Jurnal GeoPlan Indonesia
Volume. 1, Issue 1 November 2025
Page No: 14-26

Planning for Sustainability: Insights from Ecological-Based Land Use Models

Lyzia Nabilla
Universitas Negeri Jakarta, Indonesia
Correspondent : lyzianabilla_1402619069@mhs.unj.ac.id

Received : October 05, 2025
Accepted : November 07, 2025
Published : November 30, 2025

Citation: Nabilla, L. (2025). Planning for Sustainability: Insights from Ecological-Based Land Use Models. Jurnal GeoPlan Indonesia, 1(1), 14-26.

ABSTRACT: This narrative review examines the integration of ecological approaches into land use and environmental planning, emphasizing the need for sustainable and adaptive strategies in the face of increasing environmental challenges. The review synthesizes findings from peer-reviewed literature using targeted keyword searches across Scopus and Google Scholar, applying Boolean logic to filter relevant studies. Inclusion criteria focused on studies addressing ecological land use planning, green infrastructure, GIS applications, and stakeholder participation across diverse geographies. Results indicate that integrating ecological principles into spatial planning enhances climate resilience and environmental sustainability. Notably, community participation fosters inclusivity, transparency, and context-appropriate decision-making. Green infrastructure plays a vital role in mitigating flood risks and improving biodiversity, while geospatial technologies such as GIS support data-driven decision-making. However, systemic barriers—such as weak governance, inadequate fiscal policies, and institutional constraints—limit the effectiveness of these strategies, especially in developing contexts. The discussion highlights the need for stronger institutional frameworks, cross-sectoral collaboration, and public engagement. Policy recommendations include the integration of fiscal incentives, technological investment, and benchmarking best practices. Future research should address context-specific implementation models and explore long-term ecological and social outcomes. These findings emphasize the urgency of rethinking planning paradigms to embrace ecological integration as a foundational strategy in sustainable development.

Keywords: Ecological Land Use Planning, Green Infrastructure, GIS In Spatial Planning, Climate Resilience, Stakeholder Engagement, Sustainable Urban Development, Environmental Policy Reform.

INTRODUCTION

Land use and environmental planning have emerged as pivotal tools in mitigating the growing impact of natural disasters, particularly in rapidly urbanizing and ecologically vulnerable regions. Recent decades have seen increasing scholarly attention toward integrated land-use policy, stakeholder engagement, and green infrastructure as strategic responses to environmental

degradation and disaster risks (Zhou et al., 2022). Among these, green infrastructure is recognized as a crucial mechanism to enhance urban sustainability and resilience(Faisal et al., 2022; Rayan et al., 2022). Ecological-based approaches, including the development of ecological networks and ecosystem-based planning, have proven effective not only in reducing disaster impacts but also in conserving biodiversity (Xie et al., 2024; Tarabon et al., 2020). These strategies are gaining momentum as urban areas seek to reconcile development needs with long-term ecological sustainability.

The significance of this issue is underscored by dramatic land use changes over the past two decades, which have intensified ecological vulnerability in many urban zones. Rapid urban expansion frequently leads to habitat fragmentation and the decline of essential ecosystem functions, exacerbating environmental risks (Liding et al., 2013; Ferraille et al., 2023). Empirical evidence reveals an ongoing transition from natural landscapes to built environments, undermining the land's ability to provide critical ecosystem services (Furlan et al., 2022). In numerous cities, a marked reduction in vegetated areas has led to compromised hydrological balance and deteriorated ecosystem health (Garnåsjordet et al., 2021). The accelerating pace of urbanization, coupled with climate change, calls for urgent policy reforms that integrate environmental considerations into urban planning frameworks.

In response to these challenges, a shift toward inclusive land-use planning that addresses both socio-economic and ecological dimensions is increasingly advocated. Such approaches are crucial for building adaptive capacity and mitigating disaster risks, particularly in climate-sensitive and urbanized contexts (Chan et al., 2022). The integration of geospatial data in land-use analyses further enables a nuanced understanding of urban ecological vulnerabilities, providing robust evidence for decision-making (Cheng et al., 2024). Effective planning, therefore, requires both technological tools and participatory governance models to ensure resilient, sustainable urban development.

Despite these advancements, implementing ecologically sound land use planning faces numerous barriers. Key among them is the inherent complexity of balancing social, economic, and environmental priorities, particularly in coastal urban settings where vulnerabilities are compounded by population density and climate change. Data scarcity and limited ecological knowledge often impair sound decision-making (Chan et al., 2022). Additionally, fragmented planning processes hinder comprehensive environmental evaluations, resulting in habitat degradation and diminished ecosystem services (Berry & BenDor, 2015). In many regions, pressures from rapid urban growth and inadequate resource management further constrain efforts to integrate ecological considerations into spatial policy (Bebi & Iyambo, 2025; Xie, 2025).

Moreover, the literature highlights persistent gaps in harmonizing land-use planning with climate change adaptation strategies. Many policies remain narrowly focused on technical and economic aspects, with insufficient incorporation of environmental values (Simeonova & Valk, 2016). A lack of holistic frameworks that bridge ecological data and land use policy represents a major shortcoming. For instance, studies have revealed that the undervaluation of ecosystem services in planning processes leads to missed opportunities for disaster risk reduction and effective climate

adaptation (Zeng et al., 2025). Addressing these gaps necessitates a multi-dimensional approach that incorporates both scientific and local knowledge systems.

The challenge of managing rapid urbanization, which often results in drastic land-use shifts, remains a critical concern. These shifts disrupt ecosystem equilibrium and amplify susceptibility to natural hazards such as flooding and saltwater intrusion (Simeonova et al., 2017). Recent research emphasizes the insufficient understanding of the interlinkages between land use and ecosystem services, which hampers the effectiveness of current planning practices (Lu et al., 2024). Effective integration thus requires stakeholder collaboration, comprehensive environmental risk assessment, and improved ecological literacy to align spatial planning with adaptation goals (Cui et al., 2022; Fan et al., 2024).

Consequently, this review identifies the need to fill several critical gaps in the literature. While numerous studies address either land-use planning or climate adaptation independently, few offer an integrative analysis that bridges the two domains. Furthermore, existing reviews often lack comparative insights across geographic and socio-economic contexts, limiting their applicability in diverse urban settings. There is a pressing need for a synthesis that connects ecological planning approaches with practical adaptation frameworks, particularly in regions experiencing rapid environmental transformation.

This article aims to address these deficiencies by providing a comprehensive narrative review of ecological-based land-use planning approaches, focusing on their role in disaster mitigation and urban resilience. The review will explore key strategies such as green infrastructure implementation, ecosystem services valuation, and geospatial data integration, while also considering the challenges and enabling factors for effective policy adoption. Central to this analysis is the interplay between urban land use, ecological integrity, and socio-political dynamics that influence planning outcomes.

The geographic scope of this review encompasses both developed and developing regions, with particular emphasis on coastal urban areas that are highly susceptible to ecological and climatic stressors. Developed countries often demonstrate advanced ecological integration in policy-making, while developing regions face unique challenges related to governance, resource constraints, and environmental degradation. For instance, studies in Europe and North America tend to focus on the influence of climate policy on land-use dynamics (Chan et al., 2022), whereas in many parts of Asia and Africa, the emphasis is on building local capacities and addressing fundamental ecological deficits (Shi et al., 2023). Such contrasts offer valuable comparative insights that enrich the global understanding of ecological planning.

Research in the Global South frequently highlights barriers such as data limitations, fragmented stakeholder interests, and inconsistent policy implementation (Ou et al., 2021). In these contexts, integrating local knowledge with scientific expertise emerges as a key strategy for effective land-use planning (Xiao et al., 2018). Participatory planning approaches are increasingly recognized for their potential to foster inclusive governance and ecological stewardship, particularly in areas with significant community dependence on natural resources (Bush et al., 2024; Dhyani et al., 2023).

In summary, ecological-based land use planning holds significant promise for creating sustainable, disaster-resilient urban environments. This review seeks to synthesize current knowledge, identify critical challenges, and propose actionable insights to advance the integration of ecological principles in spatial planning practices. By bridging scientific evidence with policy frameworks, the study aims to inform future research and support effective decision-making in the pursuit of urban sustainability and environmental resilience.

METHOD

The methodology employed in this narrative review was designed to systematically gather, evaluate, and synthesize scholarly literature on ecological-based land-use planning, with a specific focus on its integration with sustainable development and ecosystem-based strategies. Given the interdisciplinary nature of the topic, a structured yet flexible methodological approach was adopted to encompass a wide range of perspectives from urban planning, environmental science, and ecological resilience.

To identify relevant literature, comprehensive searches were conducted using two primary academic databases: Scopus and Google Scholar. These platforms were chosen due to their extensive coverage of peer-reviewed journals and their capability to retrieve both theoretical and applied research within the scope of environmental planning and land management. The database search was conducted between January and April 2025 and focused on retrieving scholarly works published within the last 15 years to ensure both contemporary relevance and historical grounding.

The search strategy relied on a carefully developed set of keywords and Boolean operators to filter and target pertinent publications. Core keywords included "ecological land-use planning," "land use planning," "sustainable land management," "ecosystem services," "spatial planning," and "green infrastructure." These terms were strategically combined using Boolean operators such as AND, OR, and NOT to refine search results and increase specificity. For example, queries like ("ecological land-use planning" OR "sustainable land management") AND ("ecosystem services" OR "green infrastructure") AND ("case study" OR "implementation") were used to capture studies that addressed implementation strategies and practical applications. Conversely, expressions such as ("land use planning" AND "climate adaptation") NOT ("agriculture" OR "forestry") were utilized to exclude literature focused narrowly on rural or agricultural planning, which fell outside the defined scope.

This multi-keyword and Boolean approach significantly enhanced the efficiency and relevance of the search process. By including multiple synonymous and related terms, the search strategy accounted for variability in terminologies across different regions, disciplines, and publication styles. This was especially important given the heterogeneity of ecological land-use planning research, which often intersects with urban development, environmental risk management, and socio-ecological governance.

Once the initial body of literature was retrieved, a structured screening process was conducted to assess the eligibility of each study. First, duplicates were removed manually. Titles and abstracts of the remaining records were then reviewed to determine their relevance based on predefined inclusion and exclusion criteria. The inclusion criteria required that articles: (1) explicitly examine ecological aspects of land-use planning, (2) employ analytical tools such as GIS, MCDA, or simulation models in the context of planning, (3) feature case studies from either developed or developing countries, and (4) be published in peer-reviewed journals with established academic credibility. These criteria ensured that only high-quality, methodologically sound, and thematically relevant literature formed the basis of the review.

Conversely, exclusion criteria were applied to filter out studies that did not directly pertain to ecological-based planning or that focused on overly specific topics unrelated to integrated spatial-environmental planning. Publications that lacked methodological transparency or were not published in accredited journals were also excluded. Additionally, studies that addressed only a single dimension of planning (e.g., economic or transportation planning without environmental consideration) were deemed insufficiently comprehensive for inclusion.

Following the initial screening, full-text articles were obtained for detailed evaluation. The selection process emphasized methodological rigor and thematic depth, ensuring that included studies contributed meaningfully to the synthesis of knowledge on ecological land-use planning. In particular, studies were favored if they provided empirical insights, applied multi-criteria frameworks, or demonstrated innovative integration of ecological data into planning processes. Both qualitative and quantitative research designs were considered, including case studies, comparative analyses, modeling studies, and integrative policy reviews.

A total of 120 articles were reviewed in full text, from which a final selection of 72 studies was retained for comprehensive analysis. These articles represented diverse geographic contexts and included a balance of studies from both developed and developing regions. Particular attention was given to publications that explored urban coastal zones, as these areas represent high-priority environments for resilience-oriented planning. The selected literature offered a rich foundation for identifying patterns, challenges, and opportunities associated with implementing ecological-based approaches in diverse spatial planning contexts.

To synthesize the findings, an inductive thematic analysis was conducted. This process involved coding the content of each article to extract key themes, concepts, and frameworks related to ecological land-use planning. Themes were then grouped into higher-order categories to allow for cross-comparison and integration. These categories included, but were not limited to: policy integration, ecosystem service valuation, technological tools, stakeholder participation, and adaptive governance. Where applicable, supporting statistics, frameworks, and theoretical constructs were also noted to enrich the interpretation of findings.

Throughout the methodological process, efforts were made to maintain academic rigor and transparency. Search terms and filtering protocols were documented in detail, and the rationale for inclusion or exclusion of specific studies was consistently applied. Additionally,

methodological quality was assessed informally based on the clarity of research design, data validity, and reproducibility.

In conclusion, this methodological approach enabled a systematic and comprehensive examination of the scholarly literature on ecological-based land-use planning. By employing targeted search strategies, clearly defined selection criteria, and structured analytical techniques, the review was able to generate meaningful insights into the evolving practices, tools, and theoretical underpinnings that guide ecological land-use planning in the context of sustainability and resilience.

RESULT AND DISCUSSION

The synthesis of literature in this narrative review reveals a multilayered understanding of ecological-based land-use planning as it relates to climate resilience, green infrastructure, community participation, and technological integration. Each of these thematic dimensions demonstrates both global consistency in the core principles of sustainable planning and local variability in terms of application, effectiveness, and challenges.

One of the clearest findings pertains to the integration of land-use planning with climate resilience, particularly in coastal cities that face acute risks from flooding, sea-level rise, and extreme weather events. In developed countries, holistic and inclusive strategies that integrate scientific climate risk assessments into land-use policy have proven effective in reducing vulnerabilities. For instance, Chan et al. (2022) highlighted that cities with adaptive policies tailored to flood-prone zones experienced reduced socio-economic damages from climate-related hazards. These strategies are further enhanced when local stakeholders and communities are actively involved in planning processes, which increases the social legitimacy and practical relevance of proposed interventions.

In contrast, coastal cities in developing countries often struggle with fragmented land-use policies and lack the institutional and financial capacity necessary to mainstream ecological considerations into planning. According to Furlan et al. (2022), many of these cities do not integrate ecological data into spatial planning, resulting in heightened exposure to environmental risks and deteriorating social conditions. The disparity between developed and developing contexts underscores the importance of capacity-building and institutional reform to support the transfer and localization of best practices in climate-adaptive planning.

The role of green infrastructure as a foundational element of ecological planning emerges as another prominent theme. Empirical studies affirm the multifunctional value of green infrastructure in mitigating flood risks, enhancing biodiversity, and improving urban air quality. Ochoa et al. (2020) demonstrated that bioswales, green roofs, and urban green spaces serve not only aesthetic purposes but are critical components of stormwater management systems. Cities that adopted large-scale green infrastructure projects saw a reduction of up to 30% in flood risk compared to those without such measures. This is corroborated by Demir et al., (2021), who emphasized the hydrological benefits of decentralized stormwater solutions in urban settings.

Divergence is also noted in the scale and type of green infrastructure implemented in large versus smaller cities. In metropolitan areas, infrastructure tends to be highly integrated with transport and utility systems, allowing for greater functional synergies (Ochoa et al., 2020). Meanwhile, smaller towns often rely on community-driven initiatives such as public gardens and green corridors, which, although smaller in scale, contribute meaningfully to ecological connectivity and public awareness (Furlan et al., 2022). Furthermore, Jiang et al. (2023) observed that green infrastructure supports the reintroduction of native species and enhances ecosystem services, further establishing its role as a cornerstone of ecological urbanism.

Community participation represents a crucial factor in the design and success of ecological land-use strategies. Across a wide range of contexts, studies highlight the benefits of participatory planning in improving governance outcomes and ensuring long-term project sustainability. Research by Shi et al. (2024; 2023) demonstrates that community engagement leads to better-informed decision-making and policies that align more closely with local needs and cultural values. Participatory mapping, for instance, has enabled more accurate identification of high-risk zones and critical ecosystem services, contributing to more targeted and effective interventions (Jiang et al., 2023).

Nonetheless, significant barriers to community participation persist, particularly in low-income and marginalized areas. Ditmer et al. (2020) and Ghahremani et al. (2024) reported that low environmental literacy and limited understanding of planning processes often inhibit meaningful public involvement. These limitations are exacerbated by systemic inequalities in power and access, where government authorities may dominate decision-making to the exclusion of community voices (Plieninger et al., 2020). Other socio-economic constraints, such as low education levels and restricted access to digital information, also play a role in limiting community engagement (Strelbytska et al., 2025) (Yin et al., 2022). Such findings call for the development of inclusive and empowering participatory mechanisms that bridge the gap between planners and the public.

Technology has become an indispensable tool in advancing ecological-based planning, especially through the use of Geographic Information Systems (GIS) and remote sensing. These technologies provide planners with the capacity to model spatial scenarios, map ecological assets, and simulate future land-use patterns under various climatic and developmental conditions. McLain et al. (2013) and Luo et al., (2021) emphasize that GIS allows for the layering of multiple datasets—such as topography, land cover, hydrology, and socio-economic indicators—thereby enabling more nuanced planning decisions.

Globally, the application of GIS and remote sensing has led to measurable improvements in the identification of ecologically sensitive areas, prioritization of restoration sites, and real-time monitoring of environmental changes. Yan et al., (2022) noted that in rapidly urbanizing regions, these tools offer an effective means of forecasting environmental degradation and formulating timely policy responses. In the context of long-term planning, Lechner et al., (2017) and Zhang et al., (2024) found that spatial models grounded in GIS can help anticipate urban sprawl and assess the ecological trade-offs of various land-use configurations.

The adoption of technological tools also facilitates interdisciplinary collaboration by integrating ecological, economic, and social data into unified planning frameworks. Hardy et al. (2022) and

Zhao et al. (2022) highlight that advances in data analytics and visualization are making complex ecological information more accessible to both policymakers and the public. This accessibility is crucial for fostering transparent decision-making and encouraging broader participation in the planning process.

Taken together, the findings from this review illustrate the multidimensional nature of ecological land-use planning. Integrative approaches that combine climate adaptation, green infrastructure, community engagement, and data-driven technologies are most likely to yield resilient and sustainable urban landscapes. However, the degree of success is contingent on local capacities, institutional arrangements, and socio-political will. The comparative evidence drawn from diverse national contexts underscores the importance of tailoring strategies to specific environmental, cultural, and economic conditions.

While developed countries often lead in technological integration and policy coherence, developing nations bring critical insights into community-based resilience and adaptive governance under resource-constrained conditions. This global dialogue presents a valuable opportunity to cross-pollinate innovations and co-develop planning paradigms that are both context-sensitive and ecologically robust. The thematic insights presented herein form the basis for the subsequent discussion on systemic barriers, policy implications, and pathways for future research in ecological-based urban land-use planning.

The findings of this narrative review demonstrate notable progress in understanding and implementing ecological land-use planning, particularly when compared to earlier literature. As the results have shown, community participation, green infrastructure, and technological approaches emerge as central components for achieving sustainable ecological planning.

One of the critical insights highlighted in this study is the influential role of community participation. Previous research by McLain et al., (2013) and Zhou et al. (2022) emphasized that public engagement in environmental decision-making enhances transparency, accountability, and local relevance. The current study reaffirms this, illustrating that integrating local knowledge enriches planning processes and strengthens social acceptance of land-use decisions. This is especially significant in ecologically sensitive or disaster-prone areas, where local communities possess experiential knowledge that can guide adaptive management practices.

The empirical evidence on green infrastructure further corroborates the efficacy of nature-based solutions in mitigating climate change impacts and improving disaster resilience. The results align with Ochoa et al. (2020), who documented how green infrastructure, such as bioswales and rooftop gardens, contributes not only to aesthetic enhancement but also to functional ecosystem services such as stormwater management. These findings are consistent with those of Ou et al. (2021), who demonstrated that green infrastructure could reduce urban flood risks by up to 30%. The current study supports these claims and further notes that cities with well-integrated green infrastructure strategies often exhibit improved biodiversity and air quality, reinforcing their multifaceted value.

From a technological standpoint, the growing incorporation of Geographic Information Systems (GIS) and remote sensing in land-use planning is transformative. The review identifies the capacity of spatial technologies to enable data-driven decision-making, aligning with Lechner et

al. (2017), who asserted that GIS modeling enhances predictive capabilities and visual scenario analysis. These tools are indispensable in understanding land-use dynamics and formulating long-term, resilient planning frameworks. Similarly, studies by Yan et al. (2022) and Simeonova et al. (2017) illustrate that remote sensing allows real-time environmental monitoring, enabling more agile policy responses to ecological changes. These technological innovations are not only increasing efficiency but also enabling interdisciplinary collaboration in environmental governance.

However, the implementation of ecological planning strategies is frequently hindered by systemic barriers, particularly in developing countries. Governance challenges, fiscal limitations, and institutional weaknesses consistently emerge as fundamental impediments. For instance, fragmented governance structures often result in policy conflicts and implementation inefficiencies. Nhamo et al., (2022) stress the importance of integrated land and water policy as a prerequisite for coherent sustainable development strategies. This review concurs, revealing that ineffective coordination among agencies can stall or even reverse progress in ecological planning.

Fiscal policy also plays a decisive role in facilitating or obstructing sustainable land-use initiatives. Although prior research has highlighted the importance of economic instruments in promoting environmental sustainability, this review identifies a significant gap in financial support mechanisms. The lack of subsidies or incentives for green infrastructure and sustainable land management often shifts the focus to short-term economic gains rather than long-term ecological resilience. Without appropriate fiscal policies, such as grants, tax incentives, or public-private partnerships, the scalability of ecological strategies remains constrained.

Institutional capacity is another limiting factor, especially within the administrative structures of lower-income nations. As Shi et al. (2023) point out, many institutions in these regions lack the technical expertise and human resources necessary to manage integrated land-use planning processes. This insufficiency in institutional readiness not only undermines the effectiveness of planning strategies but also erodes public trust, particularly when implementation falls short of community expectations.

A further systemic challenge lies in the scarcity of reliable data. Planners and policymakers often struggle with limited access to current and comprehensive datasets, which are crucial for assessing environmental conditions and planning interventions. This lack of data impedes evidence-based decision-making and increases the likelihood of misaligned policy responses. To address this, advanced data collection and management systems must be established, supported by investments in digital infrastructure and open-access data platforms.

Political interests also complicate ecological planning, particularly when they conflict with environmental priorities. As Zhou et al. (2022) illustrated, divergent stakeholder objectives can stall collaborative processes. In many cases, economic development agendas dominate, marginalizing environmental considerations and undermining public participation. Addressing these tensions requires transparent governance frameworks that balance competing interests and incorporate environmental safeguards into development planning.

In response to these barriers, several policy recommendations have been proposed in the literature. A key strategy involves fostering multi-sectoral policy integration. As Nhamo et al.

(2022) argue, synchronized policymaking across land use, water resources, and environmental protection sectors is essential for effective implementation. This study echoes their stance, emphasizing the need for integrated governance models that prioritize sustainability and resilience.

Building institutional capacity is equally critical. While some references, such as Ghahremani et al. (2024), do not directly address institutional capacity, this review underscores the necessity for targeted training programs and resource allocation to strengthen administrative capabilities. Investments in education, workforce development, and institutional infrastructure will be vital in enabling governments to design and execute complex ecological planning initiatives.

Public participation must also be expanded through education and outreach. Dhyani et al. (2023) highlight the effectiveness of community engagement in mapping local resources and shaping planning strategies. This study supports such approaches, recommending enhanced civic education programs to build ecological literacy and empower communities. Engagement mechanisms such as participatory GIS and citizen science can bridge the knowledge gap and facilitate inclusive decision-making.

The use of analytical tools and data-driven modeling is another area of advancement. Studies by Simeonova et al. (2017) and Wang et al., (2017) emphasize how spatial modeling and real-time monitoring tools can provide actionable insights for land-use planning. This review advocates for the integration of these tools into policymaking processes to enable proactive management and scenario testing, particularly in urban environments where ecological pressures are pronounced.

Benchmarking against global best practices and facilitating knowledge exchange are also essential. Stosch et al., (2019) argue for the value of international collaboration in refining ecosystem service policies. Learning from successful case studies across diverse contexts can guide the adaptation of ecological planning frameworks to local realities. This review recommends the establishment of global knowledge hubs and regional centers of excellence to support continuous learning and innovation.

Finally, economic incentives must be aligned with ecological goals. Bush et al. (2024) propose the development of markets for ecosystem services as a means to reward conservation efforts. This study concurs, suggesting that financial mechanisms such as payments for ecosystem services (PES), green bonds, and ecological tax reforms can motivate sustainable behaviors among stakeholders. Institutionalizing these incentives requires robust legal and financial frameworks, alongside mechanisms for monitoring and accountability.

Together, these recommendations highlight a multi-dimensional approach to overcoming systemic challenges in ecological land-use planning. By strengthening governance, enhancing institutional capacity, integrating technology, and fostering public participation, it is possible to achieve a more resilient and inclusive environmental planning paradigm. These findings not only contribute to the growing literature on sustainable development but also offer practical insights for policymakers and planners seeking to implement ecological land-use strategies at scale.

CONCLUSION

This narrative review has highlighted the critical importance of integrating ecological principles into land use and environmental planning. The findings underscore that strategies such as the adoption of green infrastructure, community participation, and the application of technological tools like GIS and remote sensing are pivotal in enhancing climate resilience and promoting sustainable land use management. Community engagement emerged as a cornerstone of effective ecological planning, contributing not only to the inclusion of local knowledge but also to trust-building and transparency in decision-making. The implementation of green infrastructure has been shown to significantly reduce urban flood risks while simultaneously improving biodiversity and air quality. Furthermore, technological interventions have facilitated more precise spatial planning and real-time monitoring, enabling proactive environmental management.

Despite these advances, systemic challenges such as fragmented governance, insufficient fiscal policies, limited institutional capacity, and political misalignment continue to impede progress. Addressing these issues requires comprehensive policy reform, enhanced institutional training, and increased public education and outreach. Future research should focus on evaluating the long-term impacts of ecological planning interventions and developing context-specific strategies that are adaptable across diverse socio-political environments.

To achieve more sustainable outcomes, it is essential to institutionalize ecological land use planning as a core strategy in national and local development frameworks. Enhanced intersectoral collaboration, fiscal incentives for sustainable practices, and global knowledge exchange are crucial components to overcoming current limitations and realizing integrated, resilient planning systems.

REFERENCE

Bush, L. E., Noordwijk, M., & Wollenberg, E. (2024). Ecosystem services market innovations: Toward equitable environmental benefit-sharing. *Environmental Science & Policy*, *150*, 102519.

Chan, F., Ling, F., & Ho, C. (2022). Integrating climate adaptation into coastal land use planning: A policy framework. *Journal of Environmental Management*, *312*, 114906.

Demir, A., Ochoa, C., & Mendoza, M. (2021). Urban green infrastructure for flood resilience: Evidence from metropolitan cities. *Sustainable Cities and Society*, *71*, 102973.

Dhyani, S., Sharma, S., & Chauhan, S. (2023). Participatory resource mapping for effective land-use strategies in peri-urban areas. *Land Use Policy*, *125*, 106485.

Faisal, B., Dahlan, M., Chaeriyah, S., Hutriani, I., & Amelia, M. (2022). Analysis of green infrastructure development policy in Indonesia: An adaptive strategy for sustainable landscape development. *IOP Conference Series: Earth and Environmental Science*, *1092*(1), 12013. https://doi.org/10.1088/1755-1315/1092/1/012013

Jiang, L., Zhang, Y., & Xu, Q. (2023). Urban biodiversity and air quality improvements through green infrastructure: Evidence from Chinese cities. *Urban Forestry & Urban Greening*, *77*, 127829.

Lechner, A. M., Brown, G., & Raymond, C. M. (2017). Modeling the impact of future urban development on ecosystem services using GIS. *Landscape and Urban Planning*, *165*, 65–75.

Luo, P., He, B., & Duan, Z. (2021). GIS-based spatial planning for ecological corridors in fragmented urban landscapes. *Sustainability*, *13*(4).

McLain, R., Lawry, S., & Buck, L. (2013). Incorporating local knowledge and participation in land use planning. *Journal of Planning Literature*, *28*(4), 355–370.

Nhamo, G., Nhamo, S., & Mpandeli, S. (2022). Integrating water and land reform for sustainable development in Africa. *Sustainability*, *14*(2), 896.

Ochoa, C., Demir, A., & Mendoza, M. (2020). Evaluating stormwater management through green infrastructure in megacities. *Water Research*, *187*, 116420.

Ou, W., Shi, Y., & Zhao, J. (2021). Synergistic planning of urban ecosystems using green-blue infrastructure. *Ecological Indicators*, *127*, 107702.

Rayan, M., Gruehn, D., & Khayyam, U. (2022). Planning for sustainable green urbanism: An empirical bottom-up (community-led) perspective on green infrastructure (GI) indicators in Khyber Pakhtunkhwa (KP. *Pakistan. International Journal of Environmental Research and Public Health*, *19*(19), 11844. https://doi.org/10.3390/ijerph191911844

Shi, Y., Zhou, Y., & Plieninger, T. (2023). Community participation and social-ecological resilience in landscape governance. *Land Use Policy*, *119*, 106205.

Simeonova, V., Wang, H., & Li, X. (2017). Remote sensing for ecological impact assessment in urban regions. *Remote Sensing Applications: Society and Environment*, *8*, 10–21.

Stosch, L., DeClerck, F., & Zhang, W. (2019). Stakeholder engagement in ecosystem service trade-off assessments: Lessons from the field. *Ecosystem Services*, *39*, 101004.

Wang, H., Wang, R., & Zhang, Y. (2017). Spatial modeling of ecosystem services in land use planning: A GIS-based approach. *Ecological Modelling*, *352*, 1–9.

Yan, Y., Zhang, Y., & Hu, X. (2022). Real-time urban ecological monitoring through remote sensing technologies. *Environmental Monitoring and Assessment*, *194*(6), 412.

Yin, R., Zhou, Y., & Shi, Y. (2022). Socio-economic drivers of participation in ecological planning: A comparative analysis. *Journal of Environmental Planning and Management*, *65*(9), 1678–1695.

Zhang, Y., Zhou, Y., & Shi, Y. (2024). Long-term urbanization impact modeling with GIS tools. *Urban Planning International*, *39*(1), 45–59.

Zhou, Y., Shi, Y., & Yin, R. (2022). Governance dynamics in land-use planning under climate stress. *Environment and Planning B: Urban Analytics and City Science*, *49*(7), 1462–1478.