >20% regional carbon emission intensity reduction. Implementation of green buildings, renewable energy, smart infrastructure, and sponge city concepts.
174	A Spatial Ecosystem Services Assessment to Support Decision and Policy Making: The Case of the City of Bologna	Francesca Vignoli, Claudia de Luca and Simona Tondelli	2021	https://doi.org/10.3390/su13052787	Urban ecosystem services; Spatial proxy methods; Supply-demand mismatch; Urban planning; Green infrastructure	To develop and apply a spatially based methodology to evaluate mismatches between supply and demand of selected urban ecosystem services at district scale to support urban planning decisions.	Spatial proxy approach using GIS-based normalization of supply and demand indicators derived from land use, impervious surfaces, tree canopy cover, and emissions datasets; cluster analysis to classify districts.	Identified four district categories with varying mismatches and priority levels for interventions; city center highly built-up districts have very high mismatches and thus very high intervention priority; peripheral greener districts show low or no mismatch; suggested interventions include nature-based solutions such as green roofs, walls, and sustainable urban drainage systems.
175	Modeling climate change adaptation for sustainable coastal zones using GIS and AHP	Mohamed Marzouk and Shimaa Azab	2024	https://doi.org/10.1007/s10661-023-12287-2	Climate Change; Coastal Vulnerability; Adaptation; GIS; AHP; Coastal Protection	To assess and map spatial vulnerability to climate change impacts on the coastal zone of Al Alamein New City and to propose appropriate adaptation measures.	GIS spatial analysis combined with Analytical Hierarchy Process (AHP) for weighting multi-criteria decision-making indicators; Six different weighting scenarios tested including topography, geology, meteorological data, and shoreline effects.	Spatial vulnerability maps identifying low to very high vulnerability zones; geology found as the most critical parameter; recommendation of hybrid adaptation combining hard engineering (breakwaters) and soft engineering (dune afforestation) to mitigate coastal risks.

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176	Multi-Scenario Simulation of Land Use and Landscape Ecological Risk Response Based on Planning Control	Nan Wang, Peijuan Zhu, Guohua Zhou, Xudong Xing, Yong Zhang	2022	https://doi.org/10.3390/ijerph192114289	Planning control; land use; multi-scenario simulation; landscape ecological risk	To provide a research framework to evaluate the effectiveness of territorial spatial planning and control implementation by combining a land use multi-scenario simulation model with a landscape ecological risk model; to characterize management and control effectiveness of different territorial spatial planning; and to optimize spatial planning management methods.	Applied the Future Land Use Simulation Model (FLUS) with five planning control scenarios; categorized land use into construction land, agricultural land, ecological land; used landscape ecological risk measurement with calculated landscape vulnerability indices; CRITIC weighting method for indexes; land use evolution analysis and scenario comparison from 2009 to 2018.	Woodland and arable land are dominant. Construction land expanded significantly (1519.7 km^2 to 1617.64 km^2 from 2009 to 2018), squeezing woodland and water. Comprehensive control restrained disordered construction land spread most effectively. Ecological spatial structure control best prevented ecological land shrinkage. Landscape ecological risk increased overall with spatial core in north and east. Land use zoning control scenario showed greatest risk increase; comprehensive control best prevented landscape risk.
177	An Integrated Model for Constructing Urban Ecological Networks and Identifying the Ecological Protection Priority: A Case Study of Wujiang District, Suzhou	Liyu Pan, Wenquan Gan, Jinliu Chen and Kunlun Ren	2023	https://doi.org/10.3390/su15054487	urban ecology; ecological network; landscape connectivity; ecological corridors; MSPA; urban ecological security	To provide a scientific method for constructing ecological networks to repair fragmented ecological patches, improve ecological capacity and promote sustainable urban development.","The model integrates 'source identification – resistance surface construction – ecological corridor extraction' steps. It uses Morphological Spatial Pattern Analysis (MSPA), landscape connectivity analysis, Minimum Cumulative Resistance (MCR) model, and circuit theory tools (Pinchpoint Mapper, Barrier Mapper) to identify ecological cores, corridors, nodes, and barriers, combined with spatial data such as land use, ecological resistance surfaces, and ecological network pattern analysis.	The ecological network shows a 'two axes, three cores and multiple belts' spatial pattern with improved connectivity. 69 ecological corridors, 59 ecological nodes, and 24 barriers identified. The model's optimized ecological cores overlap approx. 60% with legally protected ecological areas, validating its simulation results. Suggestions include increasing ecological sources in high resistance urbanized areas and constructing corridors along key waterways and cultural sites.	The integrated model improves reliability in ecological network identification and provides practical suggestions for urban ecological security patterns, land use control, and urban landscape construction in rapidly urbanizing areas. It supports sustainable urban ecological development.

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178	Collaborative use of geodesign tools to support decision-making on adaptation to climate change	Tessa Eikelboom, Ron Janssen	2015	https://www.researchgate.net/publication/276369474_Collaborative_use_of_geodesign_tools_to_support_decision-making_on_adaptation_to_climate_change	Geodesign, Stakeholders, Spatial planning, Regional climate adaptation, Decision support tools	To evaluate and demonstrate the use of geodesign tools to support collaborative decision-making on regional climate change adaptation	Development and application of four interactive geodesign tools tailored to analytical and political, collective and individual rationalities; experiment with four participant groups using touch table; observation, surveys and comparative analysis of design outcomes	The tools facilitated stakeholder integration and assessment of measures, were easy to use, and positively extended participant knowledge. Different tools influenced decision-making differently. Participants preferred some tools over others with recommendations on tool improvements. Collaborative spatial designs resulted, supporting scoping stage of adaptation planning.
179	Assessing the Benefits of Climate-Sensitive Design with Nature-Based Solutions for Climate Change Adaptation in Urban Regeneration: A Case Study in Cheltenham, UK	Pourya Torkfar, Alessio Russo	2023	https://doi.org/10.3390/su152215855	Climate-sensitive design, Nature-based solutions, Urban regeneration, Thermal comfort, Climate change adaptation	To evaluate the benefits of climate-sensitive design in regenerating a grey urban space with nature-based solutions to improve thermal comfort and climate adaptation.	Using ENVI-met software (version 5.0.3) to model and analyze thermal comfort and environmental variables; evaluated scenarios using 2017 and 2050 weather data; designed two NBS scenarios (30% and 50%) based on a 3-day workshop; analysis included temperature, relative humidity, and thermal comfort indices like PMV.	NBS reduced mean radiant temperature by 6 to 15 degrees; 50% NBS scenario improved thermal comfort by average PMV decrease of 1.2; urban temperature projected to increase by 1°C by 2050 without interventions; regreening reduced urban heat island effect; improved thermal comfort can reduce heatwave mortality.

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180	Urban Living Labs for Circular Economy: Four Italian Case Studies	Carolina Innella, Grazia Barberio, Claudia Brunori, Francesca Cappellaro, Anna Rita Ceddia, Rocco Civita, Salvatore Dimatteo, Marco Ferraris, Rocco Pentassuglia and Luigi Sciubba	2024	https://www.frontiersin.org/journals/sustainable-cities/articles/10.3389/frsc.2024.1406834/full	Urban Living Labs; Circular Economy; Stakeholder Engagement; Participatory Design; Sustainable Cities	To describe the application of the Urban Living Lab (ULL) methodology framework highlighting its effectiveness to engage stakeholders and co-design circular economy (CE) project proposals in four Italian urban territories: Anguillara Sabazia, Bologna, Taranto, and Venosa.	The method includes stakeholder mapping, surveys, interviews, participatory co-design workshops following the pentahelix multi-stakeholder framework. Both quantitative (descriptive statistics) and qualitative (thematic analysis) approaches were used.	The ULL methodology fostered stakeholder engagement and co-creation of CE project proposals addressing local critical issues such as waste management, water circularity, sustainable tourism, and cultural heritage enhancement. Each ULL generated concrete project ideas and activated multisectoral partnerships beneficial for urban sustainability transitions.
181	Assessing Urban Resilience with Geodesign: A Case Study of Urban Landscape Planning in Belgrade, Serbia	Sandra Mitrović, Nevena Vasiljević, Bojana Pjanović, Tijana Daović	2023	https://doi.org/10.3390/land12101939	Urban Resilience, Geodesign, Urban Landscape Planning, Resilience Index, Urban Ecosystems, Scenario Planning	To develop a resilience index to summarize the application of resilience theory in urban landscape planning and to evaluate urban resilience through geodesign scenarios for the city of Belgrade.	The geodesign framework was applied to design and evaluate urban resilience scenarios. The methodology included development of scenarios during the IGC workshop, use of resilience indicators combined into a resilience index (parameters like area, redundancy, diversity, porosity, carbon sequestration, edge type, edge length), and evaluation of these scenarios using spatial and landscape metrics.	The study developed a resilience index combining several parameters to assess urban landscape resilience. Scenario analysis showed different levels of resilience based on innovations applied, e.g., Early Adopter scenario focusing on protection of natural areas and urban form preservation. The model allows maintaining and improving urban resilience by planning innovations, linking landscape planning across different scales.

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182	A review of integrated use of machine learning algorithms, GIS and remote sensing techniques in the prediction of rainfall patterns and floods in the U. S.	Phyllis Ang-E-Mwin Gyang, Oluwabunmi Akomolafe, Benjamin Panful and Isaac Amornortey Yowetu	2025	https://doi.org/10.30574/wjaets.2025.14.1.0025	Flash floods, Hurricane flooding, Flood forecasting, ML-GIS-RS integration, Real-time flood response, Spatial risk mapping	To illustrate practical applications of integrated technologies in real flood events across diverse U.S. environments to improve response and risk mitigation.	Use of Sentinel-1 satellite RS data combined with GIS spatial mapping and ML algorithms (e.g., gradient boosting, random forests) to model flood scenarios, identify high-risk zones, and simulate evacuation needs during specific flood events.	The 2020 Florida hurricane event prediction improved via integrated ML-GIS-RS approach (specific mention of Hurricane Sally). California and Arizona flash floods were forecasted accurately using ML models trained on RS vegetation and precipitation data alongside GIS topography and soil data. Coastal tidal flooding mapped and simulated in near-real-time using combined technologies reduced loss and improved resource deployment.
183	Advancements in Surveying and GIS for Disaster Resilience: Protecting Public Health in Vulnerable Regions	Mostafa Abdel Bary Ebrahim	2025	https://biomedres.us/pdfs/BJSTR.MS.ID.009530.pdf	Floodplain mapping, Shelter placement, Evacuation, Air quality alerts, Food aid targeting, Remote sensing, Crop classification, Water resources	To demonstrate practical applications of GIS and surveying technologies in diverse disaster contexts enhancing public health outcomes.	Utilization of advanced geospatial technologies like LiDAR, drone surveys, satellite remote sensing, and GIS data integration with health and environmental records in real-time and predictive capacities.	Improved hazard mapping, optimized resource/shelter allocation, efficient emergency response, targeted food and health aid, and enhanced water resource management. These reduced disaster morbidity and mortality and enhanced resilience.
184	An Integrated Approach for the Co-governance of Sustainable and Resilient Cities: A Focus on Green Infrastructures and Transport Mobility in Catania (Italy)	Sturiale, Luisa; Ignaccolo, Matteo; Torrisi, Vincenza; Scuderi, Alessandro	2023	https://doi.org/10.1007/978-3-031-37108-0_14	Green infrastructure, Transport mobility	This work presents an integrated approach to consider the role of Green Infrastructures (GIs) and Transport Mobility (TM) as key components in the transition towards a model of sustainable and resilient cities. The analysis of these two components of the urban system, especially in cities with high rates of motorisation and traffic congestion, on the one hand, and with a non-widespread presence of green areas, on the other, becomes strategic for implementing actions aimed at making cities more sustainable.	The study consists of two steps: (i) first, an interview-based methodology has been implemented to analyze citizen's perception of GIs to tackle climate change and the willingness to pay to sustain the maintenance of these infrastructures; (ii) on the other hand, an extended survey will be performed to evaluate the propensity of users towards innovative shared transport systems and also the willingness to pay for the service.	The obtained results from the first round of interviews highlighted the citizens point of view linked to GIs and their interest in the co-management. Research findings will constitute a decision support for administration and stakeholder to guide public investments and achieve awareness among citizens in order to promote co-governance actions and develop climate adaptation strategies and improve the quality of life in urban areas.

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185	Analysis of Effects of Sponge City Projects Applying the Geodesign Framework	Yaoxue Li and Youngmin Kim	2022	https://doi.org/10.3390/land11040455	Sponge city; Geodesign framework; Water pollutant control; Urban flood control; Low impact development (LID); Green infrastructure; Stormwater management	Evaluate the effectiveness of existing sponge city projects in different climatic zones on urban water pollutant reduction and flood mitigation.	Scenario-based land use and cover changes simulated through geodesign framework models; input into InVEST NDR and urban flood models for pollutant export and runoff assessment at watershed scale.	Varied pollutant export reductions of nitrogen and phosphorus in different cities under different scenarios. Stormwater control capacity increased with sponge projects and further improved with green infrastructure network expansion.
186	Application of Geodesign Techniques for Ecological Engineered Landscaping of Urban River Wetlands: A Case Study of Yuhangtang River	Tianjie Li, Yan Huang, Chaoguang Gu and Fangbo Qiu	2022	https://doi.org/10.3390/su142315612	Urban river wetland; Ecological engineered landscaping (EEL); Restoration; Hydrological analysis; Geodesign; GIS; 3-D modelling; Flood control	To apply and verify a geodesign-based methodology for ecological engineered landscaping of urban river wetlands in a real-world restoration project.	GIS spatial data analysis, AHP with expert voting, ecological vulnerability indexing, hydrological modelling, 3-D parametric modelling, and feasibility assessment applied to the river wetland restoration context.	The project spatially classified the river wetland into four reaches with specific functions (water conservancy, flood control, restoration, eco-tourism, recreation, nature education). Identified areas of higher ecological vulnerability and used 3-D models to visualize redesign concepts. Showcased a preliminary geodesign workflow adaptable to similar contexts.
187	Applying GIS in Blue-Green Infrastructure Design in Urban Areas for Better Life Quality and Climate Resilience	Szymon Czyża and Anna Maria Kowalczyk	2024	https://doi.org/10.3390/su16125187	Blue-green infrastructure, GIS, urban heat island, climate resilience, spatial planning, multifunctional greening	Design and plan urban BGI elements to mitigate climate change impacts and improve residents' well-being using GIS.	GIS-based spatial analysis integrating various datasets including topography, hydrology, land use, demographic data, and environmental indicators to identify suitable locations for bioswales, infiltration trenches, and green bus stops.	Identification of detailed optimal BGI locations, development of decision-support cartographic models, increased accuracy through data integration, and addressing data limitations with validation methods.

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188	Artificial intelligence-aided design: Smart Design for sustainable city development	Steven Jige Quan, James Park, Athanassios Economou, and Sugie Lee	2019	https://doi.org/10.1177/2399808319867946	Urban form; Sustainable development; AI in urban planning; Participatory design; Gangnam superblocks; Energy use intensity; Floor area ratio.	To demonstrate the feasibility and effectiveness of the proposed framework in a real urban context with complex requirements.	Iterative application of the framework involving expert knowledge, parametric urban form representation, computing distributed simulation and AI optimization. Stakeholder input was integrated via human-system interactions. Computations distributed over multiple i7 workstations were used.	Successful identification of optimal or near-optimal designs with improved sustainability metrics. The framework facilitated negotiations among various stakeholders and showed the potential of human-AI collaboration in urban design. Iterations required 10 to 70 hours computing time respectively.
189	Assessing Urban Vulnerability to Flooding: A Framework to Measure Resilience Using Remote Sensing Approaches	Mercio Cerbaro, Stephen Morse, Richard Murphy, Sarah Middlemiss, Dimitrios Michelakis	2022	https://doi.org/10.3390/su14042276	Urban flood vulnerability, Remote sensing, Google Street View, Amazon region, Resilience indicators	To demonstrate the application of the VIFOR framework and remote sensing (GSV combined with EO) methods in measuring flood vulnerability of urban populations in contrasting neighborhoods within the Amazon region.	Selection of one poor and one rich neighborhood in each of two cities (Rio Branco and Belem), based on expert recommendations and socioeconomic indicators, followed by virtual assessment of streets via Google Street View imagery and EO data. Indicators were scored to compare vulnerability and resilience.	Evidence demonstrated significant differences in vulnerability and resilience metrics between poor and rich neighborhoods with poorer areas more vulnerable. The use of remote sensing data, especially GSV, facilitated detailed, cost-effective vulnerability assessment.

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190	Assessment of Urban Resilience and Detection of Impact Factors Based on Spatial Autocorrelation Analysis and GeoDetector Model: A Case of Hunan Province	Jianhong Chen, Hongcai Ma, Shan Yang , Zhiyong Zhou, Jianhui Huang and Licheng Chen	2023	https://doi.org/10.3390/ijgi12100391	Urban resilience, spatial differentiation, GeoDetector, Hunan Province, urban system, ecological resilience, economic resilience, social resilience, institutional resilience, infrastructure resilience, spatial autocorrelation	To measure and analyze the spatiotemporal distribution and determinants of urban resilience levels across cities in Hunan Province over time and identify leading factors affecting resilience development.	Calculation of urban resilience indices across five subsystems (ecological, economic, social, institutional, infrastructure) for 14 cities from 2010–2021. Use of GeoDetector model to analyze and detect significant impact factors on resilience level spatial patterns, including single factor and interaction detection. Spatial autocorrelation analysis using Global Moran's I (GMI) and local correlation analysis via GeoDa software. Visualization and classification based on ArcGIS natural breaks. Data analysis of q-values to assess factor explanatory power.	Positive spatial autocorrelation of urban resilience with high resilience clustered in eastern cities like Changsha-Zhuzhou-Xiangtan and low resilience in western regions Economic and social factors exhibited the strongest impact on urban resilience spatial patterns, while ecological, institutional, and infrastructure factors had weaker effects Interactive detection of factors showed significant double-factor enhancement effects, emphasizing the combined influence of multiple subsystems Temporal change in subsystem influence: economic resilience impact increased; institutional resilience impact declined; social and infrastructure resilience had moderate impacts Spatial patterns showed cyclic "diffusion-agglomeration" behavior over time

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191	AN ASSESSMENT ON DAMAGE ASSESSMENT WORKS IN KAHRAMANMARAŞ EARTHQUAKE	İrşade AYDOĞDU GÜRBÜZ - Banu ASLAN	2023	https://dergipark.org.tr/tr/download/article-file/3215220	Damage Assessment Software (HTS), Multi-institution Coordination, Rapid Field Data Collection, Training and Capacity Building for Engineers and Architects, Public Communication, Legal Clarity, Crisis Management, Turkey	To highlight effective strategies and tools employed in damage assessment post-Kahramanmaraş earthquakes that can be adopted in future disaster responses.	Combination of two-stage inspections (external/internal), data collection via tablets, centralized and integrated software systems enabling swift data analysis and report generation, alongside logistical coordination for personnel and supplies.	Rapid assessment completed within about 45 days, with clear damage categorizations, effective stakeholder communication, and efficient resource allocation. The system allowed updates after aftershocks and appeals.
192	The Need for an Environmental Notification System in the Lithuanian Coastal Area	lona Šakurova *, Vitalijus Kondrat, Egl ˙ e Baltranait ˙ e and Vita Gardausk ˙ e	2023	doi.org/10.3390/jmse11081561	Coastal erosion, sediment transport, stakeholder mapping, Bayesian Networks, EASTMOC system, monitoring, data sharing, early warning	To demonstrate a proof of concept for EASTMOC, create an architecture for the system, address knowledge gaps, create a knowledge-sharing platform, and determine operational thresholds for stakeholders.	Stakeholder mapping and pilot study with 10 selected stakeholders; monitoring of coastal parameters; development of EASTMOC notification system implemented via Bayesian Networks; use of long- and short-term data including shoreline position, hydrometeorological variables, sediment size, etc.	Stakeholder-identified natural factors essential for operations include beach width/length, underwater slope, shoreline position, wave and wind data, current speed and direction; EASTMOC aims to provide automated, timely, personalized data and notifications; Bayesian Networks model system complexity and update with new information; shoreline position is key indicator; existing data gaps in nearshore bathymetry and real-time hydrometeorological data; pilot study confirmed feasibility.

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193	Planning Green-Blue Infrastructure for Urban Climate Adaptation: A Study Related to Urban Flooding Issues in Dhaka	Hossain Mohammad Nahyan	2017	https://edepot.wur.nl/459846	Green-blue infrastructure; Urban flooding;Climate change adaptation;Urban planning;Flood-risk management	To investigate existing policy, planning, and institutional structures regarding GBI planning and assess bio-physical and socio-political performance for urban flooding adaptation in Dhaka. To study spatial planning oriented GBI concepts to develop a comprehensive adaptation framework.	Mixed method approach: Expert interviews (semi-structured), policy and document survey, social survey using questionnaires. Qualitative content analysis supported by Atlas.ti. Triangulation of data sources.	Development in institutional domains but imbalance in development scenarios. Lack of social relevance in technical approaches reduces efficiency. Insufficient local collaboration and participation. Recent GBI initiatives show promising system upgrades.
194	Clustering-based disaster resilience assessment of South Korea communities building portfolios using open GIS and census data	Eujeong Choi, Junho Song	2022	https://doi.org/10.1016/j.ijdrr.2022.102817	Disaster resilience, Community-level assessment, Clustering, GIS, Census data, Physical vulnerability, Socioeconomic recoverability	To overcome the limitations of existing resilience assessments and propose a clustering-based method (CDRC) that evaluates physical vulnerability and socioeconomic recoverability of community buildings using open GIS and census data.	Separate assessment of physical vulnerability and socioeconomic recoverability; K-means clustering approach; Demonstration via virtual and real community data (Ulsan, South Korea).	The CDRC method effectively categorizes communities based on resilience attributes. It aligns with state-of-the-art models and was validated through both virtual examples and real-world data from 56 zones and 101,037 buildings in Ulsan.
195	Creating Collaborative Environments for the Development of Slum Upgrading and Illegal Settlement Regularization Plans in Brazil: The Maria Tereza Neighborhood Case in Belo Horizonte	Rogério Palhares Zschaber de Araújo, Ana Clara Mourão Moura and Thaisa Daniele Apóstolo Nogueira	2018	https://doi.org/10.4018/IJEPR.2018100102	Slum upgrading, illegal settlement, urban planning, collaborative environments, Brazil, Maria Tereza Neighborhood, Belo Horizonte	To explore and document the process and outcomes of creating collaborative environments aimed at developing slum upgrading and illegal settlement regularization plans in the Maria Tereza Neighborhood.	Case study approach focusing on the Maria Tereza Neighborhood in Belo Horizonte, involving qualitative analysis of participatory planning processes and stakeholder engagement in urban planning.	The study revealed effective collaboration among multiple actors, including local government, community members, and other stakeholders, which facilitated the development and implementation of slum upgrading and regularization plans. The approach helped address legal and infrastructural challenges in the neighborhood.

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196	DESIGNING RESILIENT CITIES: APPLICATION GUIDE SEEKING, THE CASE OF İZMİR TORBALI	Gizem ERDOĞAN -Serdar SİMSAR- Sinem Dudu SAKAL Ömer KOR- Gamze KARDOĞAN-Ceren PARILTI Yaşar Doğukan KAYA- Begüm GÜNDOĞDU	2022	https://dergipark.org.tr/tr/download/article-file/2464665	Resilient City, Spatial Plan, Disaster, Urban Heat Waves, İzmir, Torbalı	This study is based on the hypothesis that a resilient urban planning is possible using urban planning tools.	In this study, resilient city criteria obtained as a result of literature review, zoning law and spatial plan construction regulation are applied in Torbalı district within the framework of master zoning plan, aiming to create a city structure that is resistant to earthquakes and urban heat waves.	In this study, two different spatial plans of "Resilient City Torbalı", produced are presented. While resilient cities minimize the negative effects of the misuse and excessive consumption of resources, they contribute to increasing the quality of life by developing concepts such as natural-built environment, health, economy and society.
197	Detailed Mapping and Modeling of Urban Vegetation: What Are the Benefits for Microclimatic Simulations with Town Energy Balance (TEB) at Neighborhood Scale	Émilie Bernard, Cécile De Munck, Aude Lemonsu	2022	https://journals.ametsoc.org/view/journals/apme/61/9/JAMC-D-21-0134.1.xml	Urban vegetation, urban canopy model, microclimate, TEB, urban climate modeling, remote sensing, Toulouse, case study	To evaluate the sensitivity of the TEB urban canopy model to the representation of urban vegetation and the resolution of vegetation databases, assessing the benefits of detailed mapping for simulating microclimatic variables at neighborhood scale.	Two vegetation land cover databases of different resolution (a standard national database and a very high-resolution satellite-derived database) were developed. Two vegetation parameterizations in the TEB model were applied: one without explicit tree strata and one including tree layers. Field measurements of microclimatic variables (air temperature, wind, thermal comfort) were collected along instrumented routes and stop points in Toulouse. Model simulations using the different datasets and parameterizations were compared to observations to assess sensitivity and performance improvements. Statistical classification was used to distinguish urban and natural vegetation fractions, and tree characteristics were parameterized based on expert data.	- Refining vegetation input data improved simulation accuracy of air temperature slightly. - Including explicit tree strata in the TEB model (TEB-Tree) enhanced simulation of air temperature, wind profiles, and thermal comfort indices. - The refined vegetation parameterization yielded better representation of physical processes associated with trees in urban canyons leading to improved microclimate simulations. - The very high resolution satellite-derived vegetation database allowed to separate herbaceous, shrub, and tree layers, improving model inputs compared to coarser national databases. - Vegetation fractions matched reasonably well with ground-truth data (REAL database).

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198	Resilience of an Urban Coastal Ecosystem in the Caribbean: A Remote Sensing Approach in Western Puerto Rico	Yadiel Noel Bonilla-Roman, Salvador Francisco Acuña-Guzman	2024	https://doi.org/10.3390/earth5010004	tropical conditions; insular territory; data geoprocessing; ecosystem resilience; urban coastal ecosystem; remote sensing; gross primary production; NDVI; ET; LST; atmospheric events; anthropogenic activity	Investigate how an ecosystem in Western Puerto Rico responds and recovers from extreme climate events and fluctuations, specifically evaluating innate resilience	Remote sensing using MODIS and Landsat 8–9 OLI TRIS products, supplemented by PRWEB datasets; analysis covered 2012–2021; calculation of ET, NDVI, LST, GPP; use of GIS tools (ArcGIS and RStudio) for geoprocessing and spatial analyses; creation of attribute tables and fishnet sampling; correlation matrix analyses between parameters; gap-filling missing dataset values; comparison between highly urbanized and less anthropogenic impact areas.	NDVI and ET values showed the ecosystem's capacity to recover after drought (2015) and hurricanes (2017). NDVI dropped sharply post-hurricanes from average 0.79 (2015) to 0.6 (2017) and recovered to 0.8 (2019). ET values dropped after hurricanes but increased again by 2019. Areas with little anthropogenic disturbance showed more rapid and resilient restoration. Urban coastal areas demonstrated slower recovery and lower ecological resilience. Correlations were observed among ET, NDVI, and GPP. Limitations included data gaps especially in ET estimations and challenges associated with MODIS data resolution in the study area's geographic context.
199	Development of a new integrated flood resilience model using machine learning with GIS-based multi-criteria decision analysis	Muhammad Hussain, Muhammad Tayyab, Kashif Ullah, Safi Ullah, Zahid Ur Rahman, Jiquan Zhang, Bazel Al-Shaibah	2023	https://doi.org/10.1016/j.uclim.2023.101589	Flood resilience, GIS, Remote sensing, AHP, Random Forest, SVM, Disaster risk reduction, CapFlooR-M, Pakistan	To assess community-level flood resilience in District Shangla (Eastern Hindukush, Pakistan) by developing an integrated, capacity-based model (CapFlooR-M) using ML, GIS, RS, and AHP.	- Developed CapFlooR-M model integrating Random Forest (RF), SVM, AHP, GIS, and RS- Mapped four components (Is, Cc, Ac, Tc)- Conducted overlay analysis for final resilience mapping.	36.64% of the area showed moderate-to-very high resilience (northwest & southwest), while 63.46% showed low-to-very low resilience (central & southeast). Model provides actionable spatial insights.
200	Urban wetlands restoration in floodplains: a case of the city of pilsen, Czech Republic.	Macháč, Jan, and Jiří Louda.	2019	http://dx.doi.org/10.1007/978-3-030-23842-1_12		The chapter deals with the importance of implementing small-scale NBS for flood protection in cities	This study employs a case study approach combined with an economic evaluation method, specifically a cost-benefit analysis, to assess the implementation of nature-based solutions (NBS) in urban areas	NBS not only provide flood protection but also bring social and environmental benefits, such as ecosystem services and improved quality of life. In the case of Lobezská louka, the analysis showed that the NBS implemented in the first phase delivered social benefits 25 times greater than its costs.

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201	Development of an Adaptive Drainage System for Flood Mitigation Using GIS	Iin Arianti, Muhammad Rafani, Wattini, Nurul Fitriani, Nizar, Belvi Vatria	2024	https://doi.org/10.59324/ejaset.2024.2(6).07	Flood mitigation, GIS, Adaptive drainage system, Urban drainage, Climate change, IoT, Green infrastructure	To develop a GIS-based adaptive drainage system for Pontianak City to reduce flood risks and improve resilience to environmental changes.	Utilizing GIS technology for spatial analysis and flood-prone zone identification; collection of field surveys, satellite imagery, and historical rainfall data; hydrological and computer simulation modeling; validation of drainage channel capacity; incorporation of green infrastructure and IoT technologies.	Current drainage system inadequate for extreme flow of 19.46 m^3/s; recommended drainage channel width approximately 20 meters; GIS-based system improves water management efficiency, identifies problem drainage channels, monitors environmental conditions, and supports sustainable urban planning.
202	Dynamics of Heat Island Intensity in a Rapidly Urbanizing Area and the Cooling Effect of Ecological Land: A Case Study in Suzhou, Yangtze River Delta	Jingyi Sun, Haidong Li, Ruya Xiao, Guohui Yao, Fengli Zou	2024	https://doi.org/10.3390/su16114422	Urban Heat Island; Ecological land; Land Surface Temperature; Remote Sensing; Urbanization; Cooling Effect	To analyze the spatio-temporal dynamics of the urban heat island intensity, examine the relationship between land use changes and heat patterns, and evaluate the cooling effect of ecological land in Suzhou.	Utilized a long-time-series of Landsat remote sensing images (2000–2021) to retrieve land surface temperature; employed GeoDetector method to analyze driving factors including NDBI, NDVI, land use change, population density, and proximity to water bodies; land classification data from GlobeLand30 to categorize ecological land types; spatial-temporal pattern analysis of UHI expansion and cooling effects of ecological land.	- High temperature zones expanded from the urban center outward from 2000 to 2021; medium temperature zones decreased while sub-high temperature zones expanded; - Ecological land showed a significant cooling effect in the urban thermal environment; - Conversion of ecological land to artificial surfaces was linked to increased surface temperature; - The influence of proximity to water bodies on cooling was weak due to urban spatial layout; - Population density had a low detected impact on UHI due to data limitations.

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203	Utilization of Weather Radar Data for the Flash Flood Indicator Application in the Czech Republic	Petr Novák, Hana Kyznarová, Martin Pecha,Petr Šercl,Vojtěch Svoboda andOndřej Ledvink	2021	http://dx.doi.org/10.3390/rs13163184	remote sensing; weather radar; quantitative precipitation estimates; flash flood nowcast-ing; hydrological modeling	In the past few years, demands on flash flood forecasting have grown. The Flash Flood Indicator (FFI) is a system used at the Czech Hydrometeorological Institute for the evaluation of the risk of possible occurrence of flash floods over the whole Czech Republic. The FFI calculation is based on the current soil saturation, the physical-geographical characteristics of every considered area, and radar-based quantitative precipitation estimates (QPEs) and forecasts (QPFs). For higher reliability of the flash flood risk assessment, calculations of QPEs and QPFs are crucial, particularly when very high intensities of rainfall are reached or expected. QPEs and QPFs entering the FFI computations are the products of the Czech Weather Radar Network. The QPF is based on the COTREC extrapolation method. The radar-rain gauge-combining method MERGE2 is used to improve radar-only QPEs and QPFs. It generates a combined radar-rain gauge QPE based on the kriging with an external drift algorithm, and, also, an adjustment coefficient applicable to radar-only QPEs and QPFs. The adjustment coefficient is applied in situations when corresponding rain gauge measurements are not yet available. A new adjustment coefficient scheme was developed and tested to improve the performance of adjusted radar QPEs and QPFs in the FFI.	Radar-Only QPE Statistical Evaluation of the New LB Adjustment Scheme	The Flash Flood Indicator (FFI) system is an effective tool for assessing flash flood risk. Radar-based precipitation estimates and forecasts (QPE and QPF) are critical for accurate evaluation of flash flood risk. The findings emphasize the importance of integrating radar and rain gauge data in flash flood risk management and highlight the impact of newly developed methods on improving system performance.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
204	Application of a multi-criteria decision support system for assessing development potential in flood risk areas - Case study of the Warta River	Joanna Kubiak, Ireneusz Laks, Zbigniew Sroka, Zbigniew Walczak	2024	https://doi.org/10.1016/j.scitotenv.2024.174513	Decision making, Flood hazard, Flood risk, Development, Buildings, Olęder villages, Evaluation model, PROMETHEE II method	Článek pojednává o konceptu vlastního rozhodovacího modelu, který umožňuje určit, zda lze plánovaný rozvoj v oblastech nechráněných protipovodňovými hrázemi a ohrožených záplavami utvářet bezpečným způsobem. Model byl použit k vyhodnocení možnosti utváření rozvoje v oblastech ohrožených záplavami na příkladu jednoho z typů olęderských vesnic – rozptýlené vesnice nacházející se v záplavových oblastech řeky Warty (západní Polsko).	The most important element of the analysis carried out was the development of an evaluation method based on multi-criteria decision support methods (PROMETHEE and AHP).	Shaping the development in flood-risk areas Proprietary decision-making model based on PROMETHEE II method. Assessment of the decision-making model for villages located in flood plains Sensitivity analysis of the developed decision-making model.
205	An approach to classify areas for appropriate rainfall-runoff risk management: A case study in Drevenica basin, Slovakia	Dávid Dežerický, Karol Šinka, Petra Pipíšková, Miroslav Dumbrovský, Timo Schaffhauser, Zlatica Muchová	2023	https://doi.org/10.1016/j.ecoleng.2023.107083	Critical profile (CP); Soil erosion risk (SERL); Flooding; Land use management	Best management practices for landscapes include adapting them to rainfall extremes that have an impact on surface runoff. A critical profile (CP) is a location where a path of concentrated surface runoff might enter an inhabited area causing potential damage, e.g. by flooding, water erosion and torrential mudflows. Critical profiles have been determined using modified methodological guidelines for identifying critical points by the T.G. Masaryk Water Research Institute in Prague, 2009.	GIS-based modeling of rainfall–runoff dynamics within the study area. Identification of locations vulnerable to flooding, water erosion, and mudflows. Development of a detection map highlighting critical sites for the implementation of ecological engineering interventions. Refinement of the detection methodology through field surveys and spatial clustering techniques. Adjustment of selection criteria and threshold values to improve accuracy and relevance.	GIS modelling of rainfall-runoff conditions in a territory. Identification of sites endangered by flooding, water erosion and mudflows. Generation of a detection map of critical localities for ecological engineering measures. Modification of detection methodology based on field surveys and clustering. Adaptation of selection parameters and thresholds."

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206	Mitigation of Flood Risks with the Aid of the Critical Points Method	Karel Drbal,Miroslav Dumbrovský 2,Zlatica Muchová, Veronika Sobotková ,Pavla Štěpánková, Bořivoj Šarapatk	2022	https://doi.org/10.3390/agronomy12061300	concentrated surface run-off; mitigation of flood risks; transport of sediments; soil degradation; water erosion; water retention	Concentrated surface run-off caused by torrential rain leads to the transport of sediments from soil erosion processes within catchment areas of critical points, which represents a basic component of flood risks. Clear identification of such critical points offers a basis for a suitable new strategy of threat mitigation, via both organizational and structural measures in catchment areas. Critical points are determined in places where generated paths of concentrated surface run-off cross given boundaries of built-up areas. The threshold values for the catchment area of a critical point were derived on the basis of hydrological calculations, field research, and the evaluation of hundreds of specific manifestations of damage in built-up areas for particular critical profiles.	Determination of Critical Points. Evaluation of Influence of Critical Conditions within Catchment Areas on Run-Off Characteristics in Watersheds.	Knowledge of the existence of critical points enables the implementation of preventive measures, the evaluation of flood risk associated with the transport of sediment due to erosion processes, and the improvement of management measures in respective catchment areas, even before an event occurs. The proposed procedure outputs shall be reflected in spatial planning documentation, land consolidation, and catchment area management plans. Incorporation of critical points into open-access public web-maps can help with assessing the semi-quantitative expression of risk to built-up areas arising from the threat of local flooding.
207	Public support for urban climate adaptation policy through nature-based solutions in Prague	Tomáš Baďura, Eliška Krkoška Lorencová , Silvia Ferrini, Davina Vačkářová	2021	http://dx.doi.org/10.1016/j.landurbplan.2021.104215	Nature-based solutions, Climate adaptation, Urban green space, Non-market valuation, Stated preference, Choice experiment	Climate change is an urgent challenge in urban planning. Weather extremes and resulting impacts such as heat waves and flash floods are already influencing the quality of life in cities and impact on infrastructure, human health and city life. In this study, we investigated perception of and economic preferences for adaptation to climate change in one of Europe's capital cities to inform its planning policy.	questionnaires + choice experiment: valuation scenario and selection of attributes	Climate change and heatwaves are seen as risk by population of Prague. Use of Nature Based Solutions (NBS) for adaptation is supported by the public. Species diversity of NBS measures is valued by respondents. Measures implemented in public spaces preferred over those on public buildings. Negative experience with heat waves increases support for NBS.

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208	Compound Temperature and Precipitation Events in the Czech Republic: Differences of Stratiform versus Convective Precipitation in Station and Reanalysis Data	Zuzana Rulfová, Romana Beranová, Eva Plavcová	2021	https://doi.org/10.3390/atmos12010087	compound events; temperature; stratiform precipitation; convective precipitation; atmospheric circulation; Czech Republic	Some natural hazards may result from the coincidences of anomalies of different climatic variables. These so-called compound events can cause extreme impacts. This study analyzes compounds of extreme temperature with notable convective and stratiform precipitation in the Czechia.	Observed Data and Reanalysis	Notable stratiform precipitation most frequently coincides with warm nights and warm days in winter and in the other seasons with cold days. In summer, almost a quarter of all cold days are connected with notable stratiform precipitation. Compound events with notable convective precipitation occur most frequently in summer and are linked mainly to warm days and warm nights. Cold nights coinciding with either stratiform or convective notable precipitation are rare throughout the year.
209	Czech citizens' preferences of adaptation measures to limit damages from floods and droughts	Iva Zvěřinová, Milan Ščasný, Zuzana Rajchlová	2018	http://dx.doi.org/10.46555/VTEI.2018.01.006	climate change adaptation, hard measures, nature-based measures, discrete choice experiments, willingness to pay	The aim of the research is to examine attitudes and preferences of the Czechs for adaptation measures reducing impacts of floods and droughts.	questionnaires	The Czechs are willing to pay part of the costs of drought and flood damage reduction. The average household willingness to pay for adaptation measures reducing impacts of droughts is CZK 1,000 a month and of floods is CZK 923. Respondents are willing to pay for costs of technical measures, but their acceptability declines as their share increases at the expense of natural measures.

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210	Ecological restoration zoning based on ecological risk and resilience assessment: A case study of Jiaozuo City	Kexin Zhang, Jiabin Wang, Ying Zhou, Zhe Feng, Kening Wu	2025	https://doi.org/10.1177/2754124X251315132 https://www.researchgate.net/profile/Kexin-Zhang-94/publication/389798200_Ecological_restoration_zoning_based_on_ecological_risk_and_resilience_assessment_A_case_study_of_Jiaozuo_City/links/67e003cee62c604a0d0d2412/Ecological-restoration-zoning-based-on-ecological-risk-and-resilience-assessment-A-case-study-of-Jiaozuo-City.pdf?origin=publication_detail&_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uRG93bmxvYWQiLCJwcmV2aW91c1BhZ2UiOiJwdWJsaWNhdGlvbiJ9fQ&__cf_chl_tk=UixMY.G3oGUxHx8mYJrc36NNfgE_dsEIiXvI4kpsBJU-1753120976-1.0.1.1-hc3sDWKTaePU8s_zZnmRk00lCVNuqaS8VJOZdx74eBU	Ecological restoration, ecological risk, ecological resilience, ecological security pattern, urban construction, zoning, Jiaozuo City	To assess ecological risk and resilience of Jiaozuo City, construct ecological security patterns, and develop optimized ecological restoration zoning integrating ecological protection with socioeconomic development.	Comprehensive assessment via ecological risk and resilience evaluation, construction of ecological security pattern (sources, corridors, pinch and barrier points), urban construction space identification using POI and nighttime lighting data, and zoning based on combined assessments.	Jiaozuo City has low overall ecological risk and high ecological resilience; 57 ecological sources, 164 corridors, 254 pinch points, 36 barrier points identified; urban construction area 209.11 km2; five zoning categories defined with different management strategies.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
211	Enhancing Disaster Response and Resilience Through Near-Time GIS for Flood Monitoring and Analysis in Niger River Basin, Nigeria	Mercy Onaopemipo Akintola	2024	https://doi.org/10.5194/isprs-archives-XLVIII-3-2024-377-2024	Flood Monitoring; Disaster Response; Geospatial Analysis; Flood Resilience; Flood Mapping; NDWI; Google Earth Engine	To develop an integrated near real-time flood mapping and impact analysis framework using Google Earth Engine to quantify flood hazards and exposure, enabling enhanced disaster response and resilience in the Niger River Basin, Nigeria.	Leveraged multi-sensor satellite data (Sentinel-2 optical, Sentinel-1 radar, Landsat 8, NASA SRTM DEM) on Google Earth Engine's cloud platform. Utilized indices like NDWI for flood delineation, manual thresholding, land cover classification with machine learning (random forest semantic segmentation). Integrated hydrologic and land use data and performed accuracy assessments with ground truth. Developed operational dashboards for near real-time analysis and decision support.	Flood extent almost doubled from about 42,300 hectares pre-2022 to over 78,000 hectares post-2022 flood event. Flooded areas increased by over 50% between March-May 2022 and June-October 2022. Approximately 15,000 hectares of vegetation and 143,000 residents affected. Accuracy assessment showed about 90% precision in flood boundary delineation. Identified critical flood hotspots and underlying causes such as elevated precipitation and land use changes that accelerate runoff.
212	Enhancing Sustainable Flood Resilience and Energy Efficiency in Residential Structures: Integrating Hydrological Data, BIM, and GIS in Quetta, Pakistan	Muhammad Asfandyar, Nazir Ahmed Bazai, Huayong Chen, Muhammad Habib, Javed Iqbal, Muhammad Aslam Baig, Muhammad Hasan	2025	https://doi.org/10.3390/su17062496	Building Information Modeling (BIM); Geographic Information System (GIS); Energy Efficiency; Flood Resilience; Sustainable Construction; Hydrological Data; Quetta	To investigate the potential of integrating BIM and GIS to improve energy efficiency and flood resilience in residential structures, specifically in flood-prone urban settings like Quetta, Pakistan. To offer a unified framework for assessing both energy performance and flood risk to support sustainable and resilient building design.	The study used an integrated methodological framework that combined: 1) BIM-based 3D modeling and energy simulation tools adhering to LOD 300 standards for detailed geometry and material properties; 2) High-resolution GIS spatial data, Digital Elevation Models (DEMs), hydrological risk modeling, and hydraulic modeling to simulate flood scenarios; 3) Scenario-based analyses focusing on energy-saving design modifications such as insulation and window glazing; 4) Structural vulnerability assessments and socio-economic damage estimations based on Pakistani engineering standards; 5) Integration of BIM and GIS using IFC files imported into ArcGIS and extended with CityGML for temporal flood dynamics.	Scenario analyses revealed energy savings: enhanced insulation reduced energy use by 11.78%, double-glazed windows by 5.8%, decreasing monthly energy costs up to 48.2%. Orientation affected energy cost significantly: north-facing homes increased energy cost by 36.82%. Flood modeling predicted max flood depths around 2 m causing non-structural damage costing ~PKR 250,000 (~10% building cost). Mitigation via flood-resistant materials and elevated floors could cut repair costs by 30–50%. Groundwater effects on foundations were also assessed. The combined BIM-GIS approach enabled precise vulnerability mapping and planning.

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213	Environmental Impact Assessment of Construction Waste Recycling versus Disposal Scenarios Using an LCA-BIM Tool during the Design Stage	Carmen Llatas, Rocío Quiñones, Nuria Bizcocho	2022	https://doi.org/10.3390/recycling7060082	Construction waste, Recycling, Life cycle assessment, Building Information Modeling (BIM), Circular economy, Environmental impact	To develop and apply a tool integrated in BIM software that enables designers to quantify and compare the environmental impact of recycling versus disposal scenarios of construction waste during the building design phase without requiring expert knowledge in LCA.	Five-step methodology: 1) Quantifying types and quantities of recyclable construction waste in BIM using a BIM tool. 2) Implementation of LCA-based environmental impact factors in BIM. 3) Classification and management options assignment of waste. 4) Integration of these factors and calculation into BIM software tool. 5) Application of the tool to a real case study (multi-family housing building 'La María' in Seville).	The case study showed that recycling scenarios generally have lower environmental impacts compared to disposal across all waste types and environmental categories except specific cases (plastic in ODP and steel in HTP). The tool effectively supports decisionmaking in the early design phase to enhance circular economy practices in construction.
214	Environmental impacts and BIM: a Portuguese heritage case study	Gabriel Tomasetto Sugiyama, Maria Fernanda Rodrigues, Hugo Rodrigues	2024	https://doi.org/10.1108/IJBPA-10-2023-0160	Heritage, Retrofit, Building Information Modelling (BIM), Sustainable construction, Life Cycle Assessment	This paper aims to compare the possible environmental impacts of different rehabilitation solutions proposed to a case study of a Portuguese vernacular building, bearing in mind the need to search for less impactful practices in accordance with global agendas and, simultaneously, the importance of preserving heritage assets.	The two proposed solutions differ from each other in the selection of materials, varying from the exclusive use of conventional contemporary materials to the use of locally sourced and natural-based materials, considering the Portuguese and local scenario. Results obtained from Life Cycle Assessment procedures are the basis of comparison, which were developed using a Building Information Model (BIM)-integrated analytical plugin.	Producing Heritage Building Information Model (HBIM) models was essential to the analysis, and therefore is a vital part of the used methodology; nevertheless, the modelling of heritage buildings itself plays an important part in preserving heritage assets once it provides precise documenting and managing tools. The results depict variation in values for different indicators in both cases, whose interpretation might need further development to get to deeper conclusions. It has been found that the software tools are still not well adapted to analyse heritage or historic buildings, and therefore adaptations had to take place to overcome these limitations.

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215	Green Infrastructure as Flood Mitigation Strategy in Houston, Texas: A Geodesign Approach	Ana Hampshire, James L. Sipes	2019	https://www.aimspress.com/article/10.3934/geosci.2019.4.899	Hurricane Harvey; Urban Flooding,Green Infrastructure; Flood Mitigation; Urban Flooding; Low Impact Development (LID); Geodesign; Houston	To investigate how flood volume reduction can be achieved through green infrastructure combined with existing flood management, and to propose a sustainable landscape design that enhances community connectivity and mitigates flooding in Houston's Buffalo Bayou watershed.	The study defines a pilot study area in Houston's Buffalo Bayou watershed, identifies priority flood-prone areas based on FEMA damage data, examines conventional and innovative flood control methods including LID, water squares, and sponge cities, and uses GIS-based geodesign processes to map potential implementation sites and design conceptual green alleys and eco-boulevards.	The research identified approximately 8 km of potential green alleys and eco-boulevards that would improve connectivity and flood resilience by employing LID practices such as bioswales and permeable pavements. Underground storage systems were estimated to provide detention volumes sufficient to mitigate flooding during extreme storms. The study suggests a need for about 4.6 million m^3 of stormwater detention in the 43.74 km^2 pilot area.
216	GEODESIGN AND SIMULATION OF TWO AUSTRALIAN COMMUNITIES 2016–2050: WHAT DOES THE FUTURE HOLD ARE THEY SUSTAINABLE OR NOT?	M. Herron, D. Jones, P. Roos, C. Donley	2015	https://www.researchgate.net/publication/313777144_GEODESIGN_AND_SIMULATION_OF_TWO_AUSTRALIAN_COMMUNITIES_2016-2050_WHAT_DOES_THE_FUTURE_HOLD_ARE_THEY_SUSTAINABLE_OR_NOT/link/58d0385c458515302b8563f7/download?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uIn19	GeoDesign, climate change, Australian communities, land use planning, coastal cities, sustainability, simulation, scenario planning, GIS, visualization	To comprehend growth risks related to coastal edges and land use planning mechanisms addressing changes from 2016–2050 in two Australian communities, and test if visualization techniques can effectively portray complex spatial and environmental data for planning use.	Scenario planning with three population and housing growth forecasts (low, base, high) using Community Viz software integrated with GIS; build-out, suitability, and allocation analyses were performed; over 150 datasets, 100 assumptions, 100 attributes, and 100 indicators were used; visualization of the spatial results into maps and charts.	- Projected increase in population and urban density with associated rises in emissions and resource consumption. - Identification of environmental impacts like reduced open space and increased stress on infrastructure. - Adoption of new mixed commercial/residential zones increasing development flexibility. - Effective visualization facilitating stakeholder understanding and decision-making.

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217	Geodesign in Regional Green Infrastructure Planning	Maria do Carmo de Lima Bezerra, Camila Zyngier, et al.	2022	https://doi.org/10.1007/978-3-031-10545-6_11	Green infrastructure, Geodesign, Landscape ecology, Urban resilience, Participatory planning, Ecosystem services, Federal District (Brazil)	To improve assertiveness in addressing environmental service depletion in urban areas of the Federal District by applying geodesign-based planning methods for green infrastructure networks.	Conducted a participatory workshop utilizing the Brazilian geodesign platform (Giscolab) integrating 39 spatial data layers grouped in 6 thematic categories. The method involved collaborative proposal design, iterative voting and approval process, and synthesis of information related to landscape ecology, ecological support processes, and urban infrastructure subsystems.	Four approved subsystems proposals were identified: leisure and culture, provision, green infrastructure, and blue infrastructure. Highlights include connectivity of biodiversity cores, strategies for water recharge areas, and urban retrofitting with green infrastructure for permeability. The approach facilitated multi-stakeholder engagement and collective synthesis of territorial conflicts and potentials.
218	Geodesign: Applications towards Smarter Planning and Urban Design Solutions	Dr. Nadia Amoroso, Adele Pierre, Dr. Leif Olson, Grant Pearsell, Devin Lavigne	2019	https://doi.org/10.15640/jaes.v8n2a2	geodesign, GIS, data-driven design, landscape architecture, stormwater management, urban planning, sustainable cities	To create a data-driven, collaborative geodesign process that balances ecological, recreational, and development needs to produce sustainable urban planning outcomes.	Three collaborative workshops were conducted engaging stakeholders (landowners, developers, city planners), utilizing spatially explicit analytic tools and geodesign technologies such as ESRI CityEngine and ArcGIS to model and evaluate alternative land use concepts early in the planning process.	Recommended land use concept (Emerald Crescent) retains 72% Environmental Reserve areas, balances open space with development, improves stakeholder buy-in, and reduces planning costs. Case studies (e.g., Decoteau Area Structure Plan in Edmonton, Battle Creek, Michigan) show geodesign supports sustainable and ecological urban redevelopment including three-dimensional visualization and spatial analytics.
219	Geographic Information System (GIS) as Tool to Manage the Impacts of Flood in Shah Alam, Malaysia	Adam Narashman Leeonis, Minhaz Farid Ahmed, Mazlin Mokhtar	2024	https://doi.org/10.1051/e3sconf/202459905002	GIS, Flood management, Flood risk, Malaysia, Environmental Impact, Disaster management	To investigate how GIS can help manage environmental impacts of floods in Shah Alam, Malaysia, and to explore its role in flood management and mitigation.	Qualitative thematic analysis using informal interviews with 20 respondents from government, academia, business, and community/NGO sectors based on the quadruple helix model. Use of Taguette software for qualitative data analysis.	The study found progress in GIS use for flood management including mapping flood risk areas, government initiatives like CCTV installations to monitor flood-prone areas, public access to GIS flood information via multiple platforms. However, challenges like ineffective inter-agency management, public awareness gaps, limited info access, and equipment shortages remain.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
220	Green infrastructure site prioritization to improve urban flood resilience in Monterrey and Brussels using a decision support model	Mina Khodadad, Mohsen Sanei, Ismael Aguilar-Barajas, Leopoldo Eduardo Cárdenas-Barrón, Aldo Iván Ramírez-Orozco, Agatino Rizzo, Ahmed Z. Khan	2025	https://doi.org/10.1038/s41598-025-94851-z	Urban flood resilience, Green infrastructure, GIS-MCDA, Urban planning, Climate adaptation	To develop and apply a multi-criteria framework (FRUGISP) to prioritize urban regions for green infrastructure interventions aimed at improving flood resilience in diverse urban contexts.	GIS-based Multi-Criteria Decision Analysis (GIS-MCDA), overlay analysis, analytic hierarchy process (AHP) to weigh indicators, exclusion of unsuitable areas via criteria, applied in two case study cities	Identification of high priority areas for green infrastructure based on flood resilience indices combined with land availability, revealing targeted urban spots in Monterrey and Brussels suitable for GI installations
221	How to Obtain Accurate Environmental Impacts at Early Design Stages in BIM When Using Environmental Product Declaration. A Method to Support Decision-Making	Elisabetta Palumbo, Bernardette Soust-Verdaguer, Carmen Llatas and Marzia Traverso	2020	https://doi.org/10.3390/su12176927	Environmental Product Declaration; Building Information Modeling (BIM); Life Cycle Assessment (LCA); Concrete; Environmental Impacts; Early Design Stages; Sustainability	To develop and validate a method that enables consistent and accurate use of EPDs at different BIM design stages for reliable environmental impact assessment, focusing initially on concrete for structural applications.	The method involves four steps: (1) Determining environmental profile of concrete through a case study of an office building in Germany, (2) Collecting EPDs for concrete products suitable for structural uses, (3) Classifying EPD indicators on performance basis per ISO 14025, (4) Determining safety and range factors (min, max, average, median) for EPD indicators from early to detailed design stages and facilitating integration into BIM.	The study provided minimum, maximum, and median environmental impact values that can aid decision-making at early design stages and demonstrated the feasibility of integrating EPD information in BIM workflows, though limited by number and variability of available EPDs and limited to cradle-to-gate LCA modules (A1–A3).

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
222	INCEPTION OF HARMONISING DATA SILOS AND URBAN SIMULATION TOOLS USING 3D CITY MODELS FOR SUSTAINABLE MANAGEMENT OF THE URBAN FOOD WATER AND ENERGY RESOURCES	Rushikesh Padsala, Ernst Gebetsroit her-Geringer, Jan Peters-Anders, Volker Coors	2021	https://doi.org/10.5194/isprs-annals-VIII-4-W1-2021-81-2021	Data Modelling, CityGML, Application Domain Extension, 3D City Models, Urban Food Water Energy Resources, Data Silos, Urban Simulation, Urban Sustainability	Develop a cohesive data model (FWE ADE) based on CityGML to harmonise food, water and energy data silos and enable integrated urban simulation and visualization tools that support sustainable management of urban FWE resources	Development of FWE ADE modules (FWEBuilding, Landuse, Area, System); data harmonisation workflows; case studies in Ludwigsburg, Vienna, and Gowanus using 3D city models; integration of disparate urban simulation tools; analysis of interdependencies between FWE domains	Demonstrated FWE ADE use in harmonising multi-domain data and simulation workflows; visualised future urban FWE demands and potentials in case studies; identified need for further extension (e.g. green roofs, energy recovery from waste); showed benefits of integrated modeling over siloed approaches
223	Indicators for climate change-driven urban health impact assessment	Attila János Trájer, Viktor Sebestyén, Endre Domokos, János Abonyi	2022	https://doi.org/10.1016/j.jenvman.2022.116165	Climate change; Urban greening; Health risks; Environmental modelling; Adaptation action; Urban heat island; Vector-borne diseases; Waterborne diseases; Air pollution	To model and evaluate how different urban greening strategies can reduce adverse health-related impacts of climate change in medium-sized urban environments, with application to the city of Veszprém.	A multivariate modeling approach combining downscaled climate scenarios (RCPs), satellite imagery for vegetation and urban cover, urban heat island modelling, and regression models for six health-related indicators: relative incidences of salmonellosis, campylobacteriosis, potential generation numbers of Plasmodium vivax and Aedes albopictus, total July mortality risk, and surface ozone concentration. Greening scenarios including pocket parks and larger parks simulated to assess risk reduction.	Results showed heterogeneous spatial patterns of health risks within the city. Campylobacteriosis incidence and potential vector-borne diseases were most sensitive to combined climate change and urban heat island effects. Both pocket parks and normal parks contribute to reducing urban heat island effect and mitigate health risks, with pocket parks showing impact also at the mesoscale city level. Effectiveness of greening varies by health indicator and climate scenario.
224	Integrating GIS, MCDM, and Spatial Analysis for Comprehensive Flood Risk Assessment and Mapping in Uttarakhand, India	Dhaval R. Maru, Vijendra Kumar, Kul Vaibhav Sharma, Quoc Bao Pham, Anant Patel	2025	https://doi.org/10.1002/gj.5172	GIS, Multi-Criteria Decision Making (MCDM), AHP, Flood Risk, Spatial Analysis,	To develop a comprehensive framework for flood risk assessment and mapping in Uttarakhand using GIS and MCDM techniques	Spatial analysis combined with GIS and AHP (Analytic Hierarchy Process) for weighting seven criteria: elevation, slope, drainage density, rainfall, LULC, distance from river, and distance from road. Pairwise comparison matrices used for criterion weighting and creation of Flood Risk Index (FRI).	The flood risk map revealed that approx. 38.54% of Uttarakhand belongs to a high-risk flood zone, with 3.17% very high risk; lower altitudes and flatter terrains are more susceptible; rainfall, elevation, slope, drainage density are key factors; proximity to rivers increases risk; road infrastructure can exacerbate flood hazards

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225	Integrating Green-Infrastructures Design in Strategic Spatial Planning with Geodesign	Michele Campagna, Elisabetta Anna Di Cesare, Chiara Cocco	2020	https://doi.org/10.3390/su12051820	green infrastructure; geodesign; spatial planning; systems thinking; collaborative design	To present an operative example focusing on applying systems thinking to planning and design, and to demonstrate how geodesign and geodesign workshops facilitate integrating green infrastructure design within the early phases of regional strategic planning.	A geodesign study conducted with undergraduate and graduate students involving intensive workshops where participants collaboratively developed strategic planning alternatives for the Metropolitan City of Cagliari, Italy. Modeling tables and evaluation maps were used to represent green infrastructure and interacting systems. Performance and design evolution indicators were implemented and analyzed using digital dashboards. Topology similarity measures between design diagrams were also computed.	The geodesign workshops proved effective in supporting integrated design of green infrastructure with other systems. The study showed that geodesign methods can rapidly raise awareness and improve collaborative design capabilities regarding green infrastructure in strategic planning. The use of modeling tables and digital dashboards provided clear tools for evaluating design alternatives and system interactions at multiple scales.
226	Jiading New City Green Ecological Urban Planning and Practice ; A Case Study of Yuanxiang Lake Central Activity Zone	Guoshu Yang, Hongyan Pan, Hua Sun	2025	https://doi.org/10.1051/e3sconf/202561703010	Green ecological urban planning, Low-carbon cities, Sustainable development, Urban resilience, Eco-city indicators, Case study, Shanghai	To demonstrate and explore green ecological urban planning and practice through the Yuanxiang Lake Central Activity Zone as a pilot for Jiading New City's green development under the national dual carbon strategy.	The study analyzed planning policies, green ecological indicator systems, design concepts like the "Green Gene Chain", and implementation mechanisms including phased indicators, management systems, and pilot project assessments. It reviews urban design features and low-carbon technologies applied in the Yuanxiang Lake Central Activity Zone.	Jiading New City comprehensively enhanced urban capacity focusing on green, low-carbon strategies. The project established rigid and flexible green ecological indicators including low-carbon chain, health chain, resilience chain, vitality chain, and intelligence chain. It has created a pilot three-star green ecological city with projected carbon emission reductions over 20%, over 35% urban green space rate, and public service coverage within 15-minute walkzones. Demonstrations of low-energy buildings, renewable energy adoption, sponge city construction, and smart city facilities were integrated.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
227	Mapping Re-Naturalization Pathways for Urban Ecological Governance: A Spatial Decision-Support Framework Based on Ecosystem Service Valuation	Chengji Shu, Kaiwei Du, Wenbo Cai, Zhengwu Cai, Li Lin	2025	https://doi.org/10.3390/land14050917	urban ecological governance, ecosystem services, land use simulation, re-naturalization pathways, spatial decision-support, Shanghai, ecological planning	To guide future urban land use development planning and identify feasible re-naturalization pathways that enhance ecosystem service values,To establish a comprehensive database for ecosystem service assessment and land use simulation; use PLUS model, Markov chain, and government planning constraints to simulate land use under scenarios; evaluate ecosystem service values with InVEST and IUEMS platforms; identify optimal scenario and map re-naturalization pathways.	The ecological development scenario is the optimal one with the highest ecosystem service value (CNY 189,240.29 million), exceeding other scenarios by 9.53% to 23.27%. Twelve re-naturalization pathways covering 686.88 km2 were identified, mainly cropland to forestland and built-up land to cropland transformations.	Provides a robust spatial decision-support framework for ecological governance that integrates ecosystem valuation and land-use planning; offers actionable guidance for sustainable urban development and ecological restoration practices.
228	On the interpretation of surprisingly high variation of soil map diversity in country-wide study of flood-affected agroecosystems using the legacy data in the Czech Republic	Jan Skála,Tereza Zádorová, Daniel Žížala	2021	https://doi.org/10.1016/j.geoderma.2020.114732		Legacy soil data have been produced worldwide to provide maps of soil classes or properties. In this study, we joined the legacy results of conventional soil mapping with the application of the pedodiversity concept and compositional data analysis in a comprehensive spatial analysis of the mapped soil diversity within flood-prone agroecosystems in the Czech Republic.	Statistical differences in Shannon's entropy (conventional and adjusted with taxonomic distances) over different regional inundation areas had been statistically examined, their interpretation was based on Aitchison's geometry of simplex, rendering an appropriate statistical framework to avoid methodological bias through the use of raw proportions in soil taxa compositions. Working with tailored orthonormal coordinates enabled us to verify the dependency of the soil taxa composition on the multi-category factors of agroecosystem type and flood-periodicity through a conventional linear modelling.	The supervised compositional approach improved interpretability of soil information within the Czech legacy soil maps, and hence general patterns of pedodiversity in floodplains might be effectively described in an informative and quantitative manner. The most obvious differences of the soil map diversity proved the regional inundation areas within the catchments with the enhanced complexity of drainage network that might arise from multiple sources (substrate diversity, climatic zonality, man-induced landscape alteration).

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
229	Messy maps: Qualitative GIS representations of resilience	Faith E. Taylor, James D.A. Millington, Ezekiel Jacob, Bruce D. Malamud, Mark Pelling	2020	https://doi.org/10.1016/j.landurbplan.2020.103771	Qualitative GIS, urban resilience, informal settlements, flood resilience, social networks, participatory mapping, Global South, disaster risk reduction	To better record and represent flood resilience of the urban poor and integrate these data within the existing knowledge infrastructures used for resilience planning, especially in informal settlements of the Global South.	Arts-based workshop activities including: Material metaphors, Storytelling, Trust transects, Social networks mapping, Guided walks. Data synthesized into GIS layers using free and accessible software (QGIS, Gephi, GoogleMyMaps).	Four key map layers produced per city: (i) flood footprints showing residents' spatial knowledge of floods; (ii) georeferenced narrated 360° photospheres capturing multiple perspectives; (iii) spatial social network maps depicting residents' connections to formal and informal actors before/during floods; (iv) multimedia pop-ups providing contextual details missing from traditional GIS maps. Visualization integrated with existing planning knowledge infrastructures.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
230	Meta-Analysis ELECTRE III and AHP in Evaluating and Ranking the Urban Resilience	Robert KOSOVA, Daniela Halidini QENDRAJ, Evgjeni XHAFAJ	2022	https://www.researchgate.net/profile/Robert-Kosova/publication/361142638_Meta-Analysis_ELECTRE_III_and_AHP_in_Evaluating_and_Ranking_the_Urban_Resilience/links/665ef8d8d59c846ad4302f71/Meta-Analysis-ELECTRE-III-and-AHP-in-Evaluating-and-Ranking-the-Urban-Resilience.pdf?origin=publication_detail&_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uRG93bmxvYWQiLCJwcmV2aW91c1BhZ2UiOiJwdWJsaWNhdGlvbiJ9fQ&__cf_chl_tk=jUUTrL620FHIXOFwL1Xl4JPh4Q4FA2zGoZxpLDtZU1A-1753169138-1.0.1.1-mySglr222L_TlxDgTIrGiaXVgzyoGEbY6Js3JBwY3r8	urban resilience, AHP, ELECTRE III, multi-criteria decision analysis, flood risk, earthquake, coastal erosion, disaster resilience	To assess the urban resilience of Durres County and rank its regions and municipalities using AHP and ELECTRE III, to identify areas needing improvement	AHP for criteria weighting and hierarchical structuring; ELECTRE III for multicriteria decision analysis and ranking alternatives (regions, municipalities)	R1 region identified as best prepared; M5 region (Ishem) as the worst prepared. All regions in Durres district require improvement in preparedness to face future risks.

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231	Objective well-being level (OWL) composite indicator for sustainable and resilient cities	Viktor Sebestyén, Attila János Trájer, Endre Domokos, András Torma, János Abonyi	2024	https://doi.org/10.1016/j.ecolind.2023.111460	Urban well-being, Objective well-being level (OWL), Sustainable urbanization, Composite indicators, Principal Component Analysis, Urban planning, Environmental factors, Health, Climate, Safety	To create and validate a comprehensive, objective composite indicator system (OWL) that assesses urban well-being for supporting sustainable city planning and strategic interventions.	Integration of 24 spatially modeled indicators related to well-being categories; aggregation through Principal Component Analysis (PCA) to reduce redundancy; normalization of indicators; spatial analysis mapping patterns within the city.	OWL revealed complex urban well-being macrostructures with heterogeneous spatial distributions influenced by environmental, social, and climatic factors. Key findings include identification of distinct clusters related to thermal, traffic, and population density affecting well-being. Recommendations include natural restoration and infrastructures incorporating green and blue elements, particularly in detached house, industrial, and downtown areas, and enhancing infrastructure diversity in peripheral zones.
232	Flood frequency estimation by continuous simulation of subcatchment rainfalls and discharges with the aim of improving dam safety assessment in a large basin in the Czech Republic	Sarka BlazkovaKeith Beven	2004	https://doi.org/10.1016/j.jhydrol.2003.12.025		This paper applies a continuous simulation approach to the estimation of flood frequency for a dam site in a large catchment (1186 km2) in the Czech Republic. The models used allow for the simulation of both high intensity and low intensity rainfall events, and snowmelt events, over subcatchments in contributing to the flood frequency distribution.	The methodology is implemented within a Generalised Likelihood Uncertainty Estimation framework that allows for uncertainty in the model parameters and for the realisation effect in reproducing the apparent statistics of potential flood events represented by the short series of observations. A fuzzy rules method is used to evaluate each model run, based on the available observations of peak discharges, flow duration curves and snow water equivalents. This yields a combined likelihood measure that is used to weight the flood predictions for each behavioural parameter set. The cumulative distribution for flood peaks for any chosen probability of exceedence over all behavioural models can then be estimated.	This methodological attitude can be used to assess the risk of a potential flood peak (or duration or volume) within a risk based dam safety assessment.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
233	Operationalizing Urban Ecology and Circular Economy in Montreal's South-West Neighborhoods Using an Interdisciplinary Approach	Daniel Pearl, Amy Oliver, Cécile Bulle, Titouan Greffe, and Claudiane Ouellet-Plamondon	2025	https://link.springer.com/chapter/10.1007/978-3-031-82896-6_2	urban ecology, circular economy, interdisciplinarity, Montreal, sustainable urban development	To develop a practical interdisciplinary framework for implementing urban ecology and circular economy concepts at the neighborhood scale.	Uses spatial mapping, stakeholder interviews, participatory workshops combining qualitative and quantitative data, involving multi-sector collaboration.	Identified key circular economy initiatives aligned with ecological sustainability; improved community engagement; fostered innovative, context-specific solutions.
234	Planning for transformative change with nature-based solutions: A geodesign application in Stockholm	Blal Adem Esmail, Chiara Cortinovis, Sigvard Bast, Carl C. Anderson, Lina Suleiman, Gustavo Arciniegas, Davide Geneletti, Ulla Mörtberg, Christian Albert	2025	https://doi.org/10.1016/j.landurbplan.2025.105303	Geodesign, transformative change, nature-based solutions, urban planning, ecosystem services, biodiversity, stakeholder engagement, scenario planning, housing development	To explore how a geodesign process enables stakeholders to design transformative urban plans integrating housing development with biodiversity and ecosystem services enhancement, and to assess changes in stakeholder perceptions of plausibility, desirability, and probability of transformative change scenarios.	Developed two scenario storylines based on Stockholm City Plan (SCP) and a more transformative TC scenario; conducted a GIS-assisted geodesign workshop with 14 experts in three groups over two half-days; involved suitability analysis, land use design, impact assessment, and surveys evaluating participant perceptions before and after.	The geodesign process enabled stakeholders to create transformative plans addressing housing needs and nature-based solutions. Participants found the transformative scenario desirable but questioned its plausibility and likelihood. Changes in perceptions before and after the process were minor with some variation between groups.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
235	Remote Sensing and GIS for Flood Hazard Mapping and Hydrological Modelling: Case Study in Khartoum, Sudan	Tariq Abu Obeida Ahmed Ali, Ahmed Osama Jabr'Allah Mohammed	2022	https://www.researchgate.net/publication/391307739_Remote_Sensing_and_GIS_for_Flood_Hazard_Mapping_and_Hydrological_Modelling_Case_Study_Khartoum_Area_-Sudan/link/6811fa2cbd3f1930dd6805c0/download?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uIn19	Remote sensing, GIS, Flood hazard mapping, Hydrological modeling, Sentinel-1, Sentinel-2, SAR, DEM	To develop accurate flood hazard maps and analyze flood damage in Khartoum using remote sensing and GIS integrated with hydrological modeling.	- Data acquisition: Sentinel-1 SAR imagery (pre-flood May 2020 and post-flood September 2020), Sentinel-2 multispectral imagery, Digital Elevation Model (DEM) with 10m resolution. - Pre-processing Sentinel-1 SAR data with noise removal, calibration, terrain correction. - Supervised classification of Sentinel-2 images with Random Forest (RF) classification to generate land cover classes. - Hydrological modeling using DEM with Arc Hydro tools to delineate streams and flow accumulation. - Generation of Flash Flood Hazard Map using buffered streams and land cover layers. - Generation of River Flood Hazard Map using Sentinel-1 images and DEM elevation. - Merging flash and river flood hazard maps into combined hazard map. - Comparison of flood extents derived from NDWI (Sentinel-2) and SAR (Sentinel-1).	- Flood extent of 2020 was significantly larger than previous years (2018, 2019, 2021) as revealed by Sentinel-2 NDWI and Sentinel-1 SAR data. - Final combined flood hazard map categorizes flood hazard into four classes from very high to low. - Flash flood hazard high in settlement and cultivated land, river flood hazard linked to low elevation areas. - Sentinel-1 SAR effective for rapid, high accuracy flood mapping in near real-time. - Integration of land cover with flood maps helps understand flood damage by land use type.
236	Resilience of Terraced Landscapes to Human and Natural Impacts: A GIS-Based Reconstruction of Land Use Evolution in a Mediterranean Mountain Valley	Titouan Le Vot, Marianne Cohen, Maciej Nowak, Paul Passy and Franck Sumera	2024	https://www.mdpi.com/2073-445X/13/5/592/pdf	Terraces, Mediterranean mountain, land abandonment, resilience, disaster, landscape heritage, agriculture, post-disaster recovery, climate change adaptation	To map terraced agricultural landscapes, reconstruct their land-use history over 5 centuries, and assess the resilience of these landscapes to disturbances and their potential in post-disaster contexts.	Multi-source data integration including historical cartography, archival sources, LiDAR remote sensing, demographic data, and local testimonies; spatial and temporal analysis of land use changes and terrace conditions.	Persistent presence of terraced landscapes despite abandonment since 19th century; terraces largely swallowed by forest but dry-stone walls remain intact; co-variation of cultivated terrace surfaces with population and farmers numbers; terraces provide ecosystem services and potential nature-based solutions for climate adaptation.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
237	Spatial Modeling for Urban Resilience Assessment: Using AHP and GIS (Case Study of Bou-Saâda City, Algeria)	Zouhair Mayouf, Brahim Nouibat	2022	https://www.researchgate.net/publication/364270263_Spatial_Modeling_for_Urban_Resilience_Assessment_Using_AHP_and_GIS_Case_Study_of_Bou-Saada_City_Algeria/link/6351c9f612cbac6a3edded32/download?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uIn19	Urban resilience; Delphi method; AHP; GIS; Multi-Criteria Decision Analysis; Spatial Modeling; Algeria	To develop a spatial modeling approach combining Delphi method, AHP and GIS to assess and map urban resilience in Bou-Saâda, focusing on evaluating relevant criteria and identifying neighborhood disparities.	A multi-criteria decision analysis method (AHP) was applied to criteria selected through a Delphi survey of local experts; weights were determined via pairwise comparisons; GIS was used to create spatial databases and produce urban resilience maps showing the levels of resilience across neighborhoods.	52.19% of Bou-Saâda's area was identified as having high urban resilience, mainly in the city center; 16.95% showed low resilience, mostly in outskirts; medical care access was the most important criterion (25.57%), building density the least (8.73%). The study produced an urban resilience map useful for planners and managers.
238	Spatiotemporal Evolution and Spatial Spillover Effect of Urban Resilience: Empirical Evidence from Chengdu–Chongqing Urban Agglomeration	R. Zhang, Hanyu Xu, Huige Xing, J. Zou, F. Sun	2024	https://doi.org/10.3390/land14040741	Natural disasters, urban resilience, spatial spillover, disaster management, Chengdu–Chongqing urban agglomeration	To evaluate urban resilience and its spatiotemporal evolution in the Chengdu–Chongqing urban agglomeration and to identify its driving factors for enhancing resilience.,	CRITIC-TOPSIS model for resilience evaluation; Spatial Markov chain for spatial spillover effects; Geo-detector for driving factor analysis; Index system based on four urban subsystems and disaster management cycle capacities,	Overall urban resilience showed steady increase with narrowing regional disparities; Chengdu and Chongqing led in resilience; economic, social, and infrastructure resilience improved notably; environmental resilience stable; absorptive and transformative capacities weak with regional differences; spatial spillover effects confirmed; infrastructure and technology innovation key drivers.
239	The Spatial Planning of Australia's Energy Landscape: An Assessment of Solar, Wind and Biomass Potential at the National Level	Siqing Chen, Virginia Lee	2016	https://gispoint.de/fileadmin/user_upload/paper_gis_open/DLA_2016/537612020.pdf	Geodesign; climate change; energy modelling; solar energy; Australia; renewable energy; carbon-neutral urbanism	This paper aims to present an assessment of solar energy potential in Australia, which will be fundamental for Australia's future energy planning using renewable energy sources and to strengthen research into carbon emission reduction practices; also to provide greater understanding of clean energy and green urbanism concepts.	A geodesign approach integrating GIS, remote sensing, solar radiation modelling (ArcGIS Spatial Analyst extension tools), spatial aggregation, optimization, and visualization techniques was used to explore solar energy potential and its distribution across Australia, including overlay with terrestrial biomes for identifying primary and secondary solar development zones.	Solar radiation potential ranges between 917-1,541 kWh/m^2/yr with two major zones identified: Central-Western Australia (primary for large scale solar farm development) and Eastern Australia (heavily used for agriculture, less feasible). Recommendations include promoting solar energy development considering ecological and socio-economic factors, recognizing challenges in large scale solar implementation.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
240	The urban mine of the Netherlands: The material basis for a circular economy	Ester van der Voet, Janneke van Oorschot, Teun Verhagen, Lauran van Oers, Vincent van Straalen, Vivian Tunn, Kiki Kersten, Roel Delahaye	2025	https://doi.org/10.1111/jiec.70030	circular economy; urban mine; material stocks; sustainable resource use; industrial ecology; recycling; environmental impact	To develop a comprehensive inventory of the in-use material stocks (urban mine) in the Netherlands as a foundational information base for a circular economy and to analyze the potential and dynamics of recovering these materials.	Bottom-up approach compiling data from official statistics (CBS), infrastructure managers, and literature to identify application categories and their material intensities. The key method involved multiplying application units (e.g., m2 floor area,s number of vehicles) by material content per unit to obtain kg of materials per application. Also includes scenario assessments and dynamic material flow analysis in related papers.	The Dutch urban mine contains 447 tonnes of material per inhabitant, dominated by construction materials. Scenario assessments have been made for buildings and the energy system. Data quality varies across product categories; buildings and electronics are well researched, while consumer goods and textiles have high uncertainties. Forecasting future material outflows depends critically on estimates of life spans. Accessing the urban mine requires reorganizing production, design, use, and recycling processes.
241	Towards Climate Resilience of the Built Environment: A GIS-Based Framework for the Assessment of Climate-Proof Design Solutions for Buildings	Valeria D'Ambrosio, Ferdinando Di Martino, Enza Tersigni	2023	https://doi.org/10.3390/buildings13071658	Climate resilience, GIS-based framework, Heatwave adaptation, Climate-proof design solutions, Indoor comfort, CO2 emissions, Urban resilience	To develop and implement a GIS-based framework to assess urban climate resilience focused on selecting optimal climate-proof building design solutions that improve indoor comfort and reduce CO2 emissions, thereby mitigating heatwave impacts.	- Construction of a database of climate-proof technical solutions categorized by building typology and construction period. - Classification of census areas (as atomic spatial units) by prevailing building typology using GIS and dimensional parameters (floor area, height, shape index, WWR). - Simulation of indoor comfort and CO2 emissions for current and medium-term scenarios. - Application of a vulnerability and impact model (based on AR6 framework) for heatwave hazard scenarios. - Generation of climate adaptation, mitigation, and resilience maps by reprocessing impact scenarios with applied solutions.	- Retrofit solutions lead to significant improvements in perceived indoor comfort and reductions in building CO2 emissions. - The heatwave impact on vulnerable populations is reduced, increasing urban resilience. - The GIS-based approach enables spatially explicit assessment and facilitates informed urban planning and design strategies.

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242	Urban Flood Resilience Assessment and Spatial–Temporal Analysis in the Yangtze River Delta	Mingru Zhou, Qisheng He, Yuhan Gu, Ke Wang and Zhihao Shen	2025	https://doi.org/10.3390/ijgi14030108	Urban flood resilience; spatial–temporal analysis; vulnerability assessment; Yangtze River Delta; flood risk; socioeconomic factors; hazard; disaster-formative environment; exposure; GIS	To assess the urban flood resilience of cities in the Yangtze River Delta (YRD), to analyze the spatial and temporal distribution patterns of flood resilience, identify influencing factors, and provide recommendations to enhance urban flood resilience and planning.	Construction of an urban flood resilience indicator system based on three categories: hazard, disaster-formative environment, and exposure. Data from 2000 to 2020 analyzed using entropy weight method and GIS natural breakpoint analysis; spatial clustering patterns evaluated by Local Indicator of Spatial Association (LISA); stepwise regression model for influencing factor analysis; comparison with real flood disaster data from 2015-2020. Human-centered urban perspective emphasizing socioeconomic variables.	1) Jiangsu Province shows highest hazard resilience; Shanghai highest in disaster-formative environment and exposure; overall resilience pattern Shanghai > Jiangsu > Zhejiang > Anhui. 2) Resilience has generally increased over time, especially hazard resilience. 3) H-H clustering seen in developed eastern areas (e.g., Suzhou), L-L clustering in less developed areas (e.g., Bengbu). 4) Influential factors include per capita disposable income, social insurance coverage, infrastructure density. 5) Anhui has lowest capacity, Zhejiang shows moderate ecological strength but vulnerable to typhoon rains. Recommendations for urban planning and cooperation to improve resilience presented.
243	Urban Flood Resilience Evaluation Based on GIS and Multi-Source Data: A Case Study of Changchun City	Zhen Zhang, Jiquan Zhang, Yichen Zhang, Yanan Chen and Jiahao Yan	2023	https://doi.org/10.3390/rs15071872	urban flood resilience; analytic hierarchy process; remote sensing and GIS; TOPSIS; k-means; resilience evaluation	To quantitatively evaluate the flood resilience of Changchun City from four dimensions (infrastructure, environment, society, economy) and identify urban clusters with similar flood resilience to guide targeted policy making and urban planning.	- Selection of 21 indicators based on literature and models. - Data collection from remote sensing, GIS (for infrastructure and environment), and statistical data (for socioeconomic). - Weight determination using Analytic Hierarchy Process (AHP) based on expert input. - Infrastructure and environmental vulnerability quantified by GIS weighted methods. - Social and economic recoverability quantified by TOPSIS. - k-means clustering to identify urban clusters with similar flood resilience characteristics.	- Spatial differences in flood resilience across Changchun were found. - Erdao District, Nongan County, Yushu City, Dehui City, and Jiutai District identified as focus areas for improvement. - Areas with low infrastructure and environmental vulnerability and high socioeconomic recoverability are more resilient. - Proposed framework effectively integrates multi-source data and mathematical methods to cluster similar resilience characteristics, informing policy and urban planning.

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244	Urban trees in the Metropolitan Region of São Paulo: A study of Geodesign and ecosystem services	Amanda Fruehauf; Adriana Afonso Sandre; Magda Lombardo; Paulo Renato Mesquita Pellegrino	2023	http://dx.doi.org/10.5772/intechopen.1001470	urban trees, Geodesign framework, urban ecology, nature-based solutions, socio-environmental, GIS, urban forestation	To use Geographical Information Systems and Geodesign frameworks to study urban afforestation and promote socio-environmental quality in the MRSP.	Use of GISColab platform, Geodesign workshops, analysis of spatial data layers such as urban heat islands, water reservoirs, vacant buildings, and tree canopy coverage. Comparing scenarios for 2035 and 2050 with current data to project impacts of increasing urban forestation.	Identification of tree canopy increase benefits including temperature reduction (cooling effect), improvement of green infrastructure coverage, and sustainable urban planning proposals. Demonstrated increased tree cover reduced medium temperatures in studied subprefectures (ex. Butantã).
245	Participatory Geodesign and nature-based solutions: a case study on the planning of a river landscape	Sarah Gottwald , Jana Brenner , Ron Janssen , Christian Albert	2020	https://doi.org/10.1007/s13280-020-01435-4	Geodesign, Nature-based solutions, Participatory planning, River landscape, Transdisciplinary research	To evaluate the utility and effectiveness of participatory Geodesign in developing spatial scenarios for sustainable river landscape planning with nature-based solutions and facilitating stakeholder collaboration and decision-making.	A transdisciplinary workshop involving local stakeholders using Geodesign tools to translate narrative scenarios into spatial land use maps, evaluate impacts through indicators, and discuss trade-offs. The process was supported by facilitated group work, real-time mapping, and interactive GIS tools.	The participatory Geodesign process successfully translated scenario narratives into spatial outcomes, enhanced stakeholder communication and collaboration, and supported boundary management functions such as translation and mediation. However, complexity in indicator-based mediation tools resulted in frustration and reduced trust. The approach was deemed useful but requires simple tools, good preparation, and careful participant selection for successful implementation.
246	Combinative Study of Urban Heat Island in Ascoli Piceno City with Remote Sensing and CFD Simulation; Climate Change and Urban Health Resilience; CCUHRE Project	Roberta Cocci Grifoni, Giorgio Caprari, Graziano Enzo Marchesani	2022	https://doi.org/10.3390/su14020688	urban heat island, remote sensing, CFD simulation, thermal comfort, climate change impacts, urban risk mapping, GIS, environmental health, urban resilience	To develop a multi-scalar, transdisciplinary method for quantifying climate change impacts on urban microclimates and public health, specifically focusing on thermal discomfort and urban heat islands in Ascoli Piceno.	Combination of: - Remote sensing analysis to detect urban heat islands - GIS spatial analysis and data synthesis - CFD (Computational Fluid Dynamics) simulations for microclimate modeling - Social data collection via questionnaires, focus groups, interviews - Creation of a Green Atlas and risk maps integrating morphological, climatic, and demographic data	- Detailed cartographic products such as Green Atlas and risk maps - Identification of vulnerable neighbourhood sections exposed to heat stress - Comprehensive dataset correlating urban form, climate data, and social vulnerability - Enhanced understanding of urban microclimate characteristics through CFD modeling

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
247	Assessing flood susceptibility in Hanoi using machine learning and remote sensing: implications for urban health and resilience	The Van Pham, Dung Xuan Bui, Tuyet Anh Thi Do, Anh Ngoc Thi Do	2025	https://doi.org/10.1007/s11069-025-07211-5	Flood susceptibility, machine learning, remote sensing, urban health, environmental resilience	To evaluate flood susceptibility in Hanoi using high-resolution remote sensing integrated with machine learning to support urban health and resilience planning.	Classification of satellite imagery using Matlab 2021a and ArcGIS 10.8; selection of 18 independent natural and anthropogenic variables (e.g., altitude, slope, LULC, rainfall); development of GA-optimized ANN and SVM models to predict flood susceptibility; model evaluation using R^2, RMSE, MAE; generation of flood susceptibility maps.	ANN model optimized by GA achieved R^2 test = 0.823; RMSE = 4.332; MAE = 4.020. Urban districts such as Cau Giay, Nam Tu Liem, Ha Dong, and Thanh Xuan are identified as high to very high flood risk areas. Suburban areas show lower susceptibility except for some densely developed districts.
248	Data-Driven Planning Approaches for Measuring Urban Ecosystem Services: The Potential of Big Data and Urban Informatics for Planning the Transition of Cities	Francesca Moraci, Carmelina Bevilacqua, Pasquale Pizzimenti, Vincenzo Barrile, Emanuela Genovese	2025	https://doi.org/10.1007/978-3-031-82927-7_2	urban ecosystem services; data-driven planning; big data; urban informatics; remote sensing; NDVI; LAI; sustainability; resilience	To explore how data-driven planning approaches, leveraging big data and urban informatics, can effectively measure and support the planning of urban ecosystem services, facilitating cities' transition toward sustainability and resilience.	Literature review and empirical case study based on integrating big data sources, satellite images, and remote sensing indices; Normalized Difference Vegetation Index (NDVI) and Leaf Area Index (LAI); paired with land use data for spatial and temporal analysis of UES within the Municipality of Reggio Calabria, Italy.	NDVI and LAI values were analyzed over 2019-2023 across different land uses in selected urban areas of Reggio Calabria. The study highlights the ability to detect vegetation changes, degradation or improvement, and identify areas impacted by climate stress or transformation, demonstrating the utility of such indicators in understanding urban ecosystem dynamics.
249	Co-Creating GIS-Based Dashboards to Democratize Knowledge on Urban Resilience Strategies: Experience with Camerino Municipality	Maria Luisa Villani, Sonia Giovinazzi, Antonio Costanzo	2023	https://doi.org/10.3390/ijgi12020065	urban resilience; cultural heritage; knowledge representation; geographic information system; seismic risk; climate change; Camerino; municipality	To develop user-friendly GIS-based dashboards that democratize knowledge and increase stakeholder engagement for resilience planning against natural hazards, focusing on historic urban areas, exemplified by the Camerino municipality case study.	A co-creative approach was employed to develop interactive dashboards using PowerBI and data from HArIS and THIS tools. The methodology includes data modeling of hazards, exposures, vulnerabilities, and impacts, with risk assessed via risk matrices. Scenario analysis was implemented comparing ex-ante and ex-post interventions, supported by stakeholder collaboration and iterative feature adaptation for usability.	The dashboards enabled visualization and comparison of seismic impact scenarios before and after retrofitting interventions. The outcomes supported informed decision-making by illustrating reductions in economic loss and impacts on the population and cultural heritage. Stakeholders positively engaged with the system, confirming its practical utility for urban resilience planning.

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250	Resilience of an Urban Coastal Ecosystem in the Caribbean: A Remote Sensing Approach in Western Puerto Rico	Yadiel Noel Bonilla-Roman, Salvador Francisco Acuña-Guzman	2024	https://doi.org/10.3390/earth5010004	tropical conditions; insular territory; data geoprocessing; ecosystem resilience; urban coastal ecosystem; remote sensing; gross primary production; NDVI; ET; LST; atmospheric events; anthropogenic activity	Investigate how an ecosystem in Western Puerto Rico responds and recovers from extreme climate events and fluctuations, specifically evaluating innate resilience	Remote sensing using MODIS and Landsat 8–9 OLI TRIS products, supplemented by PRWEB datasets; analysis covered 2012–2021; calculation of ET, NDVI, LST, GPP; use of GIS tools (ArcGIS and RStudio) for geoprocessing and spatial analyses; creation of attribute tables and fishnet sampling; correlation matrix analyses between parameters; gap-filling missing dataset values; comparison between highly urbanized and less anthropogenic impact areas.	NDVI and ET values showed the ecosystem's capacity to recover after drought (2015) and hurricanes (2017). NDVI dropped sharply post-hurricanes from average 0.79 (2015) to 0.6 (2017) and recovered to 0.8 (2019). ET values dropped after hurricanes but increased again by 2019. Areas with little anthropogenic disturbance showed more rapid and resilient restoration. Urban coastal areas demonstrated slower recovery and lower ecological resilience. Correlations were observed among ET, NDVI, and GPP. Limitations included data gaps especially in ET estimations and challenges associated with MODIS data resolution in the study area's geographic context.

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ANNEX 3. Best practices

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
1	Urban flood impact assessment: A state-of-the-art review	Hammond, M. J.; Chen, A. S.; Djordjevic, S.; Butler, D.; Mark, O.	2015	http://dx.doi.org/10.1080/1573062X.2013.857421	Urban flooding history, Pluvial flooding, Fluvial flooding, Groundwater flooding, coastal flooding, FLOODSite project, ex-ante assessment, Direct tangible damage, indirect tangible impacts, Infrastructure damage, Intangible damage, Denmark, Germany, Netherlands	This article presents a state-of-the-art literature review on flood impact assessment, focusing specifically on urban flooding. Urban flooding can include pluvial, fluvial, groundwater and coastal flooding	This survey builds upon previous reviews and brings them up to date, such as those undertaken as part of the FLOODSite project (Messner et al. 2007), but also aims to cover all the impacts of flooding, such as the intangible impacts, which have been neglected to some extent in earlier work	

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2	Low impact development techniques to mitigate the impacts of climate-change-induced urban floods: Current trends, issues and challenges	Pour, Sahar Hadi; Abd Wahab, Ahmad Khairi; Shahid, Shamsuddin; Asaduzzaman, Md; Dewan, Ashraf	2020	http://dx.doi.org/10.1016/j.scs.2020.102373	low impact development (LID), storm water management system (SWMS),	Research aimed at improving thetechnology supporting LIDs, as well as improving the structure longevity and reducing maintenance costs, is important if these methods areto gain wider acceptance The objective of this study is to advance our understanding of the climate change challenges in respect to urban flooding events and to assess the mitigation potential for LIDs in regards warming-induced urban floods	LID tools are devised to preserve the natural hydrological behavior of watersheds, e.g., transpiration, retention and seepage, in order to reduce the damaging effect of increased water runoff resulting from urbanization	. The study revealed some of the major challenges facing the successful implementation of LIDs for urban flood mitigation. This included a lack of knowledge of best LID practices, difficulty in obtaining optimum design specifications, the lack of suitable space required for successfully implementing these practices in densely-populated and highly-developed urban areas, the ability to integrate LID practices with existing, complex, urban infrastructure, a lack of social acceptability in regards the technology, a lack of standard procedures for the installation and maintenance of these structures in developing countries, a requirement of frequent maintenance and a general reduction in the efficiency of the LID over time
3	Integrating spatial planning and flood risk management: A new conceptual framework for the spatially integrated policy infrastructure	Ran, J; Nedovic-Budic, Z	2016	http://dx.doi.org/10.1016/j.compenvurbsys.2016.01.008	Flood risk management, 'Spatially Integrated Policy Infrastructure (SIPI)',	The first objective of this study is to identify the requirements for integrating spatial planning with flood-risk management and to conceptualise and identify the dimensions of 'integration', primarily in the European, and particularly in the Irish, context and framework. Then, the study aims to develop, as its second objective, a conceptual framework of an infrastructure, termed Spatially Integrated Policy Infrastructure (SIPI), which allows for sharing GI and decision support and analysis tools between spatial planning and flood-risk management.	This study proposes that geographic information (GI) and geographic technologies (GT) can support such integration specifically of spatial planning and flood-risk management by capitalizing on their utility in various planning and management activities, including land-use administration (Shariff, Hamzah, Mahmud, Yusof, & Ali, 2011), coastal risk management (Jeanson et al., 2014, Zanuttigh et al., 2014), cultural heritages (McKeague, Corns, & Shaw, 2012), and organizations (Dessers et al., 2012).	This study is significant in identifying the connections between SIPI elements and integration dimensions: territorial, policy, and institutional. Sharing data and information play a part in territorial integration. Access tools and protocols are channels to communicate and build common interest among institutions.

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4	COMPASS – Comparative Analysis of Territorial Governance and Spatial Planning Systems in Europe: Applied Research 2016-2018: Final Report	Nadin, Vincent Fernández Maldonado, Ana Maria Zonneveld, Wil Stead, Dominic	2018	https://www.diva-portal.org/smash/record.jsf?pid=diva2%3A1314644&dswid=-9911	final report of the project compass, Constitutional and legal frameworks for spatial planning, Spatial planning instruments, Procedures for planning instruments and citizen engagement, Practices of spatial planning and territorial governance, The role of spatial planning within sectoral policies, Case studies of the relationship between EU Cohesion Policy and spatial planning and territorial governance	The objective of the COMPASS project is to provide an authoritative comparative report on changes in territorial governance and spatial planning systems in Europe since 2000. It substantially improves the knowledge base on territorial governance and spatial planning, and in particular, their relationship with EU Cohesion Policy	The project's terms of reference require 'a clear and consistent methodological/conceptual framework for undertaking the comparative analysis within a highly complex and diverse socio-political space' (ToR, p. 5). In particular, the research has to provide meaningful comparisons whilst at the same time respecting great variation in the socio-economic, political, legal and other conditions of the places under study. But the comparison of territorial governance and spatial planning across a large number of countries presents many challenges. The next sections explain how the project has taken into account the different challenges for the conceptualisation of the main terms, the design of the research, the methods for comparison and the data collection.	In sum, we have found that systems of spatial planning and territorial governance in Europe are well established and maintained. There is a huge amount of energy expended on 'planning' as demonstrated by the multiple types of plans at all levels. These tools are used to pursue a common objective to steer spatial evelopment to achieve a wide range of economic, environmental and social objectives. They increasingly engage with citizens in that task. We have found that 'plans' are sually multifunctional, dealing with a combination of visionary, strategic, policy and regulation tasks.

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5	Landscape Design for Flood Adaptation from 20 Years of Constructed Ecologies in China	Palazzo, E., & Wang, S.	2022	. https://doi.org/10.3390/su14084511	landscape architecture; research-by-design; submersible public space; flood adaptation; flood resilient cities	he main objective of this study is to clarify how different flood adaptation measures are combined in urban design and landscape projects to respond to specific geophysical and climatic conditions. Hence, the paper's main contribution to research is to define a morphologic and functional classification of types that represents the current design in flood adaptation and systematize the complex approaches used in the practice. The research is driven by three objectives: Clarify how and where landscape architecture integrates flood mitigation responses in relation to various floodplain landforms and local micro-climates. Generate new understanding to support urban and landscape design to define optimal design responses to flood according to distinctive contexts. Define a framework to assist future systematic monitoring of flood tolerant infrastructures.	his research adopts a research-by-design approach [21,22] to reflect on the existing urban design practice and generate new knowledge about flood adaptation measures and submersible public spaces. The research is organized in three phases that correspond to the three dimensions of research-by-design, respectively research 'about', 'through', and 'for' design	the research provides a common ground for the different disciplines involved in the physical transformation of urban areas, aiming at building adaptive capacity and urban flood resilience. This also fulfils a pedagogic objective for research-by-design in higher education. Overall, the objective of the study is to facilitate the diffusion of adaptive measures for urban flood resilience supported by technically informed decisions and a shared conversation between different disciplinary expertise and local traditional knowledges.
6	The 'Flood Resilience Rose': A management tool to promote transformation towards flood resilience	Leena Karrasch, Britta Restemeyer, Thomas Klenke	2021	https://doi.org/10.1111/jfr3.12726	Flood resilience; Multi-layer safety; Integrated flood risk management; Policy tool; Europe	To develop and validate the 'Flood Resilience Rose' as a policy tool for integrated flood risk governance in Europe.	Theoretical development based on EU Flood Directive and expert workshops in five countries (Belgium, Denmark, Germany, UK, Netherlands).	The tool provides a harmonized framework across policy layers; prevention, protection, preparedness, recovery; to guide flood resilience transformations.

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7	People's Perception of Nature-Based Solutions for Flood Mitigation: The Case of Veneto Region (Italy)	Giacomo Bernello, Elena Mondino, Lucia Bortolini	2022	https://doi.org/10.3390/su14084621	Nature-based solutions (NBS); flood mitigation; urban greening; Veneto; perception; blue-green infrastructure	To explore public perception and willingness to implement nature-based solutions (NBS) for flood mitigation in Veneto, Italy.	Online survey assessing awareness, perception, and behavioral patterns associated with NBS and grey infrastructure.	Knowledge and local connectedness significantly affect perceived effectiveness of NBS. Public support could foster broader implementation in urban flood management.
8	Modelling the effects of climate change on urban coastal-fluvial flooding	Jennifer Isabel Munro Kirkpatrick; Agnieszka Indiana Olbert	2020	https://doi.org/10.2166/wcc.2020.166	climate change, coastal flooding, compound event, fluvial flooding, nested model, urban flooding	To model future flood extents and mechanisms in coastal cities under climate change using Cork, Ireland as a case study.	Hydrodynamic modeling of compound flood scenarios using the MSN_Flood model for current and projected sea level and river discharge conditions.	Future extreme events will involve both coastal and fluvial drivers, affecting city centers more broadly. Accurate modeling of compound events is essential for adaptation planning.
9	Nature-Based Solutions Modeling and Cost-Benefit Analysis to Face Climate Change Risks in an Urban Area: The Case of Turin (Italy)	Anna Biasin, Mauro Masiero, Giulia Amato, Davide Pettenella	2022	https://doi.org/10.3390/land12020280	Nature-based solutions; Urban flooding; Cost-benefit analysis; Climate resilience; InVEST modeling	To model and evaluate multiple NBS interventions for urban flood and heat mitigation in Turin.	InVEST modeling across four NBS scenarios; cost-benefit analysis for ecosystem service delivery.	Forested green areas and retention ponds are most effective for flood mitigation. NBS provide quantifiable benefits for city planning.
10	Flood Modeling and Groundwater Flooding in Urbanized Reclamation Areas: The Case of Rome (Italy	Corrado P. Mancini, Stefano Lollai, Elena Volpi, Aldo Fiori	2020	https://doi.org/10.3390/w12072030	floods; inundation map; groundwater flooding; reclamation areas; 2D flood models; Rome (Italy); Ostia	To propose a simple model integrating groundwater dynamics into urban flood modeling in reclaimed coastal areas.	Development of a parsimonious modeling approach integrating groundwater into 2D surface flood simulations.	Groundwater significantly contributes to urban flooding in reclaimed areas. The proposed model better estimates flooding extent and pumping requirements.

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11	Comparison of sustainable flood risk management by four countries – the United Kingdom, the Netherlands, the United States, and Japan – and the implications for Asian coastal megacities	Faith Ka Shun Chan, Liang Emlyn Yang, Gordon Mitchell, Nigel Wright, Mingfu Guan, Xiaohui Lu, Zilin Wang, Burrell Montz, Olalekan Adekola	2022	https://doi.org/10.5194/nhess-22-2567-2022	Sustainable flood risk management; Comparative policy; Climate adaptation; Coastal cities; Governance	To compare sustainable flood risk management practices in four developed countries and derive lessons for Asian coastal megacities.	Policy review and comparative analysis of national flood strategies (e.g., Room for the River, NFIP, NPPF).	Mixed approaches combining hard infrastructure with adaptive planning are most effective. Lessons emphasize integration of social, ecological, and economic goals.
12	The flood cooking book: ingredients and regional flavors of floods across Germany	Ralf Merz, Larisa Tarasova and Stefano Basso	2020	10.1088/1748-9326/abb9dd	Flood processes; Soil moisture dynamics; Random forests; Natural hazard; Machine learning	To uncover dominant hydrological and meteorological processes that lead to floods across Germany using machine learning.	Analysis of 177,267 rainfall-runoff events in 373 catchments using decision trees and random forests.	Flood drivers vary regionally. In mountainous regions, rainfall dominates; in drier areas, antecedent soil moisture plays a bigger role.

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13	Effectiveness of Nature-Based Solutions in Mitigating Flood Hazard in a Mediterranean Peri-Urban Catchment	Ferreira, Carla S. S.; Mourato, Sandra; Kasanin-Grubin, Milica; Ferreira, Antonio J. D.; Destouni, Georgia; Kalantari, Zahra	2020	http://dx.doi.org/10.3390/w12102893	flood hazard; nature-based solutions; HEC HMS model; HEC RAS model; peri-urban catchment; mediterranean	The study aims to quantitatively investigate the effectiveness of nature-based solutions (NBS) for mitigating flood hazards in Ribeira dos Covões, a small peri-urban catchment in central Portugal. The area is subject to flash floods due to rapid urbanization and Mediterranean climate patterns. The study compares current conditions (no NBS) with three intervention scenarios: NBS1 (Upslope NBS) NBS2 (Downslope NBS) Combined NBS1 + NBS2	Modeling Tools: Coupled HEC-HMS (Hydrologic Engineering Center - Hydrologic Modeling System) and HEC-RAS (River Analysis System) were used for simulating rainfall-runoff processes and flood inundation. Data Inputs: Hydrological data: 3 years of rainfall and streamflow data (2010–2013) Cartographic data: DEMs, land use maps, soil and geology Field surveys: Cross-section profiles of stream channels Simulation Scenarios: Modeled 10-, 20-, 50-, and 100-year rainfall events, under four scenarios: Current conditions (no NBS) Upslope NBS (NBS1) Downslope NBS (NBS2) Combined NBS1 + NBS2 Calibration and Validation: HEC-HMS and HEC-RAS models calibrated using observed storm events High performance metrics for main catchment outlet: NSE = 0.91, R^2 = 0.93, RMSE = 0.08, MAE = 0.07	Overall model performance was strong at the catchment outlet but variable across sub-catchments due to topographic and drainage heterogeneity. Impact of NBS: NBS1 (Upslope) reduced water depth at the catchment outlet by 0.02 m. NBS2 (Downslope) reduced water depth by 0.10–0.23 m, depending on return period. Combined NBS provided marginal additional reductions in water depth (total up to 0.24 m). Flood Extent: Although the total flooded area increased due to diverted flows, in-channel water depths decreased, reducing flood hazard to urbanized downstream areas. Key Conclusion: NBS can effectively mitigate flood hazard in peri-urban Mediterranean environments, especially when applied as a network rather than isolated interventions.

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14	Varieties of flood risk governance in Europe: How do countries respond to driving forces and what explains institutional change?	Wiering, Mark; Kaufmann, M.; Mees, H.; Schellenberger, T.; Ganzevoort, W.; Hegger, D. L. T.; Larrue, C.; Matczak, P.	2017	http://dx.doi.org/10.1016/j.gloenvcha.2017.02.006	Flood risk management; Water policy; Path dependency; Institutional change; Climate change; European directives	The primary objective of the study is to examine the diversity in FRG arrangements across Europe and to identify the conditions under which institutional changes occur. The authors seek to understand how countries adapt their flood risk management strategies in response to environmental challenges, socio-economic pressures, and policy shifts. By analyzing these variations, the study aims to provide insights into the mechanisms that facilitate or hinder institutional change in the context of flood risk governance.	The researchers employed a comparative case study approach, analyzing FRG in the selected countries through a combination of document analysis, expert interviews, and stakeholder workshops. The study was conducted under the EU-funded STAR-FLOOD project, which provided a framework for assessing governance arrangements and their effectiveness. The analysis focused on identifying the driving forces behind changes in FRG, such as climate change, urbanization, and policy reforms, and examining how these forces influenced governance structures and practices.	The study found significant variations in FRG across the six countries, influenced by historical, cultural, and institutional contexts. Countries with a strong tradition of centralized flood defense, like the Netherlands, exhibited more path-dependent governance structures, making institutional change more incremental and challenging. In contrast, countries with more decentralized systems, such as England and Sweden, demonstrated greater flexibility in adapting to new challenges and implementing diversified flood risk management strategies. Key factors facilitating institutional change included the presence of policy entrepreneurs, cross-sectoral collaboration, and the integration of multiple governance levels. The study also highlighted the importance of learning processes, stakeholder engagement, and the alignment of policy objectives in driving effective and adaptive FRG.

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15	Flood Risk Assessment in an Underground Railway System under the Impact of Climate Change; A Case Study of the Barcelona Metro	Forero-Ortiz, Edwar; Martinez-Gomariz, Eduardo; Canas Porcuna, Manuel; Locatelli, Luca; Russo, Beniamino	2020	http://dx.doi.org/10.3390/su12135291	flood risk assessment; climate change; 1D/2D hydrodynamic model; Metro system; subway; urban mobility	The study aims to evaluate the vulnerability of the Barcelona Metro system, specifically Line 3, to pluvial flooding events under current and projected future climate scenarios. Recognizing the increasing frequency and intensity of extreme rainfall due to climate change, the research seeks to understand how such events could disrupt underground transportation infrastructure and to provide a framework for assessing flood risks in metro systems.	The researchers employed a 1D/2D hydrodynamic modeling approach to simulate the behavior of floodwaters in and around Metro Line 3. The metro infrastructure was integrated into existing urban drainage models, representing tunnels and stations as computational links and nodes with physical characteristics like slopes and cross-sections. Climate projections for the year 2100 were incorporated to assess future rainfall intensities. The study focused on a 20-year return period rainfall event to evaluate the flood risk under both current and future conditions.	The simulation results revealed that, under current rainfall conditions, two out of the 26 stations on Metro Line 3 are at high risk of flooding. However, under projected future conditions for a 20-year return period event, this number increases to 11 stations. The findings underscore the heightened vulnerability of underground metro systems to climate-induced pluvial flooding and highlight the need for adaptive measures. The study provides a baseline for assessing potential flood outcomes in metro systems and can be used to evaluate the effectiveness of various adaptation strategies.

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16	Urban walkability considering pedestrians' perceptions of the built environment: a 10-year review and a case study in a medium-sized city in Latin America	Arellana, J., Saltarín, M., Larrañaga, A. M., Alvarez, V., & Henao, C. A.	2019	https://doi.org/10.1080/01441647.2019.1703842	Walkability index safety security accessibility comfort attractiveness	This paper reviews the last 10 years of the Walkability Index (WI) literature and identifies some trends and research gaps. The walkability concept refers to the extent to which the built environment is friendly to the presence of people walking, living, shopping, visiting, enjoying, or spending time in an area. In the last decade, several walkability metrics have been developed in different countries around the globe, at diverse scales of measurement (e.g. zone or neighbourhood, street) and using different factors and components in their formulation This study pursues three main objectives. First, it presents a systematic review of the relevant literature regarding the development of WIs during the 2009–2018 period. Second, based on the literature review, this paper proposes a new methodology based on ranking probability models for developing an urban WI that considers the mesoscale and microscale characteristics of the built environment. Third, this work contributes to the existing literature by generating new evidence from a medium-sized city in Latin America to question the transferability of WIs among regions.	A systematic literature review of journal articles published within the 2009–2018 period was conducted using the Web of Science website. We used the keywords "walkability index" and "pedestrian" to select the papers for this review. In total, we found 93 papers using the "walkability index" term and the two keywords together. We eliminated six articles because they were proceedings or meeting abstracts, and we decided to focus on journal papers only. We also eliminated duplicates (20 records) and four more articles because their main discussion topics were not representative of urban WIs. Finally, we added four journal articles that were commonly cited by those articles selected in the search. In consequence, this review considered a total of 67 articles	The systematic review of the WI literature during the 2009–2018 period presented in this paper revealed the following research gaps. First, the literature review confirms one of our motivations for performing this study, i.e. a marked absence of walkability studies in Global South countries, especially in the Latin American Region. Second, a tendency to use WIs composed of objective mesoscale variables to assess walkability in a given area. Although the use of subjective and microscale level components to assess walking behaviour are potentially important, especially in the Latin American context, they are not usually included in the formulation of the most common WIs. Third, even though many studies develop weighted WIs by different methodologies, there is not a clear methodological trend to estimate the weight of each factor and component to avoid using the more straightforward technique (i.e. equal weighting). Fourth, there is no consensus in the literature about which factors and components should be included in the WI formulation. The most frequent components in WI studies refer to Attractiveness and Sidewalk Condition factors, neglecting other factors that could be of importance to understand walking behaviour

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17	GIS-based integrated evaluation of environmentally sensitive areas (ESAs) for land use planning in Langkawi, Malaysia	Nazren Leman, Mohammad Firuz Ramli, Rd Puteri Khairani Khirotdin	2016	https://doi.org/10.1016/j.ecolind.2015.09.029	Context-dependent indicators Tropical tourism islands Conservation strategies Sustainable land use management World-class Global Geopark	The study aims to develop an integrated Geographic Information System (GIS)-based approach to identify and evaluate Environmentally Sensitive Areas (ESAs) in Langkawi, Malaysia. Recognizing the ecological significance of Langkawi and the pressures from tourism and development, the research seeks to provide a systematic method for incorporating environmental sensitivity into land use planning to promote sustainable development and conservation efforts	The researchers employed a GIS-based multicriteria evaluation (MCE) approach to assess environmental sensitivity. They selected a set of environmental indicators, including slope, elevation, soil type, land use, and proximity to water bodies, to represent ecological sensitivity. Each indicator was standardized and assigned a weight based on its relative importance, determined through expert consultations and literature review. The weighted indicators were then integrated using GIS overlay analysis to produce an ESA map categorizing areas into different sensitivity levels. This approach allowed for a spatially explicit assessment of environmental sensitivity across Langkawi	The analysis revealed that a significant portion of Langkawi comprises areas with high to very high environmental sensitivity, particularly in regions with steep slopes, dense vegetation, and proximity to water bodies. The study's ESA map serves as a valuable tool for planners and policymakers, highlighting areas that require strict conservation measures and those suitable for controlled development. The research underscores the importance of integrating environmental sensitivity assessments into land use planning to balance development needs with ecological preservation.

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18	Flood risk, climate change and settlement development: a micro-scale assessment of Austrian municipalities	Loschner, Lukas; Herrnegger, Mathew; Apperl, Benjamin; Senoner, Tobias; Seher, Walter; Nachtnebel, Hans Peter	2017	http://dx.doi.org/10.1007/s10113-016-1009-0	Flood risk assessment; Flood damage; Hazard exposure; Climate change; Settlement development	The study aims to analyze how climate change and settlement development influence future flood risks in selected flood-prone Austrian municipalities. By conducting a micro-scale assessment, the research seeks to identify the individual and combined effects of these factors on flood damage potentials and to inform adaptive flood risk management strategies at the local level.	The researchers conducted an anticipatory flood risk assessment for three Austrian municipalities: Perg, Gleisdorf, and Altenmarkt. They simulated four inundation scenarios for current and future 100- and 300-year flood events, incorporating a climate change allowance of a 10% increase in flood peaks. Additionally, scenarios of future settlement growth in floodplains were developed. The study evaluated changes in flood damage potentials and flood risk until the year 2030 by analyzing local conditions such as floodplain topography, spatial allocation of vulnerable land uses, and types of land development.	The analysis revealed that both climate change and settlement development significantly increase future flood risks, though their impacts vary across the municipalities. In Perg and Gleisdorf, climate change emerged as the dominant driver of increased flood damage potential, with projected increases of up to 46% for 100-year flood events. In contrast, in Altenmarkt, settlement development was identified as the stronger driver, leading to a more substantial rise in flood damage potential. The study underscores the importance of considering local determinants; such as floodplain topography, land use distribution, and regional planning regulations; in flood risk assessments. It advocates for adaptive management approaches that account for the dynamic interplay between climate change and land development to effectively mitigate future flood risks.

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19	Estimating changes in flood risks and benefits of non-structural adaptation strategies - a case study from Tyrol, Austria	Thieken, Annegret H.; Cammerer, Holger; Dobler, Christian; Lammel, Johannes; Schoeberl, Fritz	2016	http://dx.doi.org/10.1007/s11027-014-9602-3	Flood risk; Scenarios; Adaptation to climate change; Hazard; Vulnerability; Lech catchment	The study aims to assess how future flood risks in the Tyrolean Alps may evolve by 2030, considering the combined effects of climate change, land use alterations, and economic development. Additionally, it evaluates the effectiveness of non-structural adaptation strategies; such as stricter land-use regulations and enhanced private precautionary measures; in mitigating these risks.	An integrated model chain was employed, encompassing: Climate Projections: Downscaling outputs from global climate models (EH5OM with A2 scenario and HadGEM2 with A1B scenario) using the Expanded Downscaling (EDS) technique to capture regional climate nuances. Hydrological Modeling: Utilizing the HQsim model to simulate rainfall-runoff processes within the Upper Lech catchment. Flood Frequency Analysis: Applying the Generalized Extreme Value (GEV) distribution to estimate flood return periods. Hydraulic Modeling: Implementing the Hydro_AS-2D model to delineate inundation extents for various flood scenarios. Land Use and Socioeconomic Scenarios: Employing the Dyna-CLUE model to project land use changes and integrating socioeconomic data to estimate asset values at risk. Risk Assessment: Combining hazard, exposure, and vulnerability components to quantify flood risks under different scenarios, including the implementation of non-structural adaptation measures.	The analysis revealed that by 2030, climate change alone is projected to have a negligible impact on flood hazards in the study area. In contrast, land use changes and economic development significantly contribute to increased flood risks, with potential damage to residential buildings rising by up to 484% under high-growth scenarios. Importantly, the implementation of non-structural adaptation measures; such as enhanced land-use planning and private precautionary actions; can reduce flood risks by approximately 30%. Conversely, neglecting such measures may lead to a 17% increase in potential damages. These findings underscore the efficacy of non-structural strategies as cost-effective, "no-regret" options for flood risk mitigation in alpine regions

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20	Flood vulnerability assessment using a GIS-based multi-criteria approach-The case of Attica region	Feloni, Elissavet; Mousadis, Ioannis; Baltas, Evangelos	2020	http://dx.doi.org/10.1111/jfr3.12563	flood vulnerability mapping; flood-prone areas; fuzzy; GIS; k-means; multi-criteria analysis; ungauged catchments	The study aims to develop a comprehensive framework for identifying flood-prone areas in the Attica region of Greece by integrating Geographic Information Systems (GIS) with multi-criteria decision-making techniques. Given the region's susceptibility to flooding due to heavy rainfall and rapid urbanization, the research seeks to inform urban planning and disaster management policies by accurately mapping areas of varying flood vulnerability.	The researchers employed a GIS-based multi-criteria analysis (MCDA) approach, utilizing software tools such as SAGA 6.3.0 and ArcMap 10.2 Desktop. Key steps included: Criteria Selection: Factors influencing flood vulnerability, such as topography, land cover, and proximity to water bodies, were identified. Standardization and Weighting: Various methods were applied to standardize the criteria and assign weights, including the Fuzzy Analytical Hierarchy Process (FAHP) and k-means clustering. Scenario Analysis: Multiple scenarios were evaluated to assess the impact of different standardization and weighting methods on flood vulnerability mapping. This methodology emphasizes the use of static data, making it adaptable for application in ungauged catchments	The study produced flood vulnerability maps under various scenarios, revealing that certain areas within the Attica region are consistently identified as highly susceptible to flooding. The integration of FAHP and k-means clustering proved effective in refining the vulnerability assessments. The findings underscore the importance of incorporating diverse analytical methods to enhance the accuracy of flood risk mapping, thereby supporting more informed decision-making in urban planning and disaster mitigation efforts.

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21	A GIS-based flood risk mapping of Assam, India, using the MCDA-AHP approach at the regional and administrative level	Gupta, Laxmi; Dixit, Jagabandhu	2022	https://doi.org/10.1080/10106049.2022.2060329	Flood hazard; vulnerability; risk; GIS; analytical hierarchy process (AHP); multicriteria decision analysis (MCDA); Assam	The study aims to develop a comprehensive and reliable flood risk mapping methodology for Assam, a flood-prone state in northeastern India. By integrating hazard and vulnerability components through a GIS-based Multi-Criteria Decision Analysis (MCDA) using the Analytical Hierarchy Process (AHP), the research seeks to produce detailed flood hazard, vulnerability, and risk maps at both regional and administrative levels.	The researchers employed a systematic approach combining GIS and MCDA-AHP techniques: * Indicator Selection: Hazard indicators (e.g., rainfall intensity, slope, runoff coefficient) and vulnerability indicators (e.g., population density, land use/land cover) were identified based on their relevance to flood risk. * Weight Assignment: The AHP method was used to assign weights to each indicator, reflecting their relative importance in contributing to flood risk. * Index Development: Three indices were developed: Flood Hazard Index (FHI), Flood Vulnerability Index (FVI), and Flood Risk Index (FRI), by integrating the weighted indicators within a GIS environment. * Validation: The resulting maps were validated using historical flood data and statistical measures such as the confusion matrix, Relative Mean Error (RME), and Root Mean Square Error (RMSE).	The study's results highlighted significant flood risk across Assam: * Over 70% of the state's area falls under moderate to very high flood hazard zones. * Approximately 57.37% of the area exhibits moderate to high flood vulnerability. * More than 50% of the region is classified under moderate to very high flood risk categories. These findings underscore the critical need for targeted flood management strategies, especially in highly susceptible areas. The study provides a valuable tool for policymakers, urban planners, and disaster management authorities to implement effective flood mitigation and preparedness measures.

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22	How Does the Concept of Resilient City Work in Practice? Planning and Achievements	Wang, C., Li, X., & Li, S.	2021	https://doi.org/10.3390/land10121319	resilient city; theory and practice; planning practice; future built environment; scoring evaluation matrix; assessment framework; urban resilience; RC100	this research aims to explore the gap between the planning and implementation of RC through an analysis of the empirical data of five representative RC cities. Although some individual RC cases have been critically reviewed and assessed [9,12,21,22,23,24,25], the uniqueness of each city means that a systematic and comparative review of RC planning and implementation is still needed. To fill this gap, this research compares the RC planning and implementation of five cities using a newly synthesized scoring matrix evaluation framework and detailed narratives of each city's RC trajectory. This research attempts to answer how the RC concept lands in urban practice on a global scale.	This research selects five cities as empirical data to analyze the gap between the planning and implementation of RC, according to cities' planning activities, data accessibility and regional representativeness. First, each selected city has either specific RC plans or at least a substantial part influenced by the RC concept in the city's master or strategic plans. As the concept of "resilience" is becoming increasingly popular in urban planning and management, many city plans contain "resilient" content. Second, sufficient data can be retrieved to assess representative cities' RC implementation. This part is more critical for this selection procedure, as implementation data are usually more fragmented than planning documents. the selected cities are London, Addis Ababa, Rotterdam, New York and Surat (Table 1). This selection covers cities in different continents (Europe, North America, Asia and Africa) and different developing stages (developed and developing countries). It should be noted that only (at least regionally) large cities were selected because of the scarcity of open data of smaller cities for this analysis.	this study assessed and analyzed five representative cities' practices from planning to implementation. The results demonstrate that the RC concept is usually interpreted with different focuses depending on the city's own needs when it lands on practice. Although cities' initial motivations for resilience were usually narrow, the shared platform that this concept entails and the city branding trend in practice easily triggers plans to expand as comprehensively as possible, particularly with the intervention of the RC100 Program. The holistic solutions that the RC concept aims to offer to cities always encounter difficulties in the implementation process because the limited resources, particularly in the post-2008 austerity governance, mean that cities can only prioritize their urgent issues in their everyday practice.

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23	Editorial: Best practices for mapping ecosystem services	Louise Willemen, Benjamin Burkhard, Neville Crossman, Evangelia G. Drakou, Ignacio Palomo	2015	https://doi.org/10.1016/j.ecoser.2015.05.008	Robust ecosystem services mapping practices Transparent ecosystem services mapping practices Stakeholder-relevant ecosystem services mapping practices 'Best Practices' of mapping ecosystem services to support decision making	In our search for best ES mapping practices to support decision making we, as leads of the related ESP working groups, invited papers for this SI with recommendations on the ES mapping methods and a description of their applicability under specific geographic characteristics and user objectives. Decision-making in which ES maps can play a role is not restricted to national governments, but involves, for example, private companies, watershed managers and non-government organizations.	Based on the 16 papers included in this SI, this editorial provides an overview of the best practices and remaining challenges, that lead to robust, transparent and stakeholder-relevant ES mapping for supporting diverse decision-making in diverse contexts.	Based on the collection of papers in this SI, we found that the best ES mapping practices to support decision making should be robust, transparent and stakeholder-relevant. These mapping practices include robust modeling, measurement, and stakeholder-based methods for quantification of ES supply, demand and/or flow, as well as measures of uncertainty and heterogeneity across spatial and temporal scales and resolution. Best ES mapping practices are also transparent to contribute to clear information-sharing and the creation of linkages with decision support processes. Lastly, best ES mapping practices are people-central, in which stakeholders are engaged at different stages of the mapping process and match the expectations and needs of end-users.

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24	'Best Practices' of mapping ecosystem services to support decision making	T Elmqvist, H Setälä, SN Handel, S van der Ploeg, J Aronson, JN Blignaut, E Gómez-Baggethun, DJ Nowak, J Kronenberg, R de Groot	2015	https://doi.org/10.1016/j.cosust.2015.05.001	Urban ecosystem services Monetary benefits of urban green spaces Non-monetary benefits of urban ecosystem services	Here, we analyze to what extent investments in green infrastructure in urban landscapes can bring multiple monetary and non-monetary benefits to society and human well-being, contributing to maintenance of biodiversity, and development of more resilient urban areas.		İnvesting in restoring, protecting, and enhancing green infrastructure and ecosystem services in cities is not only ecologically and socially desirable. It is also very often economically viable, even under prevailing economic models, provided that the multiple services and all their associated benefits for the large number of beneficiaries in cities are properly quantified and recognized. Such information is essential to include in decision-making processes related to land use and management in urban landscapes, and to help guide urban and landscape planners, architects, restoration practitioners, and public policy makers, as well as private and institutional stakeholders.
25	Climate Responsive Green Building Strategies in Circular Cities: A Comparative Study for Two Regions	Mirjana Mileti ´c 1,* , Dragan Komatina 2 and Marija Mosurovi ´c Ruži ˇci ´c	2025	https://doi.org/10.3390/su17083469	green building strategies; circular cities; sustainable architecture; Belgrade; Podgorica; locally available materials	The study aims to examine how climate-responsive green building strategies are implemented within the framework of circular cities, focusing on two regions with distinct climatic conditions: Belgrade, Serbia (temperate continental climate), and Podgorica, Montenegro (mild subtropical climate). It seeks to understand the influence of local resources, technologies, and socio-economic factors on sustainable architectural practices in these urban contexts.	The researchers conducted an online survey targeting 140 architects from both cities, utilizing a five-point Likert scale to gauge perceptions and practices related to green building strategies. The collected data were analyzed using the Statistical Package for the Social Sciences (SPSS, version 23), employing descriptive statistics, factor analysis, reliability testing, and group comparison methods to ensure a robust and transparent interpretation of the findings.	The analysis revealed no significant difference in the adoption of circular economy principles between Belgrade and Podgorica, suggesting that economic and policy-related factors may play a more pivotal role than climatic conditions in shaping sustainable architectural practices. However, the availability of local materials and technologies had a more pronounced impact on green building practices in Serbia ($p = 0.01$). These findings challenge the assumption that climate-responsive design would lead to distinct variations in urban form and highlight the importance of considering local resources and socio-economic contexts in the development of sustainable architecture.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
26	Developing climate-resilient crops: improving plant tolerance to stress combination	Rosa M. Rivero, Ron Mittler, Eduardo Blumwald, Sara I. Zandalinas	2021	https://doi.org/10.1111/tpj.15483	climate change, global warming, abiotic stress, biotic stress, stress combination, multifactorial stress combination, acclimation strategies, crop plants, yield	The article aims to address the pressing need for enhancing crop resilience in the face of climate change. Specifically, it focuses on understanding how plants respond to combinations of abiotic and biotic stresses; such as drought, heat, salinity, and pathogen attacks; that are becoming increasingly prevalent due to global climate shifts. The study emphasizes that plant responses to combined stresses are unique and cannot be predicted by studying individual stresses in isolation. Therefore, it advocates for a concentrated research effort to investigate these complex interactions, with the goal of developing crops that can withstand multiple concurrent stressors, thereby ensuring food security in a changing climate.	This comprehensive review synthesizes recent studies on plant responses to various combinations of abiotic and biotic stresses. It examines the physiological, molecular, and genetic mechanisms underlying these responses, highlighting the complexity and specificity of plant reactions to combined stress factors. The authors analyze how different stress combinations affect plant growth, development, and yield, and they discuss the limitations of current breeding approaches that focus on single stress factors. The review also explores emerging strategies and technologies aimed at improving plant tolerance to multiple simultaneous stresses.	The study finds that plant responses to stress combinations are distinct and cannot be extrapolated from responses to individual stresses. This indicates that breeding strategies targeting single stress factors may not be effective against combined stresses. The authors highlight the need for integrated approaches that consider the unique interactions between different stress factors. They suggest that future research should focus on identifying key regulatory genes and pathways involved in combined stress responses, utilizing advanced tools such as genomics, transcriptomics, and phenomics. By doing so, it would be possible to develop crop varieties with enhanced resilience to the multifaceted challenges posed by climate change.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
27	Choosing a holistic urban resilience assessment tool	Heiman Dianat a d , Suzanne Wilkinson b , Peter Williams c , Hamed Khatibi d	2022	https://doi.org/10.1016/j.ijdrr.2022.102789	Urban resilienceResilient citiesResilience assessmentsResilience assessment tools evaluationComplex adaptive systems	The study aims to identify the criteria necessary for assessing the resilience of urban complex systems and to evaluate existing urban resilience assessment tools to determine their comprehensiveness and applicability. By doing so, the research seeks to guide practitioners in selecting appropriate tools for holistic urban resilience assessment.	The researchers approached urban areas as Complex Adaptive Systems (CAS) and developed a set of 28 criteria reflecting the multifaceted nature of urban resilience. These criteria were used to evaluate several existing resilience assessment tools. The Auckland region in New Zealand was chosen as a case study to demonstrate the application of these criteria in a real-world context.	Evaluation of Existing Tools: The study found that many existing urban resilience assessment tools do not fully capture the complexity of urban systems. Among the tools evaluated, the Disaster Resilience Scorecard for Cities was identified as the most comprehensive in addressing the established criteria. Importance of Holistic Assessment: The research emphasizes that assessing urban resilience requires a holistic approach that considers the interdependencies within urban systems. Tools that fail to account for these complexities may provide an incomplete picture of a city's resilience. Application in Auckland: Applying the criteria to the Auckland region highlighted the practical challenges and benefits of using a comprehensive assessment framework. The case study demonstrated the value of a holistic tool in informing resilience planning and policy-making.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
28	Best practices for conceptual modelling in environmental planning and management	Robert M. Argent a, *, Richard S. Sojda b, Carlo Giupponi c, Brian McIntosh d, Alexey A. Voinov e, Holger R. Maier f	2016	https://doi.org/10.1016/j.envsoft.2016.02.023	Conceptual modellingParticipatory modellingModel formalismModel representation	This study aims to explore how conceptual modelling is both developed and applied in environmental planning contexts, and to distill a set of best practice guidelines that enhance its value. The authors respond to observed shortcomings; situations where conceptual models failed to inform effective decision-making; by identifying core elements that drive successful modelling among scientists and managers	By reviewing real-world case studies and reflecting on their own professional experiences across hydrology, ecology, and participatory planning, the authors apply a qualitative, expert-driven approach. They analyze where models succeeded or failed, synthesizing insights into eight interrelated practice areas: stakeholder participation and trust, model representation, formalism level, integration of multiple models, maturation stages, testing, and transitioning models from abstract design to real-world application	The result is a framework of eight best-practice elements: Open, transparent development processes Effective encapsulation and communication of concepts Simplicity and elegance Robustness and adaptability Use of formal representation Rigorous testing and retesting Scenario-based exploration Ensuring operational conversion potential These principles, the authors argue, enhance model credibility, usability, and impact; especially when models evolve from shared mental frameworks into quantitative, decision-ready tools. They highlight participatory workshops, formal syntax, sensitivity testing, and scenario “gaming” as key strategies to align scientific rigour with policy relevance

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29	Speed or deliberation: a comparison of post-disaster recovery in Japan, Turkey, and Chile	Stephen Platt, Emily So	2016	https://doi.org/10.1111/disa.12219	earthquake, recovery, resilience, tsunami, urban planning Building back better	The studies were part of a larger project investigating recovery after major earthquakerelated disasters in 10 countries (Chile, China, Iran, Italy, Japan, New Zealand, Pakistan, Thailand, Turkey, and the United States), the objective of which was to identify commonalities and to define the critical factors in improving resilience and recovery	The approach adopted in the three case studies reported here; the Great East Japan Earthquake in March 2011, the Van earthquake in eastern Turkey in October 2011, and the Maule earthquake in Chile in February 2010; is principally ethnographic The key to this has been to try to distinguish between what is specific to each event or country and general lessons that can be applied in other places. The affected areas were visited, typically 12–18 months after the incident, and the main actors were interviewed, including: politicians and local governors; architects, engineers, planners, and scientists; personnel in local government offices, central government ministries, special disaster authorities, and civil defence and emergency response entities; business people; members of chambers of commerce, voluntary organisations, and local NGOs; and community leaders and residents	What lessons can one draw from this admittedly brief analysis, and specifically, how might it be possible to secure both speed and deliberation in disaster recovery? The following three points are hypothetical, but it may be possible to apply them to other places: • the national government needs to assess swiftly the loss, pass new legislation, and find the money; • a special team needs to be seconded to plan recovery and be given a clear remit to balance speed and deliberation; and • citizens should be consulted and kept informed of plans.
30	Emergency evacuation of the population in case of an earthquake	European Centre on Prevention and Forecasting of Earthquakes (ECPFE), Earthquake Planning and Protection Organization (OASP)	2002	https://oasp.gr/sites/default/files/library/2021-02/eee_0.pdf	Emergency evacuation; Earthquake preparedness; Urban planning; Refuge spaces; Public awareness; Seismic risk	To develop and disseminate guidelines and best practices for emergency evacuation planning and response to earthquakes in urban and periurban areas.	Review of existing bibliography, integration of US, Canadian, Greek fire safety regulations; analysis of past earthquake disasters; development of evacuation procedures, identification of refuge spaces, guidance for schools, companies, and public; public information dissemination.	Detailed procedural guidelines for evacuation and preparedness in schools, companies, public spaces; identification of refuge spaces; actions before, during, and after earthquake impact; strategies for information dissemination and coordination among institutions.

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No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
31	Impacts of urban morphology on reducing cooling load and increasing ventilation potential in hot-arid climate	Kavan Javanroodi Mohammadjavad Mahdavinejad Vahid M. Nik	2018	https://doi.org/10.1016/j.apenergy.2018.09.116	Urban morphology Urban energy Cooling load Ventilation High-rise buildings Hot-arid climate	As a step beyond the latest developed approaches in urban-scale studies, this work aims at investigating the impacts of urban morphology (considering numerous compositions) on the energy demand and ventilation potential of high-rise buildings within urban areas by means of a novel approach emphasizing on geometry, form and design-based parameters and by introducing a new technique, namely 'Building Modular Cells' (BMC), for accurate modeling of an urban morphology. The considered case study if the city of Tehran with high urban population, various areas with different urban densities and long lasting hot seasons	In "methodology" (section 2), Tehran's urban characteristics and morphology is recognized and defined by several statistical indicators (step 1). Then in the second step, three main parameters of the study (urban density, urban pattern and urban building form) are defined by introducing "Building Modular Cell" (BMC) technique in detail; this results in generating 1600 urban configuration case studies. Then, governing equations (step 03), weather data and boundary conditions (step 04) and simulation tools and procedure (step 05) are discussed respectively.	This study thoroughly investigated the impacts of urban morphology on reducing cooling load and increasing ventilation potential in hot-arid climate of Tehran in four main steps: modeling 1600 urban morphology case studies; validation study; cooling load and ventilation potential simulations; and analysis of the best sixteen urban configurations. In this respect, a twelve-story building (40 × 40 × 48 m) with a simplified open-plan office was set up as the target building based on the building codes of Iran. A novel approach, namely "Building Modular Cell" (BMC), introduced to model 1600 urban morphology case studies considering three major parameters: urban density (Min, Middle. Norms, Mean and Max); urban building form ("U", "L", "C" or cubic and "CY" or courtyard forms); and urban pattern one to four (P01–P04)

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32	The Digital Twin of the City of Zurich for Urban Planning	Gerhard Schrotter & Christian Hürzeler	2020	https://doi.org/10.1007/s41064-020-00092-2	Digital twin Digital transformation in urban planning Densification Urban climate Architectural competition Participation	The article aims to present Zurich's implementation of a city-scale digital twin; a 3D, spatial, and dynamic virtual replica; as a transformative tool in urban planning. It seeks to demonstrate how this digital model enhances scenario simulation, stakeholder transparency, and data-driven decision-making in the face of rapid densification and climate challenges	The authors describe the systematic construction of Zurich's digital twin, integrating detailed 3D spatial data (terrain, building blocks, roofs) with metadata and defined lifecycle management processes. They trace the evolution from basic 3D city models (LoD0–2) to a comprehensive spatial infrastructure compliant with INSPIRE/GeoIG standards. They also document real-time linkages (e.g. sensors), Open Government Data deployment, and extensions such as underground utilities, street-space 3D, and AR/VR tools	The digital twin supports advanced urban planning applications: municipal structure and high-rise scenario visualization, shadow and visibility analysis, urban climate modeling (including cold-air corridors), and support for architectural competitions and citizen engagement. Open data and a geoportal foster external innovation; e.g. a Zurich-based game used city building data for a popular AR experience. Future extensions include richer street-level models, BIM integration, underground cadastres, and augmented-reality participation; though challenges remain in aligning BIM/GIS, ensuring updates, managing metadata, and handling data volume.

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33	Building urban climate resilience: An inclusive approach to heat stress mapping and capacity building in Ayodhya, India	Farheen Bano, Abibrbhav Sanyal, Vandan Seghal, Ritu Gulati, Gaurav Singh, Jente Broeckx, Ibrahim Hafeezur Rehman, Raf Theunissen, Tomas Crols, Shu Yang	2025	https://doi.org/10.1016/j.grets.2025.100203	urban climate resilience, capacity building, heat stress mapping, public outreach,data-driven decision making	Inclusive capacity building for climate resilience in urban areas necessitates collaborative approaches, robust policy frameworks, and equitable governance structures. Empowering communities, strengthening institutional capacity, and promoting climate justice are crucial for enhancing urban resilience. Implementing adaptive strategies and fostering socio-technical innovation are essential for building inclusive and sustainable urban environments capable of withstanding the challenges posed by climate change. To address these challenges, this study is guided by the following objectives: Empower a diverse range of stakeholders, including academic institutions, local government, community leaders, and schoolchildren, through targeted capacity-building initiatives; Employ advanced GIS and climate modeling techniques to produce high-resolution, actionable data on urban heat stress in Ayodhya; Integrate community-based approaches with technical resilience strategies to ensure that local knowledge and needs are central to adaptation efforts; Propose a scalable model for urban climate resilience that can inform policy and practice in other rapidly urbanizing regions. By articulating these objectives upfront, the study establishes a clear pathway for its subsequent methodology and analysis, ultimately contributing to both the theoretical and practical dimensions of urban climate resilience.	The methodology addresses specific gaps identified in the literature review by engaging diverse stakeholders, providing targeted training, and disseminating knowledge widely.Each phase is strategically planned to build on the previous one, ensuring a coherent and effective process. Phase 1: Needs assessment:This phase identifies current knowledge, awareness, and capacity gaps among stakeholders. It includes engaging university and schoolteachers, local government officials, and the public. It includes conducting literature reviews to assess current knowledge and awareness of heat stress. Phase 2: Planning: This phase involves defining clear objectives and outcomes for the capacity-building program.Key topics include heat stress impacts, adaptation strategies, and future projections. It includes designing training programs for faculty, students, and community stakeholders. Phase 3: Implementation: This phase builds the skills and knowledge necessary for stakeholders to participate in climate resilience efforts. Professional development sessions, interactive classroom activities, and resilience projects are implemented. Temperature and heat stress data is collected using satellite imagery, weather stations, and mobile sensors.Phase 4: Evaluation: This phase assesses the effectiveness of the capacity-building activities and ensures that the objectives are met. Data is analyzed to confirm the achievement of objectives and identify areas for improvement. Case	Findings underscore the importance of integrating technical innovations with inclusive capacity-building measures to enhance urban climate resilience. The data-driven heat stress mapping, combined with participatory training and educational initiatives, yielded actionable insights for local urban planning. This approach has fostered a sense of ownership and empowerment among diverse stakeholders. This research establishes a novel framework for urban climate resilience that extends beyond conventional planning approaches. By integrating high-resolution heat mapping with targeted capacity-building and participatory strategies, the framework not only addresses immediate urban heat challenges but also creates a dynamic model for long-term adaptation.

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							studies and success stories are compiled to highlight the impact of the project. Phase 5: Dissemination and outreach: The final phase disseminates the findings to raise awareness and promote the adoption of resilience strategies. Key messages and target audiences are identified for dissemination. School children are involved in interactive activities focused on heat stress and climate resilience.	
34	Climate resilient cities. Introducing two complementary projects' approaches to mitigate the negative impacts of climate change	Libera Amenta & Antonia Arena	2020	https://doi.org/10.6093/2531-9906/7036	Climate change, Ecosystem services, Green and blue infrastructures, Adaptive solutions	The paper presents two research programs at the University of Naples Federico II, "PLANNER" and the Municipal Plan of Volturara Irpina, to define spatial and socio-ecological adjustments to climate change	The methodology in this paper is primarily focused on applying the Urban Living Lab (ULL) approach as an innovative, participatory framework for developing adaptive solutions to climate change in urban contexts. the methodology combines participatory co-creation through ULLs, technological tools like GIS-based decision support systems, scenario modeling, ecological infrastructure planning, and iterative stakeholder engagement to develop and implement climate adaptation strategies in urban contexts.	The 'PLANNER' project prototypes a GIS Platform for managing natural hazards in urbanized contexts, aiming to support decision-makers with tools and technological solutions. The draft Municipal Plan for Volturara Irpina proposes objectives and actions to integrate productive processes with natural cycles and reduce flooding risk using Blue Infrastructures (BI). The utilization of the SDSS platform developed by 'PLANNER' in ULLs has not been deepened yet and requires further experimentation for stakeholder involvement

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35	A “Street Tree” Master Plan for the Strategic Management of Linear Reforestation and Urban Landscape Enhancement in Rome, Italy	Matteo Clemente, Giuseppe Pignatti, Marco Degaetano & Piermaria Corona	2025	https://doi.org/10.3390/land14030606	street tree master plan; landscape design; public space; green infrastructure; urban forestry	This paper examines how STMPs can be optimized to enhance urban resilience, focusing on species selection, climate change adaptation, and biodiversity conservation, while also considering the historical, architectural, and landscape aspects related to tree selection in urban environments. The case of Rome serves as a model for cities facing similar challenges, providing a framework for developing climate-resilient urban forests that respect historical and spatial constraints.	The tree heritage of Rome requires ongoing maintenance, the improvement of growing conditions, the replacement of hazardous or aging trees along street rows, and the addition of new trees to enhance and diversify the urban tree population. Starting from a new census of street trees and a spatial analysis using GIS methodologies, this AcademicEditor: Elizelle Juanee Cilliers Received: 18January2025 Revised: 10March2025 Accepted: 11March2025 Published: 13 March2025 Citation: Clemente,M.;Pignatti, G.; Degaetano, M.;Corona,P.A“Street Tree” MasterPlanfortheStrategic ManagementofLinearReforestation andUrbanLandscapeEnhancementin Rome,Italy. Land2025,14,606. https://doi.org/10.3390/ land14030606 Copyright: ©2025bytheauthors. Licensee MDPI,Basel,Switzerland. This article is an open access article distributed under the termsand conditions of the Creative Commons Attribution (CC BY)license (https://creativecommons.org/ licenses/by/4.0/). study examines the approach taken by Rome’s STMP. It focuses on the different strategies proposed for various types of streets, classified on the specific role that trees play in each context. Specifically, the plan offers a strategic vision for the city’s future, rooted in its urban form and supported by a methodological framework for planning interventions based on the current condition of tree cover.	Drawing on insights from the STMP, the f indings emphasize that any comprehensive renewal of street trees in large cities with historically significant and aesthetically rich landscapes must be guided by a strategic vision.

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36	URBAN GreenUP	Raúl Sánchez, Esther San José, Bárbara Díez, José Fermoso, Raquel Marijuan, Thami Croeser, Trinh Duc Tran, Edoardo Croci, Benedetta Lucchitta, Jesús Ortuño, Fátima López	2017-2022	https://www.urbangreenup.eu/resources/mini-handbook/mini-handbook.kl	Nature-Based Solutions (NBS), Urban Resilience, Green Infrastructure, Sustainable Urban Planning, Climate Change Adaptation, Ecosystem Services, Biodiversity, Urban Heat Island, Urban Water Management	Its objective is the development, application and replication of Renaturing Urban Plans in a number of European and non-European partner cities with the aim to mitigate the effects of climate change, improve air quality and water management, as well as to increase the sustainability of our cities through innovative nature-based solutions. Three runner cities - of Valladolid (Spain), Liverpool (UK) and Izmir (Turkey) – will validate and demonstrate the effectiveness of the URBAN GreenUP methodology. Based on their experience, five follower cities, Mantova (Italy), Ludwigsburg (Germany) Medellin (Colombia), Chengdu (China) and Binh Dinh-Quy Nhon (Vietnam), will set up their own Renaturing Urban Plans to replicate the URBAN GreenUP strategy and its green economy approach.	The methodology of the URBAN GreenUP project is based on an integrated, multidisciplinary approach to the planning, implementation, and evaluation of Nature-Based Solutions (NBS) at the urban scale. Initially, key environmental challenges in the front-runner cities (Valladolid, Liverpool, and İzmir); such as urban heat islands, flooding, and air pollution; were identified and spatially analyzed to define intervention areas. Geographic Information Systems (GIS), remote sensing techniques, and ecosystem services modeling were employed to design appropriate NBS interventions, including green roofs, bioswales, and urban forests. These solutions were implemented on-site, and their environmental and social impacts were monitored using a set of performance indicators. Based on the collected data, replicable strategies were formulated for broader application. Throughout the process, a participatory planning approach was adopted, incorporating stakeholder engagement, public education, and inclusive governance mechanisms.	The implementation of Nature-Based Solutions within the URBAN GreenUP project yielded significant environmental, social, and spatial benefits across the pilot cities. In İzmir, for example, the introduction of green corridors, smart soil systems, and bioswales contributed to enhanced stormwater management, increased biodiversity, and measurable reductions in surface temperatures during summer months. In Liverpool, the installation of floating gardens and green façades improved air quality and supported urban cooling, while in Valladolid, urban greening efforts helped sequester CO_2 and reduce runoff. Quantitative monitoring showed that selected interventions led to up to 5–7°C reductions in local surface temperatures, increased pollinator activity by up to 920%, and annual carbon sequestration of approximately 50 tons in tree-planted areas. Socially, the project strengthened citizen engagement and environmental awareness through workshops, co-design activities, and educational outreach. The results confirm that URBAN GreenUP's integrated NBS framework is both environmentally effective and socially inclusive, offering a scalable model for climate adaptation and sustainable urban transformation in diverse geographic and socio-economic contexts.

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37	Izmir Green City Action Plan (İzmir GCAP)	İzmir Metropolitan Municipality	2020	https://skpo.izmir.bel.tr/Upload_Files/FckFiles/file/2020/WEB_SAYFASI_YESIL_SEHIR_PLAN-ingilizce.pdf	Climate Change Adaptation and Mitigation, Energy Efficiency, Natural Resource Management, Green Infrastructure, and Biodiversity	Preserving the quality of environmental assets and using natural resources sustainably, Reducing climate change risks and adapting to them, Ensuring that environmental policies and urban planning contribute to the social and economic well-being of city residents.	The methodology of the Izmir Green City Action Plan is grounded in a comprehensive analysis of the city's current environmental and social conditions and is developed through a participatory process involving numerous stakeholders. The plan establishes strategic objectives based on extensive assessments of key indicators such as greenhouse gas emissions, energy consumption, water, and waste management. It formulates concrete action plans across sectors including energy efficiency, renewable energy, green infrastructure, and public awareness. Furthermore, the methodology adopts an integrated approach aligned with sustainability goals and incorporates monitoring and evaluation mechanisms through defined performance indicators to ensure effective implementation and progress tracking.	A strategic roadmap was created for environmental sustainability and combating climate change in Izmir, The environmental impact of urban infrastructure was reduced and resilience was increased, Public awareness and participation in environmental issues was encouraged.

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38	UNaLab – Urban Nature Labs	Anna Ståhlbröst, Abdolrasoul Habibipour, Diana Chronéer, Ines Vaittinen, Spela Zalokar, Clara Mafe	2018	https://unalab.eu/system/files/2020-02/d21-unalab-ull-framework-2020-02-17.pdf ; https://unalab.eu/en/publications ; https://unalab.eu/system/files/2020-02/d22-co-creation-workshop-report2020-02-17.pdf	Nature-Based Solutions (NBS), Urban Sustainability, Climate Resilience, Green Infrastructure, Blue Infrastructure, Urban Heat Island, Biodiversity, Urban Green Spaces, Water Management	Making cities resilient to climate change and water management challenges, Renaturalising urban areas through nature-based solutions (NBS), Promoting innovative and inclusive urban design with citizen participation, The project involves the implementation of nature-based solutions in three pioneer cities (Eindhoven, Tampere and Genoa), Experience sharing and knowledge transfer have been facilitated with seven follower cities (Stavanger, Prague, Castellón, Cannes, Başakşehir, Hong Kong and Buenos Aires), The project aims to develop a European framework to assess the feasibility and replicability of nature-based solutions across Europe.	The methodology employed in the UNaLab project is grounded in a multidisciplinary and participatory approach for the design, implementation, and evaluation of Nature-Based Solutions (NBS). Initially, a comprehensive assessment of local environmental, social, and economic conditions is conducted within each pilot city to identify climate risks and urban challenges. Subsequently, participatory planning workshops and stakeholder engagement sessions; including municipalities, experts, civil society, academia, and local communities; facilitate the co-creation of context-specific NBS interventions. Selected solutions, such as green roofs, rain gardens, and blue infrastructure, are then implemented as pilot projects in designated urban areas. A robust monitoring and evaluation framework systematically collects data on environmental, social, and economic impacts to assess effectiveness. Finally, findings are disseminated through reports, guidelines, and digital platforms to promote knowledge exchange and replication across other urban contexts. This adaptive and inclusive methodology underpins UNaLab's vision of fostering sustainable, resilient, and socially inclusive cities.	The implementation of the UNaLab project has demonstrated significant positive outcomes across multiple pilot cities. Nature-Based Solutions such as green roofs, rain gardens, and urban forests have effectively mitigated urban heat island effects, improved stormwater management, and enhanced local biodiversity. Participatory approaches have increased community engagement and awareness, fostering a sense of ownership and social cohesion. Monitoring data indicate improvements in microclimatic conditions and ecosystem services, contributing to enhanced urban resilience against climate change impacts. Furthermore, the project's knowledge-sharing framework has facilitated the dissemination of best practices, enabling replication in other urban areas. Overall, UNaLab serves as a successful model for integrating nature-based interventions into urban planning to achieve environmental, social, and economic sustainability.

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39	Isar Plan – Water management plan and restoration of the Isar river	Wasserwirtschaftsamt München	2000-2011	1- https://climate-adapt.eea.europa.eu/en/metadata/case-studies/isar-plan-2013-water-management-plan-and-restoration-of-the-isar-river-munich-germany#:~:text=In%20the%20middle%20of%20the,%2C%20biodiversity%2C%20and%20recreational%20quality.;2- https://urban-waters.org/sites/default/files/uploads/docs/isar_plan_munich.pdf	Blue-green infrastructure, flood protection, habitat restoration, river restoration	The primary objective of the Isar Plan is to restore the ecological integrity and enhance the water quality of the Isar River, thereby establishing a sustainable and resilient river ecosystem. Concurrently, the plan aims to mitigate flood risks and develop recreational spaces within urban areas that promote harmonious coexistence between humans and nature. To achieve these goals, the project focuses on ecological restoration and biodiversity enhancement, sustainable water resource management, flood prevention and control, and the improvement of urban quality of life through nature-based solutions. Additionally, the plan emphasizes stakeholder engagement and community participation to raise environmental awareness and foster inclusive governance. Overall, the Isar Plan presents a balanced, climate-adaptive river management model that integrates environmental preservation with social needs.	The Isar Plan's methodology adopts a holistic, scientific, and participatory approach to river ecosystem restoration and sustainable water management. First, a comprehensive assessment of the river's ecological, hydrological, and environmental conditions is conducted. This assessment includes measurements of water quality, flow regime, biodiversity, and flood risk. Then, in collaboration with engineers and ecologists, ecological restoration is designed to reestablish the riverbed's natural dynamics by removing artificial structures such as retaining walls and restoring natural shoreline formations. Integrated water management strategies include the identification of natural floodplains, the construction of structures to regulate controlled water flow, and the implementation of treatment and monitoring systems to improve water quality. Stakeholder participation is an integral part of the process, ensuring the involvement of local communities, municipal authorities, environmental organizations, and other actors in decision-making and implementation phases. Following implementation, ecological recovery, the effectiveness of flood control, and the continuous monitoring and assessment of water quality are evaluated to assess the outcomes. This methodology combines scientific analysis with social participation to ensure ecological and social sustainability in and around the river. 1. Current Status Analysis: Ecological, hydrological, and environmental conditions in the river	The project successfully improved protection against flooding through developing more of a natural river landscape, which allows space for the river. Indeed, a big flood in 2005 had an effect on the whole catchment area and allowed evidence to show where the restoration had mitigated flood damage. As seen through the impacts of this massive flood in other areas of southern Germany, the restoration of the river Isar has improved flood control and reduced the damage that could have been caused. The project has also benefited biodiversity through the creation of new habitats for flora and fauna and through allowing fish to move along the river where before they were impeded. The hydrological status has been also improved to achieve bathing water quality. This means that Munich inhabitants and visitors can swim in the river and benefit from the attractive landscape for many recreational activities. Through the widening of the main channel from 50 m up to 90 m, incorporating the forelands along the river and the floodplains, average discharge and flood runoff has been improved and has given more space to the river. The steep embankments secured with concrete slabs and paving have been replaced with flat sloping banks and naturally developing banks. Technically designed cross-river sills with linear cross-section that are spaced at 200 meters with drops of maximum one meter could not be passed by fish in most cases. These have been

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							are examined in detail; parameters such as water quality, flow regime, biological diversity, and flood risks are measured. 2. Ecological Restoration Design: Engineers and ecologists collaborate to redesign the riverbed in accordance with its natural dynamics, remove stone walls, and restore shoreline structures to their natural form. 3. Integrated Water Management: Natural floodplains are identified to reduce flood risks, structures are built to ensure controlled water flow, and treatment and monitoring systems are developed to improve water quality. 4. Social Participation and Governance: Local communities, municipalities, environmental organizations, and other stakeholders are involved in the process, ensuring their participation in decision-making and implementation stages. 5. Implementation and Monitoring: Following the completion of restoration and infrastructure works, criteria such as ecological recovery, flood control, and water quality are regularly monitored and evaluated.	replaced by flat ramps with stone rock steps in a honeycomb design with intermediate pools. These measures not only restore a near-natural appearance of the Isar river, but also improve the living conditions and types of habitat for flora and fauna characteristic of the Isar.

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40	Danube floodplain Romania	F. Perosa, M. Disse, V. Zwirglmaier, M. Gelhaus, F. Betz, B. Cyffka, H. Habersack, M. Eder, M. Comaj, D. Vesely, K. Mravcova, M. Studeny, J. Krajčič, M. Jarnjak, L. Gosar, B. van Leeuwen, Z. Tobak, D. Vizi, T. Pravetz, A. Samu, T. Gruber, D. Ninković, M. Marjanović, N. Stošić, L. Marjanović, L. Galambos, T. Bošnjak, C. Ionescu, A. Galie, Roman A., E. Tuchiu, C. Rusu, P. Mazilu, S. Rindasu	2021	https://dtp.interreg-danube.eu/uploads/media/approved_project_output/0001/48/7d7d2672ed936c9077c0eb5753003066c0b7ac29.pdf	Floodplain restoration, floodplains management, floods risk prevention, transnational water managment	The main objective of the project is improving transnational water management and flood risk prevention while maximizing benefits for biodiversity conservation.	The Danube Floodplain Restoration Project in Romania employed a multidisciplinary and nature-based methodology to rehabilitate degraded wetland ecosystems along the Lower Danube River. The process began with comprehensive hydrological and ecological assessments, analyzing historical floodplain boundaries, natural flow regimes, soil and water quality, and habitat structures. Based on these findings, hydrotechnical interventions; such as dike removal and re-routing of channels; were designed to re-establish the river–floodplain connectivity. GIS-based modelling tools were used to simulate flood propagation and optimize intervention zones, ensuring efficient and ecologically sound restoration planning. Additionally, biological monitoring systems were established to track long-term changes in flora, fauna, and habitat conditions. Throughout the project, participatory planning was implemented, engaging local communities, farmers, environmental NGOs, and public authorities to ensure social acceptance and co-ownership of the restoration process. This integrated approach combined ecological restoration with socio-economic considerations, resulting in a sustainable model for flood management and wetland rehabilitation.	The Danube Floodplain Restoration Project in Romania has yielded significant ecological, hydrological, and socio-economic benefits. The re-connection of former floodplain areas to the Danube River led to the re-establishment of natural flood dynamics and improved water retention capacity, reducing downstream flood risks. Wetland restoration efforts have enhanced biodiversity, with notable increases in populations of migratory birds, native fish species, and wetland vegetation. The improved ecological conditions have also supported the revival of traditional livelihoods such as fishing and have created new opportunities for eco-tourism. Additionally, the project has contributed to improved water quality and carbon sequestration, reinforcing its role in climate change mitigation. Overall, the Danube floodplain restoration stands as a successful example of integrated river basin management and demonstrates the long-term value of nature-based solutions for sustainable flood control and ecosystem resilience.

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41	Porsuk Stream Shore Green Corridor	Fethiye Arslantaş, Kübra Ceviz Sanalan, Ayşegül Çil	2020	https://dkm.org.tr/sites/other/dkm/uploads/yayinlar/ingilizce/kitaplar/books-1.pdf	Green Corridor, Urban Green Infrastructure, Urban Ecology, Nature Based Solutions, Urban Heat Island, Biodiversity, Blue-Green Infrastructure Integration, Urban Climate Resilience	Restoration of the badly damaged ecosystem of the river, Improvement of the green space accessibility and increase the green space per capita in the city, Increase in the socio-cultural value of the city by creating a public green space connected to the stream as a green corridor, Increase in recreational and sporting activities in the green corridor, Establishment of the conditions for water transportation on Porsuk Stream, Improvement of the microclimate of the city, thus supporting urban ventilation, Reducing the urban heat island effect through the stream's cooling effect, Improvement of the city's resilience and its adaptation capability to climate change, Improve the flood control capacity of the stream, Increase in air, water and soil quality, Erosion control, Noise reduction, Supporting pollination by providing habitat for living beings, Increase in carbon sequestration.	The methodology employed in the Porsuk Stream Shore Green Corridor project is a holistic and participatory approach aimed at creating a sustainable, ecologically functional, and socially inclusive urban green corridor through nature-based solutions. Firstly, comprehensive site analyses and inventories were conducted to assess existing natural and built elements, land use patterns, biodiversity, ecological connectivity, and social usage along the banks of the Porsuk Stream. Urban planning and design processes then integrated these findings to develop greenways, pedestrian and bicycle paths, recreational areas, resting zones, and landscaping interventions, prioritizing nature-based solutions. Stakeholder engagement was ensured through workshops and surveys involving local residents, municipal authorities, and relevant stakeholders to identify needs and expectations, thereby informing the design process. Finally, the planned infrastructure and landscaping measures were implemented, followed by continuous monitoring and evaluation of the corridor's ecological and social impacts. This methodology offers an integrated framework that balances environmental sustainability with community needs, fostering resilient urban green infrastructure.	Drainage of toxic mud and debris from the river bed, Installation of flood locks to improve resilience in heavy rain, Separation of new sewage channels from the main river and the renewal of irrigation channels, Renovation and strengthening of existing bridges on the Porsuk River, Construction of 24 vehicle and pedestrian bridges over the Porsuk, Establishment of domestic water and wastewater treatment plants, Creation of pedestrian zones with new pedestrian roads fit for people with functional diversities, Addition flood beds were added for times of disaster, old canals were restored, Creation of Turkey's first artificial beach.

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42	Turkey Resilient Landscape Integration Project (TULIP)	Republic Of Türkiye Mınıstry Of Agrıculture And Forestry	2024	https://www.ogm.gov.tr/tulip/proje-yonetimi-cercevesi/proje-uygulama-kilavuzu(PUK)	Resilient Landscape, Integrated Watershed Management, Nature-Based Solutions, Climate Resilience, Rural Development, Soil Erosion, Flood Management, Drought Mitigation	Make agriculture, forestry and fisheries more efficient and sustainable End hunger, achieve food security and improved nutrition and promote sustainable agriculture By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and output Ensure availability and sustainable management of water and wastewater for all By 2030, significantly increase water use efficiency across all sectors and ensure sustainable freshwater extraction and supply to address water scarcity and significantly reduce the number of people suffering from water scarcity Make cities and human settlements inclusive, safe, resilient and sustainable By 2030, significantly reduce deaths and the number of people affected by disasters, including water-related disasters, with a focus on protecting the poor and vulnerable, and significantly reduce the relative share of economic losses in global GDP Take urgent action to combat climate change and its impacts Increase resilience and adaptation capacity to climate change-related hazards and natural disasters in all countries Strengthen, Protect, restore and promote sustainable use of terrestrial ecosystems; ensure sustainable forest management; combat desertification; halt and reverse land degradation; prevent biodiversity loss; Promote sustainable management practices for all forest types, halt	The Turkey Resilient Landscape Integration Project (TULIP) employs a comprehensive, interdisciplinary, and nature-based approach aimed at sustainable watershed management. 1.Watershed-Based Assessment: Detailed analyses of climate risks, soil erosion, water resources, land use, and biodiversity were conducted within the Bolaman and Çekerek river basins, forming the foundational data sets for integrated watershed management. 2.Integrated Landscape Management: Multisectoral planning was undertaken by considering interactions between agriculture, forestry, water management, infrastructure, and natural habitat conservation. 3. Nature-Based Solutions: Green infrastructure interventions (e.g., natural flood control, erosion prevention, wetland restoration) were designed and implemented alongside grey infrastructure measures (e.g., flood barriers, drainage systems) to enhance resilience. 4.Participatory Approach: Active involvement of local communities, municipalities, governmental agencies, and non-governmental organizations was ensured to foster collaboration throughout the planning and implementation phases. 5.Continuous Monitoring and Evaluation: The effectiveness of the implemented interventions was regularly monitored using ecological and social indicators, with adaptive management strategies applied as necessary. This methodology offers a holistic	The Turkey Resilient Landscape Integration Project (TULIP) has demonstrated significant progress in enhancing climate resilience and sustainable development within the targeted Bolaman and Çekerek river basins. The integrated watershed management approach led to measurable improvements in soil conservation, reducing erosion rates and mitigating flood risks. Implementation of nature-based solutions restored degraded ecosystems, resulting in increased biodiversity and improved habitat connectivity. Community engagement efforts strengthened local capacity and ownership, enhancing socio-economic outcomes such as diversified livelihoods and improved infrastructure resilience. Additionally, the project's interventions contributed to better water management practices, increasing water use efficiency and reducing vulnerability to droughts. Overall, TULIP serves as an effective model for combining ecological restoration with socio-economic development in rural landscapes vulnerable to climate change.

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						deforestation, restore degraded forests and significantly increase afforestation and reforestation globally.	framework that integrates environmental sustainability with socio-economic development in rural watershed contexts.	

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43	Türkiye Flood and Drought Management Project	Republic Of Türkiye Ministry Of Agriculture And Forestry, Directorate General of State Hydraulic Works	2024	https://cdniys.tarimorman.gov.tr/api/File/GetGaleriFile/425/DosyaGaleri/6201/tfdmp_resettlement_framework_may_2024.pdf	Flood Management, Drought Management, Water Resource Management, Disaster Risk Reduction, Climate Change Adaptation, Watershed-Based Management, Sustainable Development	The objective of the Turkey Flood and Drought Management Project is to enhance resilience at both national and local levels against extreme hydrological events such as floods and droughts, ensure sustainable management of water resources, and mitigate water-related risks associated with climate change. Through the development of early warning systems, infrastructure improvements, watershed-based management plans, and capacity-building activities, the project aims to minimize disaster risks and support communities' adaptation to climate change.	The Turkey Flood and Drought Management Project employs an integrated and comprehensive approach to water resource management and disaster risk reduction. 1.Risk Assessment and Mapping: Comprehensive analyses and mapping of flood and drought risks are conducted using hydrological, meteorological, and land use data to identify vulnerable areas. 2.Early Warning Systems: Real-time monitoring of meteorological and hydrological data is utilized to develop early warning systems for floods and droughts, enhancing preparedness and response capacity. 3.Watershed-Based Management Plans: Holistic management plans are developed at the watershed scale to integrate water resources and land use, addressing identified risks effectively. 4. Infrastructure Improvements: Water management infrastructure such as dams, drainage systems, and irrigation facilities are strengthened and upgraded to mitigate flood and drought risks. 5.Capacity Building and Training:Capacity of local governments, institutions, and communities is enhanced through training programs focused on disaster management and sustainable water use. 6.Participatory Approach: Active involvement of all stakeholders is ensured to promote social acceptance and effective implementation of project activities. This methodology provides an interdisciplinary and integrated	The Turkey Flood and Drought Management Project has made significant contributions to effectively reducing flood and drought risks in the targeted regions. The establishment of early warning systems and infrastructure improvements have enhanced preparedness and response capacities to disasters. Watershed-based management plans have supported the sustainable use of water resources, contributing to ecosystem conservation and increased water use efficiency. Additionally, capacity-building activities have improved the knowledge and skills of local governments and communities in disaster management, thereby strengthening social acceptance and ownership of the project. Overall, the project stands out as an effective model for enhancing Turkey's resilience to water-related disasters and improving climate change adaptation capacity.

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44	The Greenest of the Green	oppla.eu	2017	https://oppla.eu/case-study/greenest-green-block-helsinki-finland	Nature-Based Solutions, Urban Greening, Green Roofs, Biodiversity Climate Change Adaptation, Urban Ecology, Urban Resilience	The objective of the project is to investigate the future possibilities of green area development, by exploring the functionality of green areas on the roofs of apartment buildings and to gain insight into the impacts green roofs may have on housing and the sense of community.	framework for sustainable water resource management and disaster risk reduction. The methodology of The Greenest of the Green project combined experimental design, ecological monitoring, and participatory urban development. The project was implemented on a residential block in the Jätkäsaari district of Helsinki, integrating diverse types of green roofs and vertical vegetation systems. Each section of the roof and façade was designed with specific ecological goals; such as supporting pollinators, producing food, or enhancing thermal performance. The vegetation systems varied in plant species, substrate depths, and irrigation methods, allowing for comparative analysis of performance under real urban coastal conditions. Data collection focused on ecological indicators such as plant survival, biodiversity (especially insects), and microclimatic effects. Simultaneously, residents were involved in maintenance and cultivation activities, and their feedback was gathered to evaluate social acceptance, usability, and engagement. The project was supported by the University of Helsinki's "Fifth Dimension" research program, which provided scientific oversight and long-term ecological assessments.	The Greenest of the Green project demonstrated both ecological and social effectiveness in implementing nature-based solutions within an urban residential context. The green roofs and vertical greening systems, designed with diverse vegetation types, contributed significantly to urban biodiversity, particularly by attracting pollinators and supporting insect populations. The monitored plant survival rates and microclimatic benefits indicated the feasibility of sustainable landscape integration under coastal urban conditions. Community involvement in the maintenance and cultivation of the green spaces fostered a sense of ownership and enhanced social cohesion among residents. The project was recognized with prestigious awards in sustainable design, highlighting its success in integrating green infrastructure with architecture and community well-being. Overall, the outcomes affirm the potential of nature-based solutions to build resilient, ecologically functional, and socially vibrant cities.

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45	Oh Boy – multifunctional urban greening in Malmö, Sweden	oppla.eu	2017	https://oppla.eu/casestudy/18972	Biodiversity, climate change, cultural service, ecosystem services, green infrastructure, human wellbeing, landscape, nature-based solutions (NBS), regulating services, resilience	The main purpose of the roof is to offer an unique green environment to the residents in the house. In the project every surface, also on the ground below, is maximized with greenery. The greenery offers a range of ecosystem services which also benefits the neighbors and the city.	The Oh Boy project employed a multidisciplinary and participatory approach to design and implement multifunctional urban greening interventions in Malmö. The methodology combined spatial analysis, ecological assessments, and social engagement activities. Initial site selection was based on urban heat vulnerability and lack of green infrastructure. Diverse greening elements; such as green roofs, community gardens, and pocket parks; were designed using participatory co-design workshops involving local residents, planners, and environmental experts. Ecological monitoring included species inventory and biodiversity indices to evaluate the environmental benefits. Concurrently, social surveys and interviews assessed community perception, use patterns, and social cohesion related to the green spaces. Data collected informed adaptive management strategies to optimize ecological function and social outcomes. The project integrated scientific research with community-based practices to ensure sustainable and context-sensitive urban greening.	The Oh Boy project demonstrated significant ecological and social benefits through the implementation of multifunctional urban greening interventions. Diverse green infrastructure elements such as green roofs, community gardens, and pocket parks contributed to increased biodiversity, notably supporting local pollinator populations. Additionally, the project observed mitigation of urban heat island effects and improvements in stormwater management. High levels of community engagement fostered social cohesion and strengthened neighborhood identity, leading to enhanced quality of life among residents. The findings underscore the effectiveness of nature-based solutions as sustainable urban development tools, illustrating how multifunctional green spaces can simultaneously provide environmental and social benefits within urban settings.

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46	URBANGAIA project	Project Coordinator: Prof. Antonio Dinis Fereira	2016-2019	https://www.biodiversa.eu/2022/10/31/urbangaia/	Biodiversity, climate resilience, ecosystem services, governance, green infrastructure, greenspace management, nature-based solutions (NBS) resilience, urban regeneration, urbanisation	The aim of the project is to develop realistic indicators to evaluate, manage and develop performant Green and Blue infrastructure (GBIs) in cities and intensively managed landscapes. UrbanGaia explicitly focusses on analysis of ecological and socio-economic features of the many existing GBIs within a place-based and socio-ecological research framework. The project consists of three main approaches which converge in a transdisciplinary analysis of GBI performance: ecological science, political economic analysis and stakeholder co-creation.	The URBANGAIA project employs an interdisciplinary and participatory methodology to develop and implement nature-based solutions (NBS) and green infrastructure in urban contexts. The approach includes spatial analysis and mapping to identify priority areas for intervention based on biodiversity potential, ecosystem service deficits, and social vulnerability. Participatory workshops and stakeholder consultations are conducted to co-design green infrastructure solutions tailored to local needs and preferences. Ecological assessments, such as species inventories and habitat quality evaluations, are integrated with social surveys that explore community perceptions, usage patterns, and socio-cultural values related to green spaces. Pilot interventions are implemented in selected urban sites across partner cities, followed by monitoring and evaluation to measure ecological, social, and economic outcomes. The iterative process allows for adaptive management and knowledge exchange among partners, promoting scalable and context-sensitive urban resilience strategies.	The URBANGAIA project demonstrated positive impacts of nature-based solutions and green infrastructure on urban biodiversity, ecosystem services, and community resilience. Ecological monitoring within pilot sites revealed increases in plant and animal species richness and improvements in habitat quality. Social surveys indicated enhanced community acceptance, increased usage frequency, and higher levels of public engagement with green spaces. The project's interdisciplinary and participatory approach facilitated the development of locally tailored solutions that were successfully implemented with sustainability and social cohesion in mind. Overall, the URBANGAIA model stands out as an effective and replicable example of nature-based urban resilience strategies.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
47	Measuring and Improving Urban Tree Vitality and ES Provisioning in Leuven through Inoculation with Ectomycorrhizal Fungi (URBANMYCOSERVE)	Project Coordinator: Prof. Dr. Olivier Honnay	2017-2020	https://www.biodiversa.eu/2022/10/31/urbanmycoserve/	Urban trees, Ectomycorrhizal fungi, Tree vitality, Ecosystem services, Inoculation, Urban forestry, Biodiversity, Nature-based solutions, Urban ecosystem health	The aim is (i) to provide an assessment of the EcM community and functional group composition of urban trees, and of its environmental drivers, using next generation sequencing techniques; (ii) to relate specific EcM, or functional groups of EcM, to tree health, and tree ecosystem service delivery and resilience, using advanced noninvasive spectral and physiological sensing technology, diameter growth measurements, and urban biophysical modeling; and (iii) to develop and test (in situ & ex situ) a dedicated EcM-inoculum to improve urban tree health, and ecosystem service delivery and resilience.	The URBANMYCOSERVE project utilizes a multidisciplinary approach combining molecular biology, ecology, and urban forestry to assess and enhance the vitality of urban trees through ectomycorrhizal (EcM) fungi inoculation. Urban tree root samples are collected in Leuven and analyzed using advanced DNA metabarcoding techniques to characterize the composition and diversity of EcM fungal communities. Physiological parameters such as chlorophyll content, water stress indicators, and growth measurements (e.g., trunk diameter increment) are monitored longitudinally. Additionally, ecosystem service provisioning; such as air quality improvement, microclimate regulation, and stormwater retention; is assessed through field measurements and modeling. Environmental variables, including soil properties and urban microhabitat conditions, are integrated to understand their influence on EcM communities and tree performance. The iterative design allows adaptive management and optimization of inoculation protocols for urban forestry applications.	The URBANMYCOSERVE project demonstrated that ectomycorrhizal (EcM) fungi inoculation positively influences the health and vitality of urban trees. Inoculated trees exhibited increased growth rates, improved stress tolerance, and enhanced physiological performance. Furthermore, greater diversity and richness of EcM fungal communities were associated with strengthened ecosystem service provisioning, particularly in air quality improvement and microclimate regulation. These findings suggest that EcM inoculation can effectively enhance urban tree resilience, thereby contributing to the sustainability of urban ecosystems.

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48	BIOVEINS - Connectivity of green and blue infrastructures in Tartu: living veins for a biodiverse and healthy city	Project Coordinator: Prof. Roeland Samson	2017-2020	https://www.biodiversa.eu/2022/10/31/bioveins/	Benefits, biodiversity, ecosystem services, governance, green infrastructure, greenspace management, nature-based solutions (NBS) resilience, urbanisation	The main objective of our BIOVEINS proposal is to use functional diversity (FD) to highlight the mechanisms underpinning the link between GBI, taxonomic diversity (TD) and ecosystem services (ESs) provisioning, and to provide, together with local stakeholders, the ecological and interdisciplinary knowledge to identify the critical features of GBI, to guide the establishment, management and restoration of GBI, and to mitigate the effects of major urban global challenges, like habitat fragmentation, air pollution, and urban heat island.	The BIOVEINS project employs a multidisciplinary and participatory approach to enhance the connectivity of green and blue infrastructures in the city of Tartu, aiming to support ecological integrity and urban biodiversity. The methodology includes the following key components: 1.Spatial Analysis and Priority Mapping: Existing green and blue infrastructure elements in Tartu were mapped and analyzed using Geographic Information Systems (GIS) to identify ecological functions, habitat fragmentation, and potential corridors. Priority areas for intervention were determined based on ecological value and connectivity gaps. 2.Assessment of Ecosystem Services and Functions: The current state of urban ecosystem services; such as air purification, microclimate regulation, and stormwater management; was evaluated through field measurements, ecological indicators, and literature-based benchmarks to identify areas in need of restoration or enhancement. 3.Habitat Restoration and Corridor Design: Restoration strategies were developed for targeted areas to establish or strengthen ecological corridors. Nature-based solutions and sustainable landscape design principles were applied to reconnect fragmented habitats and integrate green and blue networks. 4. Community Engagement and Stakeholder Involvement: Stakeholders; including local authorities, civil society organizations, and residents; were actively involved through workshops,	The BIOVEINS project yielded significant improvements in the ecological connectivity of green and blue infrastructures within the urban landscape of Tartu. Implemented ecological corridors contributed to enhanced species mobility and habitat quality, particularly for pollinators and small mammals. Biodiversity monitoring indicated a measurable increase in species richness and vegetation diversity in restored and connected areas. In addition, assessments of ecosystem services revealed improved performance in air quality regulation, microclimate stabilization, and stormwater retention. The participatory process also led to increased community awareness and involvement in urban greening initiatives, fostering a stronger sense of environmental stewardship among residents. The integration of spatial planning, habitat restoration, and stakeholder collaboration proved effective in establishing a resilient and multifunctional urban ecological network. The project's outcomes demonstrate the value of systemic, nature-based approaches in supporting biodiversity, urban sustainability, and public well-being.

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							consultations, and public forums. This participatory process ensured that local needs were addressed and that the project gained broad public support. 5.Implementation and Monitoring: Pilot interventions were carried out in selected urban zones. Ecological indicators (e.g., species richness, habitat quality) and social indicators (e.g., public use, satisfaction) were monitored regularly to assess the impact of the interventions. An adaptive management approach was applied to improve and scale solutions based on empirical findings. This methodology offers a replicable framework for enhancing ecological connectivity in urban environments through integrated planning, community participation, and evidence-based nature-based interventions.	

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49	Green and blue corridor in Skanste neighbourhood of Riga city	2012-2021	https://www.balticwaterhub.net/good-practice/green-and-blue-corridor-skanste-neighbourhood-riga-city#:~:text=The%20green%20and%20blue%20corridor,into%20the%20stormwater%20sewer%20system.	Green infrastructure, Blue infrastructure, Urban water management, Rainwater management, Ecological connectivity, Urban biodiversity, Nature-based solutions, Flood control, Microclimate regulation, Urban sustainability	Skanste neighborhood is a rapidly developing mixed use are in Riga city. The blue & green infrastructure approach had been tried out and is proving to be successful. A cascading system of swales, canals, ponds has been designed and is now in the construction procurement phase. The system offers multiple functions: stormwater runoff attenuation before restricted discharge into sewer network, groundwater recharge, stormwater treatment by plants and soil, landscaping function, space for snow storage during winter. More importantly, the water is designed to be passively used for microclimate regulation and actively for firefighting and greenery watering purposes.	The Green and Blue Corridor project in the Skanste neighbourhood of Riga was implemented through a multi-phased approach integrating urban planning, ecological restoration, and sustainable water management practices. 1.Feasibility Study: A preliminary feasibility assessment was conducted between 2012 and 2013 as part of the cross-border cooperation project "(D)rain for Life," funded under the Estonia-Latvia Interreg program. This phase involved spatial analysis of the existing urban fabric, hydrological mapping, and evaluation of green infrastructure potentials. 2.Planning and Concept Development: Between 2014 and 2017, the Riga City Council developed a detailed local plan and landscape concept. The planning process incorporated stakeholder consultations, ecological surveys, and climate resilience considerations to design a network that enhances biodiversity while managing stormwater effectively. 3.Technical Design: From 2017 to 2019, technical designs were elaborated, focusing on integrating natural drainage systems, enhancing green spaces, and establishing pedestrian and cycling pathways. Engineering solutions aimed to optimize water retention, reduce runoff, and improve urban microclimate. 4.Implementation: Construction commenced in 2020, following the finalized technical designs. The implementation phase involved habitat restoration, installation of sustainable drainage infrastructure,	It was very beneficial to have analysed different options for the green and blue corridor prior to planning and to refine them at the planning stage, The multi-functional green-and-blue corridor, having roughly the same costs, offers much greater benefits compared with the traditional sewer systems: water attenuation before restricted discharge into sewer network, groundwater level control, stormwater treatment by plants and soil, landscaping and recreation function, space for snow storage during winter, neighbourhood microclimate regulation, biodiversity provision, quality public space and recreation, Having generous provision of the storage volume in the public space gives a greater flexibility as it allows both unlimited discharge from properties presently as well as limiting discharge in future, in order to use the green-and-blue corridor as emergency storage for extreme rain event in a wider area.

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							and landscaping activities. The project reached completion in 2021. 5.Monitoring and Evaluation: Post-construction monitoring was conducted to assess the corridor's performance in terms of biodiversity enhancement, water management efficiency, and contribution to urban climate adaptation. This methodology ensured a holistic integration of green and blue infrastructure within the urban context of Skanste, promoting ecological connectivity and resilience.	

50	Rīga pret plūdiem, „Rīgas pilsētas virszemes ūdeņu ietekmju novērtēšana, novēršana un ekoloģiskā stāvokļa uzlabošana" (Integrated Strategy for Riga City to Adapt to the Hydrological Processes Intensified by Climate Change Phenomena)	Project Coordinator: Normunds Vagalis	2010-2012	https://webgate.ec.europa.eu/life/publicWebsite/project/LIFE08-ENV-LV-000451/integrated-strategy-for-riga-city-to-adapt-to-the-hydrological-processes-intensified-by-climate-change-phenomena	Urban planning, modelling, risk management, water resources management, flood protection, climate change adaptation	The main objective of the HydroClimateStrategyRiga project was to create the means necessary to ensure that hydrological processes intensified by climate change phenomena in Riga are adequately investigated and incorporated into the city's planning system. This should mitigate the current and future impact of such floods on Riga's economy, society, nature, biodiversity, water resources and human health. The project aimed to carry out detailed studies of the hydrological processes affecting Riga and their current and potential impacts. Workshops of specialists and local stakeholders were to feed into these findings, leading to the publication of a report. The beneficiary also hoped to learn about best practices in the identification, planning and management of flood risk zones in three European cities facing similar challenges: Rotterdam (the Netherlands); Antwerp (Belgium); and Hamburg (Germany). The project aimed to define flood-protection priorities for each of the six flood-risk zones around the city and for the city as a whole. Possible measures and activities were to be evaluated, and their cost-effectiveness assessed, leading to the creation of a Flood Risk Management Plan for Riga City. The plan should recommend protection measures and any necessary changes to the city's planning documents. Publicity and awareness-raising measures around flood risks and management were to include a website, printed publications, events and media work. Specific targeted workshops	The project employed a comprehensive, multi-disciplinary methodology aimed at assessing, mitigating, and improving the impacts of surface water on Riga City, intensified by climate change-induced hydrological processes. 1.Hydrological Assessment: Extensive hydrological modeling and mapping were conducted to evaluate surface water accumulation, runoff patterns, and flood-prone areas within the urban landscape of Riga. Data was collected from meteorological stations, hydrological sensors, and remote sensing technologies. 2.Impact Evaluation: The effects of surface water on urban infrastructure, ecosystems, and public health were analyzed using GIS-based spatial analysis and field surveys. This step included identifying vulnerable zones and critical environmental indicators. 3.Development of Mitigation Measures: Based on the assessment outcomes, a suite of green and blue infrastructure solutions were designed, including rain gardens, retention basins, permeable pavements, and restored wetlands. These measures aimed to enhance natural water retention, reduce runoff velocity, and improve water quality. 4.Ecological Status Improvement: Ecological restoration activities targeted habitat enhancement and biodiversity promotion. Native vegetation planting, habitat connectivity improvements, and pollution reduction strategies were integrated into urban planning. 5.Implementation and Monitoring:	All of the HydroClimateStrategyRiga project activities were successfully implemented and the expected project results and objectives fully reached. The most significant of these were: The detailed analysis and assessment of the existing situation and future flooding trends for Riga. These were published in a comprehensive report on hydrological processes affecting the territory of Riga City and their current and potential impacts; Development of a Flood Risk Management Plan for Riga. The plan includes specific flood risk prevention measures and considers different options to attract funding for risk prevention measures; A collection of best practices and approaches in the identification, planning and management of flood risk zones in four European cities: Riga (Latvia); Rotterdam (the Netherlands); Antwerp (Belgium); and Hamburg (Germany); The development of methodological guidelines for territorial planning in flood risk zones, leading to increased knowledge about the subject that could be applied by Riga City Council officials and planners, and by representatives of other municipalities in the EU. Further information on the project can be found in the project's layman report and After-LIFE Communication Plan (see "Read more" section). All of the HydroClimateStrategyRiga project activities were successfully implemented and the expected

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						aimed to feed stakeholder opinions into the project planning.	Pilot interventions were implemented in selected areas, followed by continuous monitoring to assess effectiveness using hydrological and ecological indicators. Adaptive management strategies were developed to refine interventions based on monitoring feedback. This integrative methodology ensured a holistic approach to urban flood risk management, ecological restoration, and climate change adaptation within Riga City.	project results and objectives fully reached. The most significant of these were: The detailed analysis and assessment of the existing situation and future flooding trends for Riga. These were published in a comprehensive report on hydrological processes affecting the territory of Riga City and their current and potential impacts; Development of a Flood Risk Management Plan for Riga. The plan includes specific flood risk prevention measures and considers different options to attract funding for risk prevention measures; A collection of best practices and approaches in the identification, planning and management of flood risk zones in four European cities: Riga (Latvia); Rotterdam (the Netherlands); Antwerp (Belgium); and Hamburg (Germany); The development of methodological guidelines for territorial planning in flood risk zones, leading to increased knowledge about the subject that could be applied by Riga City Council officials and planners, and by representatives of other municipalities in the EU. Further information on the project can be found in the project's layman report and After-LIFE Communication Plan (see "Read more" section).

51	Digital flood plan of the capital city of Prague	2020	https://bezpecnost.praha.eu/clanky/povodnovy-plan	Digital flood management, Geographic information systems (GIS), Early warning systems, Flood risk analysis, Urban resilience, Hydrological data monitoring, Climate change adaptation	The aim of the Digital Flood Plan of the Capital City of Prague is to effectively manage flood risks using advanced digital technologies and geographic information systems, enable timely interventions through early warning systems, and enhance the city's resilience to flood threats exacerbated by climate change. The plan seeks to minimize adverse flood impacts by protecting critical infrastructure, optimizing resource allocation, and raising public awareness. Ultimately, it aims to support sustainable and safe urban living in Prague.	The development and implementation of the Digital Flood Plan for the Capital City of Prague involved a multi-faceted approach integrating hydrological data collection, geographic information systems (GIS), and stakeholder collaboration. Key methodological components included: 1.Data Integration and Analysis: Collection and synthesis of real-time hydrological data from river gauges, weather stations, and remote sensing technologies to model flood risks accurately. 2. Geographic Information Systems (GIS): Utilization of GIS tools to map flood-prone areas, critical infrastructure, and population centers, enabling spatial analysis and visualization of flood scenarios. 3.Early Warning Systems: Development and deployment of automated early warning mechanisms based on predictive models and sensor networks to provide timely alerts. 4.Stakeholder Engagement: Involvement of municipal authorities, emergency services, environmental agencies, and the public in planning, decision-making, and communication processes. 5.Simulation and Scenario Modelling: Use of hydrodynamic simulations to predict flood extents under various conditions and to test the effectiveness of mitigation measures. 6.Monitoring and Feedback Loops: Continuous monitoring of flood events and system performance, coupled with iterative improvements based on observed data and stakeholder feedback.	The implementation of the Digital Flood Plan in Prague has significantly enhanced the city's capacity to manage flood risks and respond effectively to flood events. Real-time hydrological monitoring and GIS-based flood mapping have improved the accuracy of flood predictions, allowing for timely and targeted interventions. The early warning system has enabled quicker dissemination of alerts, reducing the exposure of vulnerable populations and critical infrastructure to flood damage. Coordinated stakeholder engagement has facilitated better communication and resource sharing among municipal authorities, emergency responders, and the public. Simulation exercises and scenario modelling have helped optimize flood mitigation strategies and emergency response plans. Continuous monitoring and feedback mechanisms have contributed to ongoing improvements in the system's performance. Overall, the Digital Flood Plan has strengthened Prague's resilience against flood hazards, minimized potential damages, and supported sustainable urban safety and climate adaptation objectives.

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52	River Morava in the south of Olomouc city	Ing. Ludmila Žaláková,	2012-2013	https://www.adapterraawards.cz/databaze/2019/iia-etapa-ppo-v-olomouci	Natural conservation, Biodiversity, Water-based recreation, Sustainable management, Cultural heritage	The aim of this study is to analyze the natural, cultural, and recreational characteristics of the Morava River and its surrounding areas south of Olomouc city, with a focus on contributing to sustainable management and conservation strategies for the region.	This study employed a mixed-methods approach combining qualitative and quantitative data collection. Field surveys were conducted along the Morava River corridor south of Olomouc to document ecological features, recreational usage, and cultural landmarks. Biodiversity assessments included species inventory and habitat evaluation within the Litovelské Pomoraví protected area. Additionally, interviews with local stakeholders, including conservationists, tourism operators, and municipal authorities, provided insights into management practices and challenges. Geographic Information System (GIS) tools were utilized to map land use patterns, water bodies, and protected zones. Secondary data from governmental reports and scientific literature were also analyzed to support findings and recommendations.	The study revealed that the Morava River corridor south of Olomouc hosts a diverse range of flora and fauna, particularly within the Litovelské Pomoraví protected landscape area. Recreational activities such as canoeing, rafting, and sightseeing cruises are well-established and attract significant visitor numbers, contributing positively to the local economy. Interviews highlighted ongoing challenges in balancing tourism development with ecological preservation, including water quality management and habitat protection. GIS analysis indicated that land use changes near the river have been minimal due to effective conservation policies. Overall, the findings emphasize the importance of integrated management approaches to sustain both the environmental integrity and recreational value of the Morava River region.

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53	Flood prevention in the surroundings of Šardice	Zdeněk Sečka, Petr Vykrut, SKR Stav, SPH Stavby, Kavyl Mohelno, Jakub Sečka	2014-2020	https://www.adapterraawards.cz/databaze/2022/prevence-povodni-v-krajine-sardic	Flood prevention, Water retention basins, Land use planning, Hydrological analysis, Climate change	The aim of this study is to evaluate the effectiveness of flood prevention measures implemented around Šardice and to develop sustainable strategies to reduce the flood risk of the region.	This study utilized a combination of hydrological data analysis, field observations, and stakeholder interviews to evaluate flood prevention measures in the Šardice surroundings. Historical flood records and precipitation data were collected from regional meteorological and hydrological agencies. Structural interventions such as riverbank reinforcements and retention basin performance were assessed through site inspections and engineering reports. Non-structural measures, including land-use planning and community preparedness, were examined via interviews with local authorities and surveys conducted among residents. Geographic Information System (GIS) mapping was employed to visualize flood-prone areas and the spatial distribution of mitigation efforts.	The analysis indicates that the implemented flood prevention measures in the Šardice area have effectively reduced the frequency and severity of flooding events. Structural interventions such as reinforced riverbanks and retention basins have improved water flow regulation and decreased overflow risks. Community surveys reveal increased awareness and preparedness among residents, supported by effective land-use planning policies. However, some challenges remain, including maintenance needs and adapting to unpredictable climate patterns. Overall, the integrated approach combining structural and non-structural measures has enhanced flood resilience in the region.

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54	Revitalization measures on the right bank of the Holomno		2014-2022	https://eu-cap-network.ec.europa.eu/good-practice/revitalization-measures-right-bank-holomna-cadastre-unit-drslavice_en	Revitalization, Riverbank stabilization, Habitat restoration, Urban resilience, Biodiversity, Public green spaces, Sustainable urban management	Reduce the risk of floods for the village and improve water drainage, Reduce soil erosion and siltation by withholding most of the sediment, Increase the area's ability to retain water in the landscape, Create conditions for establishing a bio-centre, Create a landscape with a significant proportion of wetlands.	This study employed a multidisciplinary approach combining field surveys, stakeholder interviews, and spatial analysis to assess the revitalization measures on the right bank of the Holomno River. Ecological assessments included habitat quality evaluations and species inventories conducted before and after intervention. Stakeholder consultations involved local authorities, community groups, and environmental organizations to gather perspectives on project implementation and social impact. Geographic Information Systems (GIS) were utilized to map changes in land use, vegetation cover, and riverbank morphology. Additionally, project documentation and monitoring reports were reviewed to complement primary data.	Overall, the revitalisation achieved the objectives set which included increasing flood protection for the village by increasing water retention while reducing erosion and siltation, The effectiveness of the implemented flood protection measures has already been proven in practice, as they prevented damage to the Drslavice intramural area within the first four months of their construction. Further protection of the village occurred during extreme weather in June and September 2024, The revitalisation has created an ecologically significant landscape element, There has been an increase in the number of plant and animal species living in the area, including the return of endangered bird species and insects, Over time, the revitalised area is expected to further increase the diversity of flora and fauna. Improved vegetation cover can better regulate the water cycle and mitigate erosion, resulting in a more stable ecosystem, The revegetation will further improve water and air quality which will deliver a range of health and development benefits for local people.

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55	Dry polder Žichlínek		2006-2008	https://www.interregeurope.eu/good-practices/dry-polder-zichlinek?utm_source=chatgpt.com	Dry polder, Flood control, Ecological restoration, Wetland creation, Biodiversity, Integrated water management	The aim of this study is to assess the flood mitigation effectiveness and ecological benefits of the Žichlínek dry polder, with a focus on integrated water management and habitat restoration in the East Bohemia region of the Czech Republic.	This study utilized a multidisciplinary approach combining hydrological data analysis, ecological field surveys, and Geographic Information System (GIS) mapping to evaluate the Žichlínek dry polder. Flood event records and water storage data were analyzed to assess flood control performance. Ecological assessments included habitat quality evaluation and species inventories conducted within the polder and surrounding areas. GIS tools were employed to map changes in land use, river morphology, and wetland distribution. Additionally, project reports and stakeholder interviews were reviewed to gain insights into design rationale and management practices.	The findings indicate that the Žichlínek dry polder has significantly contributed to flood risk reduction in the Moravská Sázava River basin by effectively storing excess water during peak flood events. Ecological assessments revealed improvements in habitat diversity and the establishment of wetland ecosystems, supporting various bird and small mammal species. GIS analysis demonstrated successful restoration of river meanders and increased wetland areas, enhancing landscape connectivity. Stakeholder feedback highlighted the importance of integrated management approaches in achieving both flood mitigation and ecological restoration goals.
56	Revitalization of the Nová Oleška River Basin		2008-2014	https://www.adapterraawards.cz/cs/databaze/2020/revitalizace-povodi-u-nove-olesky	Ecological restoration, Water quality, Flood management, Wetland creation, Biodiversity, Integrated basin management, Urban water resources	The aim of this study is to evaluate the effectiveness of revitalization measures in the Nová Oleška River Basin, focusing on ecological restoration, water quality improvement, and enhanced flood management to support sustainable urban water systems.	This study employed a multidisciplinary approach involving field surveys, water quality monitoring, and stakeholder interviews to assess the revitalization of the Nová Oleška River Basin. Ecological assessments included habitat mapping and biodiversity inventories conducted before and after restoration. Water samples were collected periodically to analyze physical and chemical parameters. Geographic Information Systems (GIS) were used to map land use changes, river morphology, and wetland development. Additionally, feedback from local authorities and community members was gathered to evaluate social and management aspects of the project.	The revitalization efforts in the Nová Oleška River Basin led to notable improvements in ecological conditions, including increased habitat diversity and enhanced water quality parameters. Monitoring data showed reductions in nutrient concentrations and improved flow regimes, contributing to flood risk mitigation. Biodiversity assessments recorded the return of several native species, indicating successful habitat restoration. Stakeholder feedback reflected positive community engagement and increased awareness of sustainable river basin management practices. These results demonstrate the effectiveness of integrated restoration strategies in promoting urban ecological resilience.

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57	Flood protection measures on the Desná river		2018-2021	https://ohla-zs.cz/en/project/flood-protection-measures-on-the-desna-river/	Flood protection, Flood parks, River basin management,Risk mitigation	The aim of this study is to evaluate the effectiveness of flood protection measures implemented on the Desná River, focusing on structural interventions designed to reduce flood risk and enhance ecological sustainability in the affected municipalities.	This study employed a mixed-methods approach including hydrological data analysis, field inspections, and stakeholder interviews to assess the flood protection measures on the Desná River. Hydrological records were analyzed to evaluate changes in flood frequency and severity before and after the implementation of structural measures. Field inspections were conducted to verify the condition and functionality of flood parks, embankments, water channels, and fish passages. Additionally, interviews with local authorities and community members provided qualitative insights into the social and environmental impacts of the project.	The implemented flood protection measures on the Desná River have significantly reduced flood risks in the surrounding municipalities, as evidenced by decreased frequency and severity of flood events in recent years. Structural interventions, including flood parks, embankments, and water channels, have effectively managed peak flows, while fish passages have improved ecological connectivity. Stakeholder feedback indicates increased community confidence in flood resilience and positive environmental outcomes. Overall, these integrated measures demonstrate a successful balance between flood risk management and ecosystem preservation.
58	Povodňový park Svratka nad Židlochovicemi		2022-2023	https://www.adapterraawards.cz/cs/cena-za-krajinu/povodnovy-park-svratka-nad-zidlochovicemi	Flood park, Flood mitigation, Natural flood retention, Ecological restoration, Biodiversity, River basin management, Hydrological modeling, Recreational area	The aim of this study is to assess the effectiveness of the Povodňový park on the Svratka River near Židlochovice in reducing flood risks while enhancing ecological functions and providing recreational benefits to the local community.	This study employed hydrological modeling to simulate flood scenarios and assess the flood retention capacity of the Povodňový park. Ecological field surveys were conducted to evaluate biodiversity and habitat quality within the park area. Additionally, stakeholder interviews and community surveys were utilized to gather qualitative data on recreational use and social acceptance. Geographic Information Systems (GIS) tools were applied to analyze land use changes and spatial relationships within the river basin.	The study found that the Povodňový park significantly increases flood retention capacity during peak flow events, reducing downstream flood risks. Ecological assessments showed enhanced biodiversity with the presence of diverse plant and animal species thriving in restored habitats. Community feedback highlighted the park's value as a recreational space and its positive impact on local flood awareness. These findings demonstrate that multifunctional flood parks can effectively balance flood protection with ecological and social benefits.

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59	Amálie Pilot Farm Application of the Smart Landscape Concept	Petr Máca	2024	chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://bf.sfzp.cz/wp-content/uploads/2024/06/Maca-Pilotni-farma-Amalie.pdf	Smart Landscape, Sustainable agriculture, Climate change adaptation, Water management, Biodiversity, Agroforestry, Wetland restoration, Ecosystem services, Integrated land management	The aim of this study is to evaluate the implementation of the Smart Landscape concept at Amálie Pilot Farm, focusing on improving water management, enhancing biodiversity, and increasing agricultural resilience to climate change.	The Amálie Pilot Farm project utilized an integrated, multidisciplinary approach combining biotechnical interventions, advanced water management technologies, and community engagement to enhance agricultural sustainability. Key methods included the implementation of agroforestry systems to increase tree cover and biodiversity, restoration of drainage networks to improve soil moisture retention, and installation of solar-powered irrigation pumps linked to 5G network infrastructure for precise water use. Ecological surveys and hydrological monitoring were conducted to assess habitat quality and water dynamics. Public outreach was facilitated through educational trails and interactive information panels to foster stakeholder participation and awareness.	The implementation of the Smart Landscape concept at Amálie Pilot Farm resulted in significant improvements in water retention and biodiversity within the agricultural landscape. Hydrological monitoring indicated enhanced soil moisture levels and more regulated water flows, contributing to improved resilience against drought and flooding. Ecological assessments recorded increased species richness, particularly among pollinators and native flora. The integration of advanced irrigation technology optimized water use efficiency, reducing overall consumption. Community engagement initiatives successfully raised local awareness and support for sustainable land management practices. These outcomes demonstrate the effectiveness of combining technological innovation with ecological restoration in adapting agriculture to climate change.

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60	Ostrůvek u Kobylí Biocenter		2012-2015	https://www.miseklima.cz/praxe/biocentrum-ostruvek-u-kobyli/	Ecological restoration, Water retention, Biodiversity enhancement, Wetland creation, Climate change adaptation, Fishpond rehabilitation, Habitat restoration, Sustainable ecosystem management	The aim of the Ostrůvek u Kobylí Biocenter project is to restore a historically dried fishpond ecosystem in South Moravia by enhancing water retention, increasing biodiversity, and mitigating the impacts of climate change through sustainable ecological restoration and biotechnical interventions.	The Ostrůvek u Kobylí Biocenter project employed a multidisciplinary ecological restoration approach. The methods included reshaping and extending tributaries to improve water flow, excavation of thirteen ponds with varied depths and slopes to enhance water retention, and the installation of biotechnical structures such as reptile habitats (plazník), insect breeding areas (broukoviště), and stone walls (kamenná zídka) to provide diverse microhabitats. Regular ecological monitoring and water quality assessments were conducted to evaluate the effectiveness of these interventions. Educational and recreational facilities were integrated to engage the local community and promote awareness of sustainable ecosystem management.	The restoration efforts at Ostrůvek u Kobylí Biocenter led to increased water retention and significantly improved habitat diversity across the site. The creation of multiple ponds and reshaped tributaries enhanced local hydrological stability, reducing drought vulnerability. Ecological monitoring demonstrated an increase in species richness, particularly among amphibians, reptiles, and wetland birds. Biotechnical structures successfully provided suitable habitats for target species, contributing to the re-establishment of native flora and fauna. Additionally, the site's educational and recreational features have increased community engagement and awareness regarding sustainable ecosystem management and climate adaptation strategies.

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61	Rainwater management in SUOMI Hloubětín		2016-2023	https://www.misekline.cz/praxe/hospodareni-s-destovkou-v-suomi-hloubetin/	Rainwater management, Urban water retention, Sustainable urban drainage systems (SUDS), Green roofs, Permeable surfaces, Flood risk mitigation, Groundwater recharge, Urban biodiversity	The aim of the SUOMI Hloubětín project is to implement sustainable rainwater management strategies within an urban residential district by applying Low Impact Development principles. The project seeks to reduce surface runoff, improve water quality, enhance groundwater recharge, and promote urban biodiversity while integrating seamlessly with the natural landscape and existing water bodies.	The SUOMI Hloubětín project employed a comprehensive Low Impact Development (LID) strategy to sustainably manage rainwater within an urban residential district. Key methods included: -Implementation of permeable pavements and green roofs to enhance infiltration and reduce stormwater runoff,-Construction of retention basins and infiltration trenches to temporarily store and facilitate groundwater recharge, Integration of natural landscaping features and vegetation buffers to improve water quality by filtering pollutants and supporting urban biodiversity,-Use of monitoring systems to evaluate hydrological performance and environmental impacts,-Close collaboration among architects (ABM architekti s.r.o. for the first stage, Loxia Architectes Ingenierie s.r.o. for subsequent stages) and engineering consultants to ensure integrated design and execution,-Engagement with local communities to promote awareness and encourage sustainable water management practices.	The implementation of sustainable rainwater management strategies in the SUOMI Hloubětín project led to significant improvements in stormwater control and environmental quality within the urban district. The use of permeable surfaces, green roofs, and retention basins effectively reduced surface runoff, minimizing flood risk and decreasing the burden on municipal drainage systems. Monitoring data indicated enhanced groundwater recharge and improved water quality. Additionally, the integration of green infrastructure contributed to increased urban biodiversity and improved aesthetic and recreational value for residents. The project demonstrates the feasibility and benefits of applying Low Impact Development principles in dense urban environments.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
62	Cosmic bird meadows	Ing. Kamil Lisal	2000	https://www.miseklima.cz/praxe/kozmicke-ptaci-louky/	Wetland conservation, Bird habitat, Biodiversity, Meadow restoration, Ecosystem services, Habitat management, Invasive species control, Sustainable land use	The aim of the "Kozmické ptačí louky" project is to conserve and restore meadow and wetland habitats that serve as vital breeding and feeding grounds for native bird species. The project seeks to enhance biodiversity, improve ecosystem services, and promote sustainable land management practices through habitat rehabilitation and monitoring.	The project employed a combination of ecological restoration techniques and habitat management practices, including: Removal and control of invasive plant species to restore native vegetation, rehabilitation of wetland hydrology through reestablishment of natural water regimes, implementation of periodic mowing and grazing to maintain meadow habitat structure, monitoring of bird populations and biodiversity using standardized survey methods, collaboration with local stakeholders and conservation organizations to ensure sustainable land use.	The restoration and management efforts in the "Kozmické ptačí louky" led to a measurable increase in bird species diversity and abundance. Native vegetation cover improved, and invasive species were effectively controlled, resulting in enhanced habitat quality. Hydrological restoration contributed to the stabilization of wetland ecosystems, supporting a wider range of flora and fauna. Overall, the project demonstrated successful integration of conservation goals with sustainable land use, benefiting both biodiversity and local communities.
63	Modrozelená infrastruktura v Modřanském cukrovaru		2022-2025	https://www.praha12.cz/assets/File.ashx?id_org=80112&id_dokumenty=87734	Blue-green infrastructure, Urban sustainability, Stormwater management, Urban redevelopment, Natural water cycle, Ecological design, Biodiversity, Climate change adaptation, Urban climate, Sustainable living environments	The aim of the Modřanský cukrovar blue-green infrastructure project is to develop a sustainable urban neighborhood by integrating natural water management systems with green spaces to enhance ecological resilience, reduce urban flooding and heat stress, and improve overall environmental quality and livability in a post-industrial area of Prague.	The project employed an interdisciplinary design approach combining landscape architecture, urban planning, and environmental engineering. Site analysis included hydrological assessments, biodiversity surveys, and microclimate studies. Blue-green infrastructure elements such as permeable pavements, rain gardens, retention ponds, green roofs, and urban vegetation corridors were integrated into the master plan. Stakeholder engagement involved community consultations to align ecological goals with social needs. Implementation phases were monitored for effectiveness in stormwater management and ecological enhancement using environmental indicators and remote sensing data.	The implementation of blue-green infrastructure in the Modřanský cukrovar area has led to significant improvements in urban environmental quality. Stormwater management capacity increased, reducing flood risk during heavy rainfall events. Enhanced green spaces and biodiversity corridors contributed to improved habitat connectivity and local microclimate regulation, resulting in lower urban heat island effects. Community feedback indicated higher satisfaction with the quality of life and recreational opportunities. The project demonstrated that integrating natural water management and green infrastructure is an effective strategy for sustainable urban redevelopment in post-industrial contexts.

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64	Total Disaster Risk Management - Good Practices 2006	Asian Disaster Reduction Center	2006	https://www.adrc.asia/publications/TDRM2005/TDRM_Good_Practices/GP2006_e.html	Disaster risk management, Emergency preparation, Multi-stakeholder partnerships, Education, Information management	To facilitate an enhanced understanding of the TDRM approach and its applications and promote comprehensive disaster risk reduction worldwide.	Compilation and presentation of various case studies and practices contributed by ADRC member countries, NGOs, international organizations; includes technology use, education, collaboration	Key practices include preparation of emergency preplans and resource allocation before typhoon events; standing orders to disseminate cyclone information; collaborative multi-sectoral programs mitigating flooding; educational programs engaging students; the use of technological tools such as SUMA system for supply management and computerized systems for damage estimation
65	Total Disaster Risk Management - Good Practices 2007	Asian Disaster Reduction Center	2007	https://www.adrc.asia/publications/TDRM2005/TDRM_Good_Practices/GP2007_e.html	Disaster Management, Total Disaster Risk Management (TDRM), Regional Solidarity, Disaster Risk Reduction natural disasters,	To raise awareness of disaster risk reduction, promote the TDRM approach, and share good practices among stakeholders for a safer world.	Description of recent disaster events and ADRC's approach including collaboration with UN-OCHA, IRP, and stakeholders, and publication of good practices handbook.	
66	Total Disaster Risk Management - Good Practices 2008	Asian Disaster Reduction Center	2008	https://www.adrc.asia/publications/TDRM2005/TDRM_Good_Practices/GP2008_e.html	earthquake, tropical cyclone, disaster risk reduction, knowledge sharing	To support the development of scientific capacity against disasters and promote information sharing and effective education in disaster risk reduction.	mentions collaborative efforts by ADRC and partners to form a holistic approach	mentions publications and knowledge sharing efforts among established stakeholders

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67	Total Disaster Risk Management - Good Practices	Asian Disaster Reduction Center	2009	https://www.adrc.asia/publications/TDRM2005/TDRM_Good_Practices/GP2009_e.html	Disaster risk reduction, disaster mitigation, awareness-raising, cooperation, Hyogo Framework for Action, sustainable development, community capacity-building	To promote disaster risk reduction activities and the implementation of the Hyogo Framework for Action by sharing good practices from different countries to build resilience in communities and nations.		
68	İKLİM DEĞİŞİKLİĞİ, SÜRDÜRÜLEBİLİR KENTLER VE KENTSEL PLANLAMA ETKİLEŞİMİ	Elif Çolakoğlu	2019	https://bulutsehir.csb.gov.tr/share/preview/wUWCwrDWjP6QtP7ZWQVfPedSZgUqSgrZtkbwAcnmbRRjcDFwy836231715759649428 31	Climate Change, Sustainable Cities, Urban Planning, Disaster Risk Reduction, Urban Resilience, Sustainable Development Goals (SDGs), New Urban Agenda, Paris Agreement, Climate Action, Urban Indicators, Adaptation, Mitigation, Urban Governance.	To analyze the interrelation between climate change, sustainable cities, and urban planning; to provide insights on policies, indicators, and best practices that help cities cope with climate change impacts and promote sustainability; and to discuss international frameworks and local responses to environmental and urban challenges.	Literature review and synthesis of international agreements, policies, case studies, and urban sustainability indicators. The document draws from diverse sources including United Nations reports, city initiatives (e.g., Copenhagen, Stockholm, San Francisco, New York City), and climate action platforms. It includes references to empirical cases and ongoing practices as examples.	The document highlights the critical role of integrated urban planning and governance in addressing climate change impacts in cities. References to various international commitments, such as the Paris Agreement and the New Urban Agenda, along with city-led examples demonstrating successful sustainability and resilience initiatives, emphasize pathways for action. It also underlines the importance of monitoring through urban indicators.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
69	Development and practices of nature-based solutions in China	Ming Luo, Jiayu Cai, Zhiwei Zeng, Yicheng Zheng, Tao Lin	2024	https://doi.org/10.1016/j.nbsj.2023.100109	Nature-based solutions Chinese practice Territorial space Ecological restoration methods	To analyze development and localization of NbS in China, explore integration with ecological civilization construction, and assess application of NbS in ecological restoration guidelines.	Literature review; policy and standards analysis; case synthesis; mapping NbS criteria to Chinese guidelines.	China established a unique top-down policy system guiding NbS implementation, demonstrated by successful NbS initiatives such as national parks and the Three North Shelterbelt Forest project. The "Guidelines for Ecological Protection and Restoration Projects in Mountain, Water, Forest, Field, Lake, and Grass" reflect mainstreaming of NbS concepts.
70	G20 Brasil - A Compendium of Good Practices on Disaster Resilient Infrastructure (DRI)	G20 Brazilian Presidency of Disaster Risk Reduction Working Group	2024	https://cdri.world/upload/pages/G20_Brazil_Compendium.pdf	Resilience, Sustainable Development Goals, Sendai Framework	To provide timely insights and practical examples to aid stakeholders adopt resilient infrastructure strategies tailored to local contexts and vulnerabilities	Compilation of case studies and good practices through collaboration among G20, invited countries, organizations, and CDRI members; reviews by technical experts; process of knowledge exchange and peer review	Provides examples and lessons to support actionable steps for resilient infrastructure; promotes collaborative approaches across sectors and regions
71	Kentlerde İklim Değişikliği ile Mücadele için Yeşil Altyapı Çözümleri	Çiğdem Coşkun Hepcan	2019	https://bulutsehir.csb.gov.tr/share/preview/vSJRyAHQQhVAw6EKctNhGX6qDeATQarRfrnpjnXMvCFmTMNQrM3623171575964971460	Climate Change,Green Infrastructure; Urban Climate Adaptation; Ecosystem Services; Urban Planning; Stormwater Management	To provide green infrastructure approaches and practical guidelines for enhancing urban resilience against climate change impacts through improved ecosystem services and sustainable management practices.	Review and compilation of existing guidelines, examples, and ecosystem service categorizations from various cities and literature.,Identifies that green infrastructure reduces urban heat islands, improves soil quality through biological activity, enhances stormwater management by using permeable and vegetated areas, and requires integrated, phased management involving multiple stakeholders.	Demonstrates the role of green infrastructure in increasing urban resilience and sustainability against climate change, highlighting internationally recognized examples and management frameworks.,Includes references to specific city guidelines (e.g., New York, Vancouver), international projects, and details about types of green infrastructure components like rain gardens, permeable pavements, street trees, and green roofs.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
72	An Ecology for Cities: A Transformational Nexus of Design and Ecology to Advance Climate Change Resilience and Urban Sustainability	Daniel L. Childers, Mary L. Cadenasso, J. Morgan Grove, Brian W. McGrath, Steward T. A. Pickett	2015	https://doi.org/10.3390/su7043774	urban design, urban ecology, sustainability, climate resilience, climate adaptation, design-ecology nexus, social-ecological systems, urban heat island, drought, flooding, urban sustainability	1) Summarize interactions among design, infrastructure, and urban development for climate resilience and sustainability; 2) advocate for an ecology for cities moving from ecology of cities to ecology for cities; 3) present a transformative design-ecology nexus model; 4) demonstrate model efficacy with case studies.	Transdisciplinary, inclusive, iterative process combining social and natural sciences; urban design studios; micrometeorological monitoring (e.g., temperature, humidity, soil moisture sensors); case study analyses; knowledge-to-action framework integrating stakeholders at multiple urban scales.	The design-ecology nexus model enables adaptive, innovative urban solutions, promotes resilience to climate uncertainties, and supports sustainable urban development across diverse city types; case studies illustrate practical challenges and successes of implementation, such as demonstration landscape projects.
73	Integrating ecological perspectives into engineering practices – Perspectives and lessons from Japan	Naoya Furuta, Yukihiro Shimatani	2018	https://doi.org/10.1016/j.ijdrr.2017.12.003	Ecosystem-based disaster risk reduction Ecological engineering Great East Japan Earthquake Hurricane Sandy Coastal hazards Japan	To address how ecosystem-based approaches could be mainstreamed in recovery and reconstruction from large scale, rare and infrequent coastal hazards by reviewing experiences from GEJE and Hurricane Sandy with emphasis on the role of technical guidance and guidelines.	Policy and literature review, field visits, stakeholder interviews, review of Hurricane Sandy reconstruction using existing materials and participation in community workshop.	Revealed how ecosystem approaches are integrated in river and coast works in Japan, challenges in implementation, questioned the effectiveness of technical guidelines alone, and emphasized participatory planning and cross-sector collaboration from Hurricane Sandy experience. Highlighted difficulties in mainstreaming Eco-DRR after GEJE and importance of a different approach for large scale disasters.
74	Nature-based Solutions to Climate Change Adaptation in Urban Areas	Nadja Kabisch • Horst Korn Jutta Stadler • Aletta Bonn (Editors)	2017	https://link.springer.com/book/10.1007/978-3-319-56091-5	nature-based solutions, climate adaptation, urban sustainability, ecosystem services, governance, financing	To synthesize main outcomes related to NBS for climate change adaptation in urban areas, propose recommendations for implementation and policy, and identify remaining challenges for science and society.	Critical review of literature and case studies, synthesis of lessons, policy analysis, and collection of European conference outcomes.	NBS can mitigate and adapt urban areas to climate change by enhancing ecosystems' capacity; multi-stakeholder collaboration is crucial for implementation; financing and governance challenges exist; social benefits are significant alongside environmental outcomes. NBS provide mitigation (CO2 reduction), adaptation (cooling, drainage), social, and health benefits.

No	Name of the Article	Author(s)	Year	Source / doi number	Tags & Keywords	Aim	Method	Results
75	Climate-resilient urban planning and architecture with GREENPASS illustrated by the case study 'FLAIR in the City' in Vienna	Kraus F, Scharf B	2019	https://iopscience.iop.org/article/10.1088/1755-1315/323/1/012087/pdf	Urban planning, Climate resilience, GREENPASS, Green and Blue Infrastructure, Thermal Comfort, Urban heat islands	To demonstrate the effectiveness of the GREENPASS® approach in climate-resilient urban planning and architecture using a case study.	Use of GREENPASS® certification methodology including ENVI-met microclimate simulation, key performance indicators (KPIs), iterative planning and optimization with architects and developers to improve thermal comfort and green infrastructure integration.	Optimization of 'FLAIR in the City' project improved total degree of fulfillment from 67% to 79%, achieving the worldwide first GREENPASS® Gold certificate. Integration of green and blue infrastructure enhanced thermal comfort, cost-efficiency, climate resilience, biodiversity and quality of life.

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ANNEX 4. WP2 Literature Review and Analysis Progress Tracking Table

Actions	Notes
Partner assignments completed	All WP2 roles confirmed via ClickUp & email; personnel assignment forms finalized (March 2025)
Basic coordination meeting held (WP Task T2.1)	The procedure and schedule were discussed (24 April 2025)
Literature submission complete (WP Task T2.1)	197 publications, 75 best practices, 250 case studies submitted and tagged by 20 June 2025
Harmonization workshop held (WP Task T2.2)	Held June–July 2025 at Ankara University; codes introduced (CS001, BP001); projection-supported sessions allowed real-time collaborative tagging; standard Excel updated
Categorization and finalization (WP Task T2.2)	Database cleaned and aligned with regard to proposed curriculum topics (July 2025)
Draft report submission	Final draft delivered by AU on July,15 2025. Feedback requested from WP2 partners till 24 July 2025
Submission of D2.1 to coordinator (WP Milestone MS2)	No additional feedback received as of July, 24 and the report was submitted for coordinator approval on 27 July 2025.

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Filling the Gap: Development of Ecological Planning and Design Learning Network and Adaptive Smart Training Module for Disaster Resilient and Sustainable Cities

INTERNAL EVALUATION REPORT FOR D1.5 - LITERATURE REVIEW REPORT

1. INTRODUCTION AND THE BASIS AND CONTENT OF THE EPD-NET PROJECT

EPD-Net Project (*Filling the Gap: Development of an Ecological Planning and Design Learning Network and Adaptive Smart Education Module for Disaster Resilient and Sustainable Cities, GA No:* 101183961) is an innovative initiative that aims to integrate ecological planning and nature-based solutions for the design of disaster resilient and sustainable cities. The project, carried out with the support of the European Union Erasmus+ program, adopts a multidisciplinary structure based on artificial intelligence-supported smart training modules and international collaborations. The basic scientific approach of the project is supported by advanced techniques such as Geographic Information Systems (GIS), Remote Sensing (RS) and scenario simulation, and is continuously updated through literature reviews and field applications. The EPD-NET Monitoring and Evaluation Report is intended to strengthen the alignment of the project with the Erasmus+ program priorities and the Erasmus+ Digital Education Action Plan (2021-2027). This report presents the results of the internal evaluation of the project's quality assurance, risk management, project evaluation strategy and project monitoring dimension, together with literature-supported data and evidence.

1.2. Epd-Net Project Foundation and Content

EPD-Net Project aims to create multidisciplinary, international and smart learning platforms in the field of ecological planning and design to support the development of disaster resilient and sustainable cities. Funded by the Erasmus+ program of the European Union, the project develops comprehensive digital training modules aiming to increase resilience to disasters through ecological planning techniques. Among the main outputs of the project are adaptive training modules supported by artificial intelligence to increase effectiveness in disaster management. The project, coordinated by Eskişehir Technical University, is supported by a comprehensive quality assurance system that encourages stakeholder engagement and is based on the principles of continuous improvement. The quality assurance approach developed within the project guarantees the effectiveness of the project processes and the quality of its outputs, in line with the European Standards and Guidelines (ESG2015). In addition, risk management and monitoring plans are systematically implemented throughout the project and preventive and corrective actions are defined for emerging risks. The use of modern tools such as ClickUp for digital project management and monitoring ensures timely and effective project execution.

Literature review and case studies provide the basic scientific evidence and methodological framework for the development of the project's training modules. Furthermore, Geographical Information Systems (GIS), Remote Sensing (RS) and artificial intelligence assisted analysis are used as innovative tools in the design of preventive and adaptive solutions to urban disasters. The long-term goal of the project is to contribute to the design of disaster resilient cities in Europe and beyond by sustainably disseminating the methods and modules developed.

2. QUALITY ASSURANCE PLAN INTRODUCTION AND PURPOSE

2.1. A Holistic Overview of Quality Assurance Plan Activities

The Quality Assurance Plan (QAP) D1.1 of the EPD-Net Project outlines a comprehensive, structured and stakeholder-driven framework designed to ensure that all project activities and outputs meet the highest standards of quality, relevance and impact throughout the 36-month life cycle of the project (D1.1:4). The quality approach adopted throughout the process is not limited to the control of outputs, but is also learning-based, flexible and inclusive, covering the whole process. The plan (D1.1:10), prepared in line with Erasmus+ quality standards and the European Higher Education Area's ESG 2015 guidelines, aims to ensure that the tasks defined in each work package are carried out in a timely, transparent and high quality manner and the processes are currently being carried out as planned.

When the EPD-NET D2.1 Consolidated Literature / Case Study / Best Practices Report is evaluated holistically in line with the quality principles and evaluation criteria defined in the D1.1 Quality Assurance Plan, it is seen that it largely meets the key quality indicators such as *"content integrity*", *"thematic inclusiveness*" and *"interdisciplinary collaboration*". The principle of scientific validity and timeliness of the

content, which is among the "Deliverable Quality Criteria" stated in the Quality Assurance Plan (D1.1:10), is directly supported by 201 academic publications, 170 case studies and 85 best practice examples in the D2.1 report. The case studies compiled for the EPD_NET literature review represent a diverse and practice-oriented collection of projects aligned with the project's main themes of ecological planning and design, disaster resilience and NbS. The fact that the examples provided cover European cities such as Riga, Rome, Milan and Prague, as well as various geographical contexts, and that the common focus of many of the examples is the implementation of green and blue infrastructure as both ecological and climate adaptive interventions, the literature review supports the EPD-Net project to integrate the three categories of skills (green skills, digital skills and resilience skills) identified in the D1.1 Quality Assurance Plan WP 2: Research Analysis (D.1.1:37) into its training content and work. Furthermore, the evaluation of selected literatures through standardized templates and management of metadata tagging through the Mendeley platform demonstrates that traceability is ensured in accordance with quality control processes (D2.1:1-2). Strengthening the integrative role of the quality assurance system by checking the quality assurance approach specified in the D.1.1 Quality Assurance Plan in terms of academic quality, accessibility, inclusiveness and compliance with digital competence standards of the contents of the EPD-Net Project and evaluating the user experience (UX), technical competence and sustainability of the smart education module to be developed within the framework of quality (D.1.1:8)..1:8) is in line with D2.1 Consolidated Literature / Case Study / Best Practices Report, which states that future research should focus on identifying and designing inclusive, adaptive and operational governance models that can reconcile different stakeholder interests (D.2.1:55). The principle of "Scientific Validity and Relevance" defined in D1.1 Quality Assurance Plan (D1.1:10) is directly reflected in the studies included in the D2.1 Literature Review. The "knowledge-to-action" framework developed by Childers et al. (2015) serves the quality objectives of the training module at both content and implementation level by demonstrating how ecological planning can be integrated with disaster risk reduction (D 2.1:8). Similarly, Kabisch et al. (2016) emphasize the contribution of integrating nature-based solutions (NbS) into planning processes to disaster resilience (D 2.1:18), which is in line with the principles of inclusiveness and sustainability outlined in the D1.1 Quality Assurance Plan. These publications both support the scientific basis of the educational content and reinforce the academic and practical validity of the quality assurance system. Overall, the D2.1 Consolidated Literature / Case Study / Best Practices Report provides a structured and evidence-based basis that is highly aligned with the D.1.1 Quality Assurance Plan and provides a quality content that can methodologically guide the development of the training module.

2.2. Quality Assurance Plan Data

The Quality Assurance Plan of the EPD-Net Project provides a holistic and integrated quality management framework horizontally integrated across all work packages (WP1-WP6) developed under the Project (D1.1:24). Effective coordination, continuous review and feedback loops have been established between project partners and internal and external quality checks are regularly carried out. The Quality Assurance Plan, designed with a dynamic quality management approach, is systematically updated to ensure that quality standards are up to date and aligned with project objectives. The main data sources in the quality assurance dimension of the project are user feedback, performance evaluation results, internal and external audit reports of project teams, and information obtained from project implementation and monitoring tools. In addition, scientific and applied methods supported by best practices and case studies identified in the literature continue to be utilized in the processes (D2.1, 2025).

2.3. Quality Assurance Plan Monitoring and Evaluation Mechanisms

Monitoring and evaluation mechanisms within the scope of quality assurance include digital platforms and tools (ClickUp, Traffic Light Monitoring System) that enable monitoring and evaluation of project activities, quality control and standardization documents for processes and deliverables, continuous evaluation reports based on performance indicators (PIs), and feedback mechanisms that measure stakeholder engagement and satisfaction (D1.1:12-13).

2.4. Quality Assurance Plan Evaluation Notes

Overall, the D1.1 Quality Assurance Plan provides a viable and sustainable quality management system integrated with the strategic objectives, implementation methods and evaluation framework of the EPD-NET project. Quality assurance is structured through a dynamic and multilevel control system integrated into the whole project life cycle as well as results evaluation. The quality control process is systematically planned and supported by internal control mechanisms (project teams, WP leaders, PM Team) and the contribution of independent evaluators (D1.1:13). As a result of the evaluations carried out since the beginning of the project, it has been determined that the current studies have strengthened the reliability, effectiveness and reusability of the project outputs.

2.5. Evidence

- Preparation of quality assurance plan and sharing with stakeholders - 30.06.2025
- Conducting surveys, interviews and focus groups with stakeholders to identify the skills and knowledge needed - 01.06.2025 - Ongoing.
- Development of a report summarizing the findings and conclusions of the research and analysis - 01.07.2025 - Ongoing.
- Implementation of the project according to the project management plan- 1.03.2025- Ongoing.

3. RISK MANAGEMENT PLAN

3.1. Holistic Overview of Risk Management Plan Studies

The EPD-Net Risk Management Plan (RMP) embodies a comprehensive strategy for identifying, assessing and managing risks that may affect project implementation by adopting a preventive and responsive approach to risk management (D1.2:4). Based on the principles of proactivity, integration, transparency, scalability, accountability and reassessability (D1.2:4-5), the risk management system aims to be a dynamic governance tool that ensures that risks are taken into account rather than a static compliance document. Risk monitoring, mitigation and response strategies for potential emergencies have been identified in detail and specific risk mitigation strategies are developed and implemented throughout the Project. In addition, risk registers are updated when a new risk is identified, when there is a significant change in the impact or likelihood of an existing risk, or when a contingency plan is activated (D1.2:12). In this way, project management minimizes the impact of risks and guarantees the achievement of the intended success.

The EPD-NET D2.1 Consolidated Literature / Case Study / Best Practices Report largely overlaps with the "systematic risk identification", "analysis" and "monitoring" approach described in D1.2 Risk Management Plan (RMP). EPD-Net adopts a preventive and responsive approach to risk management, integrating risk analysis into the core of management and decision-making processes and emphasizing early identification of foreseeable risks, systematic assessment of risk likelihood and impact, internal reporting cycles and continuous monitoring through SC oversight (D.1.2:7) coincides with the fact that the publications assessed in the D2.1

3.2. Risk Management Plan Data

The main data used in the risk management process consists of information collected during regular risk assessment meetings of the project partners and continuous feedback from consortium members. In addition, data from tools such as the Risk Tracker, Risk Heat Map and Emergency Response Framework developed under the project also play an important role in the processes (D1.2:19-22). In addition, best practice examples identified through literature review and case studies are also instrumental in shaping risk management approaches.

3.3. Risk Management Plan Monitoring and Evaluation Mechanisms

The main outputs that stand out in the risk management dimension are the detailed Risk Management Plan (RMP) that includes the strategic and operational risks of the project, the Risk Matrix and Risk Heat Map where risks are classified and visualized according to their impact and probability levels, the

detailed action plans that include concrete mitigation and response strategies for the identified risks, and the continuous evaluation of the risk profile of the project through the continuously updated Risk Tracker and monitoring reports.

3.4. Risk Management Plan Evaluation Notes

The EPD-Net Project's systematic and structured risk management approach, as defined at the beginning of the Risk Management Plan (D1.2:3), is highly effective in protecting the project's timeline, quality and results against known and unknown threats; defining clear processes for risk identification, escalation and response at all consortium levels; meeting Erasmus+ requirements on governance, transparency and responsiveness; and enhancing the project's institutional learning capacity by institutionalizing responsive decision-making. Clearly defining and continuously monitoring the project's risk management processes allows for early resolution of emerging problems and improves the overall performance of the project. Supporting risk management activities with best practices in the literature and scientific methods is also a factor that strengthens the success and sustainability of the project.

3.5. Evidence

- D1.2 RMP submission of the first register of 12 known risks - May 2025
- E1.2 First formal SC review of risk register with Team Meeting (Czech Republic) - July 2025
- Monitoring according to Risk Severity - March 2025 - Ongoing.

4. PROJECT MONITORING PLAN

4.1. Holistic Overview of the Project Monitoring Plan

The EPD-Net Project Monitoring Plan (PMP) outlines a robust multi-level monitoring architecture (D1.3:4), defining the framework, tools, roles and reporting flows to monitor the implementation of the project over its 36-month duration and aligning with the Quality Assurance Plan (QAP - D1.1) and Risk Management Plan (RMP - D1.2), Grant Agreement (GA No: 101183961). The project monitoring plan (D1.3:8), structured around six key objectives: timeliness, quality alignment, financial alignment, task execution, risk synchronization and reporting readiness, ensures that the project is on time, on target and in line with quality standards. Regular review and improvement of the project monitoring plan allows for adaptive and dynamic project management. With monitoring tools, deviations and performance degradation are identified at an early stage and necessary interventions are made in a timely manner (D1.3:9). Thus, project monitoring activities provide a proactive approach that ensures continuity and consistency.

D2.1 The thematic diversity and conceptual depth of the Consolidated Literature / Case Study / Best Practices Report in the field of ecological planning, disaster resilience and nature-based solutions significantly overlaps with the multi-layered and data-driven monitoring strategy defined in the project monitoring plan. Elements that strengthen monitoring processes, such as the integration of digital technologies, the use of spatial analyses and a scenario-based approach, both increase technical monitoring capacity and contribute to a learning-based, adaptive management system. This holistic approach enables the project to have a process-oriented monitoring structure rather than an output-oriented one, and is supported by a structure based on participation, transparency and real-time feedback.

However, it is envisaged that more direct linking of the technological and governance examples presented in the literature report with the performance indicators and key monitoring/evaluation questions defined in the project monitoring and evaluation plans will facilitate the transfer of this knowledge into practice. While the tools suggested in the literature provide a strong theoretical framework, systematically matching them to project indicators will enable more effective monitoring of outputs and ensure that monitoring and evaluation processes support each other. D2.1 The Consolidated Literature / Case Study / Best Practices Report includes examples of how approaches such as AI-based decision support systems, digital twins and scenario modeling can be used in monitoring processes, but does not analyze in detail how these technologies overlap with project monitoring indicators (PIs). As it is stated in D1.3 Project Management Report that the ClickUp platform should be structured to work in line with these indicators

and in D1.4 Project Management Report that each evaluation question should be answered based on specific data sources, a more holistic integration of literature synthesis into the project monitoring and evaluation system is recommended as it will support a stronger linking of WP2 outputs with the WP1 framework.

By evaluating the studies holistically, additional methodological configurations can be made to contribute to the monitoring and evaluation logic defined in the D2.1 reports and Project Monitoring and Evaluation Plans (D1.3-D1.4). This could include mapping geospatial tools, scenario modeling methods and systems-oriented approaches (e.g. geodesign, ULL) directly to performance measures (PIs). It can also be linked to recommendations on output-based risk synchronization tracked through ClickUp, drawing on case studies on nature-based solutions (NbS), which are strongly presented in the report (D1.3, p.16). It is envisaged that such improvements will support the D2.1 Consolidated Literature / Case Study / Best Practices Report to serve as a guide to guide the development of the M&E system as well as providing content.

4.2. Project Monitoring Plan Data

The main data collected for project monitoring activities consist of qualitative sources such as task level completion logs, meeting minutes (WP and SC levels), internal evaluation tools (checklists, dashboards, etc.), participant feedback and EPDAssist data analysis (for module participation) (D1.3:9). The data obtained from these tools are systematically analyzed and regularly evaluated and reported by the project management team.

4.3. Project Monitoring Plan Monitoring and Evaluation Mechanisms

The monitoring and evaluation mechanisms of the project monitoring plan are tools such as the Tracking Table (WP level) that tracks the status of each task, percentage of completion and deviations, the traffic light system with red-orange-yellow-green indicators per output, Progress Dashboards that are updated quarterly and visualize project progress and partner activities (D1.3:9). The EPD-Net Project uses a combination of indicators supported by digital tools, checklists and template-based documentation to provide accurate, standardized and actionable reporting for monitoring processes, allowing project actors to move seamlessly from detailed task updates to consolidated project-level dashboards (D1.3:15).

4.4. Project Monitoring Plan Evaluation Notes

The systematic monitoring approach of the EPD-Net Project has significantly supported the effective and timely achievement of the project's objectives. The use of digital platforms and tools (in particular ClickUp) that enable real-time monitoring during the monitoring process has made it possible to identify and respond to deviations and risks that may occur during the execution of the project at an early stage. The detailed definition of responsibilities at all governance levels also supports the smooth interaction of task leads, WP leads, Coordinator, PM team and SC through defined reporting and escalation cycles.

4.5 Evidence

- Task Level progress Tracking - ClickUp Card - March 2025 - In Progress.
- Planned Task Tracking via Tracking Matrix - March 2025 - In Progress.
- Joint Contribution Tracking Matrix Follow-up - March 2025 - Ongoing.

5. PROJECT EVALUATION STRATEGY PLAN

5.1. Holistic Overview of the Project Evaluation Strategy Plan

The Project Evaluation Strategy Plan (ESP) of the EPD-Net Project defines a structured, data-driven and participatory framework for assessing the effectiveness, relevance, quality, engagement and long-term impact of the project and is fully aligned with the Grant Agreement (GA), Quality Assurance Plan (QAP) (D1.1), Risk Management Plan (RMP) (D1.2) and Monitoring Plan (D1.3) (D1.4:4). The EPD-Net Project Evaluation Strategy is based on five key objectives: effectiveness, relevance, quality and consistency, engagement and interaction, and sustainability and impact (D1.4:9). Best practices and case studies from

the literature play an important role in structuring the evaluation strategy and the project uses digitally integrated evaluation tools (through the ClickUp platform).

The D2.1 Consolidated Literature / Case Study / Best Practices Report provides a strong theoretical basis and multidimensional scope of application for the evaluation of project outputs and is highly aligned with the evaluation framework defined in D1.4 Project Management Plan. Numerous examples from the literature, particularly in relation to the key evaluation dimensions of effectiveness, quality, participation and sustainability, support the applicability, contextual validity and multi-stakeholder contribution mechanisms of the training module. The conceptual models and good practice examples in the literature demonstrate that the content developed under the project is not only theoretical but also testable and evaluable in a practical context. In this context, the literature review supports the evidence-based, inclusive and learning-oriented nature of the EPD-Net evaluation strategy.

In addition to these positive contributions, more explicitly mapping the rich scientific content presented in the D2.1 Consolidated Literature / Case Study / Best Practices Report to the key evaluation questions (KEQ) and performance indicators (PI) defined in the D1.4 Project Management Report will strengthen the integration of the literature report into the evaluation system. Digital twins, scenario-based analyses, studies on the impact of nature-based solutions and AI-enabled tools (D2.1:36, 44, 58) can provide methodological underpinnings for the analysis of causality between impact, sustainability and outcomes in D1.4 (D1.4:9-13). Through such pairings, the D2.1 report is intended to go beyond being a synthesis of literature and become a strategic source of information that guides project evaluation processes and supports decision-making mechanisms. In this way, the value of project outputs in terms of relevance, validity and sustainability at local and international level can be comprehensively assessed on a more solid analytical basis.

D2.1 Consolidated Literature / Case Study / Best Practices Report Although the report offers a comprehensive and thematically strong content, the integrity and representativeness of the document will be enhanced by working within the principles of inter-team communication, regular participation in meetings and equal contribution during the preparation of the report. Especially in multi-partner projects, the coherent progress of the literature synthesis is directly related to the use of common terminology, timely sharing of feedback and clear distribution of writing responsibilities. In this context, attention to the process quality as well as the content quality of the literature review will be in line with the principles of horizontal communication and team cohesion envisaged in the monitoring and evaluation plans (D1.3, p.9; D1.4, p.7). Elements such as active participation in meetings, joint decision-making and follow-up of feedback will both support the holistic structure of the report and set an example for other outputs as good practice within the project.

5.2. Project Evaluation Strategy Plan Data

Data for the Project Evaluation Strategy Plan is generated through performance indicators from the project implementation phases, feedback collected from stakeholders and regular evaluation meetings of the project consortium. Important data is also obtained from digital tools such as the evaluation question tracker (EQT) and outcome assessment tables (OAT) tracked through the ClickUp platform (D1.4:4). To ensure flexibility in implementation, the evaluation strategy also identified key enablers and potential barriers and integrated processes to mitigate disruptions and support continuous project adaptation through preventive mechanisms, including early warning indicators, adaptive feedback loops and contingency planning at WP level (D1.4:5).

5.3. Project Evaluation Strategy Plan Monitoring and Evaluation Mechanisms

The key outputs of the project evaluation strategy are detailed evaluation reports on the effectiveness, relevance, quality, participation and sustainability of project activities (D1.4:19), "Outcome Assessment Tables" (OAT) that present evaluation results in a clear and transparent manner (D1.4-24), systematic feedback mechanisms to measure stakeholders' level of engagement and satisfaction with the project, and an "Evaluation Checkpoint (EC) Tracking System" and "Corrective Action Tracking System" (D1.4:9) supported by digital tools and monitored through a revised alert and action log system linked to a

regularly updated master ClickUp calendar. Evaluation outputs are directly cross-referenced in the updated Sustainability Action Tracking, thus securing the sustainability feedback loop.

5.4. Project Evaluation Strategy Plan Evaluation Notes

The EPD-Net Project Evaluation Strategy Plan is one of the strategic partners in the governance architecture of the project, monitoring and critically and constructively evaluating performance, quality, stakeholder engagement and impact (D1.4:20). The effective and participatory evaluation approach adopted has the effect of enhancing the quality of project results by increasing stakeholders' commitment to the project.

5.5. Evidence

- Quarterly Monitoring Reports (QMRs) based on Steering Committee Meetings - March 2025 - Ongoing.
- Work Package (WP) Adjustments and Risk Responses - March 2025 - Ongoing.
- Sustainability and Dissemination Strategies Tracking - March 2025 - Ongoing.
- EC Technical Reporting and Audits - March 2025 - Ongoing.

6. Conclusion and General Evaluation

The EPD-Net project's quality assurance plan, risk management plan, project monitoring plan, project evaluation plan and related activities constitute an integrated framework that not only generates knowledge but also provides a holistic transformation model where processes are traceable, measurable and sustainable. As detailed in this M&E report, each component of the project continues to be designed and implemented in full compliance with Erasmus+ program expectations and the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG 2015). Strengthening monitoring and evaluation processes with robust tools such as digital platforms like ClickUp, the Traffic Light System and various reporting templates supports data-driven decision-making, enabling early detection of deviations and ensuring transparency and accountability throughout the process.

Ensuring interdisciplinary and cross-country collaboration, creating a multi-layered knowledge base by reviewing a total of 201 publications, 85 best practice documents and 170 case studies as part of the literature review conducted for the project, providing a solid foundation for the training module at both theoretical and practical levels, emphasizing stakeholder collaboration, leadership and local governance, and including an approach based on not only physical but also social resilience, The strengths of the EPD-Net project include supporting the enhancement of environmental resilience by providing detailed examples of NbS applications such as green-blue infrastructure, ecological corridors, refuge green spaces and urban heat island mitigation, and making the project innovative and future-proof by integrating technological tools such as artificial intelligence (AI), geographic information systems (GIS), digital twins and remote sensing (RS) into ecological planning. While digital monitoring and decision support tools are frequently emphasized in project plans, the long-term sustainability of monitoring systems should be closely monitored and supported by local capacity, technical infrastructure and institutional cooperation, as there are significant gaps in data reliability, timeliness and accessibility, especially in low- and middle-income countries. To increase the effectiveness and efficiency of the training modules, it is recommended to increase the number of scenario studies and simulations to support participants to develop themselves according to different socio-economic and administrative contexts, and to enrich the training content in a way that balances social justice, accessibility and cultural differences.

The EPD-Net project is in strong alignment with both monitoring and evaluation plans by focusing on key elements such as interdisciplinary cooperation, integration of technological innovations and social-environmental resilience. In particular, the integration of tools such as artificial intelligence, geographical information systems, digital simulations and remote sensing into pre-disaster preparedness processes shows that the project is directly related to objectives such as early identification of risks, planning through scenarios and real-time monitoring. This approach not only ensures timely and effective monitoring of project activities but also contributes to the assessment of the long-term impacts of its outputs. Moreover,

the project's development of training modules structured in a way that is sensitive to different socio-economic contexts supports the need for an accessible and inclusive evaluation system that considers cultural diversity. This holistic structure demonstrates that EPD-Net is an exemplary practice that emphasizes not only the results but also the quality of the processes.

Regular participation of the teams in meetings and active involvement in open communication processes is of great importance for the integrity and representativeness of the reports. Especially in multi-stakeholder projects, the use of common terminology, timely sharing of feedback and balanced distribution of responsibilities are key elements of an effective writing process. Therefore, communication between teams should be considered not only as a technical requirement but also as a structural component that directly contributes to the quality assurance system. Maintaining this approach in future reporting will be in full harmony with the monitoring and evaluation approach of the project.

The EPD-Net Project continues to manage its processes successfully, supported by a systematic, measurable, participatory and transparent quality assurance framework that aims not only *to "achieve success*" but also to "*secure and multiply success"* in the field of ecological planning and design for disaster resilient and sustainable cities. As a unique and pioneering initiative at the European level with its interdisciplinary and technology-supported approach to ecological planning and disaster resilience, it creates a rich synergy in knowledge production by bringing together different geographical and institutional experiences with its multi-partner structure. Through extensive literature reviews, case studies and good practice examples, the training module has a solid academic and practical grounding. The integration of innovative tools such as artificial intelligence, GIS and nature-based solutions strengthens the project's vision of technological and environmental sustainability, and its approach that focuses on social participation and governance capacity contributes not only to reducing disaster risk but also to building resilient living spaces. The fact that the developed contents can be disseminated and scalable for stakeholders in Europe and beyond reinforces the lasting impact of the project and in this context, the EPD-Net Project continues to make significant contributions at both scientific and societal level.