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Editorial: The sustainable management of land systems

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Editorial on the Research Topic

The sustainable management of land systems

1 Introduction

The sustainable management of land systems is central to addressing some of the most pressing global challenges of our time, including climate change, food security, biodiversity loss, and sustainable urbanization (Abduljabbar et al., 2025; Jayawardana et al., 2025; Juarez-Quispe et al., 2025). Land systems—defined as intertwined socio-ecological networks shaped by land use, governance, biophysical characteristics, and institutional arrangements—are impacted by and drive environmental and social change (Babli et al., 2025; Xiao et al., 2025). As such, their management plays a pivotal role in achieving multiple Sustainable Development Goals (SDGs), from zero hunger (SDG 2) and clean water (SDG 6) to climate action (SDG 13) and life on land (SDG 15) (Lambin and Meyfroidt, 2010; United Nations, 2025).

Land systems are inherently dynamic and multifaceted due to the intricate relationships that exist between ecological processes, human activities, economic demands, and policy frameworks (Pissourios et al., 2025; Wei S. et al., 2025). Whether due to urbanization, agricultural growth, infrastructure development, or deforestation, changes in land cover and land use have profound effects that cut across administrative and spatial borders (Huang and Lin, 2025; Min et al., 2025; Wei L. et al., 2025). These changes lead to habitat fragmentation, resource depletion, land degradation, and social injustices in many areas, necessitating integrated, place-based, and adaptive management approaches (Baldi et al., 2013; Loures et al., 2019; Naranjo Gómez et al., 2020).

Recognizing the need to better understand and guide these transformations, the Research Topic “*The Sustainable Management of Land Systems*” was launched to provide a platform for interdisciplinary research focused on identifying pathways, tools, and governance mechanisms that promote sustainability in land systems (Hashed et al., 2025; Ishiwatari et al., 2025; Zhao X. et al., 2025). This Research Topic sought to attract contributions from across disciplines, including geography, ecology, environmental

engineering, agriculture, urban planning, remote sensing, economics, and social sciences, as well as from different world regions and institutional contexts (Matuk and Calka, 2025; Wang X. et al., 2025; Zhou et al., 2025).

This editorial synthesizes and reflects upon the findings of the 24 peer-reviewed articles published in this Research Topic. These contributions cover a wide range of case studies, conceptual analyses, and methodological approaches applied to various land-related issues, such as trade-offs between ecosystem services, interactions between urban and rural areas, neutrality of land degradation, stakeholder engagement, and the incorporation of technological innovations such as remote sensing, GIS, and modeling tools. These articles highlight the global significance of sustainable land system governance by representing geographic diversity across Europe, Asia, Africa, and Latin America.

By organizing the contributions thematically, this editorial aims to highlight not only the scientific advances made but also the broader insights into policy, planning, and practice. We begin by examining how the published works contribute to key thematic areas—such as ecosystem restoration, sustainable agriculture, urban dynamics, and land-use modeling—and conclude by identifying common lessons, ongoing gaps, and opportunities for future research and action.

2 Insights from research: the sustainable management of land systems

The articles published in the Research Topic *The Sustainable Management of Land Systems* offer a comprehensive overview of how diverse regions and disciplines address the challenge of managing land systems in a sustainable way. These 24 contributions employed a broad range of methodologies—from spatial modeling and ecological assessment to stakeholder surveys and optimization tools—to explore land use change, ecosystem services, agricultural sustainability, urban expansion, and land degradation. Despite their diversity, these studies collectively emphasized the need for integrated and adaptive land management approaches informed by both scientific evidence and socio-cultural realities.

Several studies applied spatially explicit modeling techniques to assess ecosystem functions and land-use dynamics under different scenarios. For instance, articles based in China (e.g., the Min River Basin, the Yangtze River Economic Belt, and Huize County) used tools such as PLUS, InVEST, and the Human Footprint Index to evaluate habitat quality, ecological security, and karst desertification over time. These models allow researchers to compare future land-use trajectories under competing policy scenarios, thereby supporting decision-makers in selecting pathways that prioritize ecological integrity and long-term sustainability. Their findings underscore the potential of integrated simulation frameworks for large-scale land planning and restoration. Embedding ecosystem services into planning processes is essential to ensure holistic outcomes, as highlighted in previous research (Alves et al., 2022, 2024; Li W. et al., 2025; Zhang K. et al., 2025).

Agricultural land systems also featured prominently, with research addressing both the biophysical and socio-economic dimensions of sustainability (Diogo et al., 2025; Morán-Alonso et al., 2025; Rabelo et al., 2023). A study on wheat cultivation evaluated nitrogen fertilizer optimization as a pathway to reduce carbon emissions across different regions of China, revealing significant regional disparities in efficiency (Guo et al., 2025; Wang and Su, 2025; Xu et al., 2025). Another long-term experiment with maize-based systems highlighted the benefits of Integrated Soil-Crop System Management in enhancing yields while maintaining soil health (Gui et al., 2025; Koumaki et al., 2025; Oldoni et al., 2025). Studies conducted in tropical settings, including Benin and Latin America, proposed indicators to assess and redesign silvopastoral systems and smallholder strategies (Culqui et al., 2025; dos Santos et al., 2025; Morales-Ruiz et al., 2025). These findings align with agroecological principles that emphasize the need for agricultural systems to be both productive and regenerative, while accounting for environmental boundaries and social contexts (Gopalsamy, 2017; Gonçalves, 2020; Silva et al., 2021).

A number of contributions focused on land-use change and scenario simulation to inform policy under uncertainty (Li C. et al., 2025; Zhao R. et al., 2025; Zou et al., 2025). Articles simulating spatial development in the Yellow River Basin, Henan Province, and resource-based cities showed that ecological protection scenarios outperform economic development ones in terms of sustainability metrics. These studies support the growing consensus that scenario-based planning, when combined with stakeholder engagement, can illuminate trade-offs and synergies in complex land systems (Baldi et al., 2013; Ruzgiene et al., 2025). Similarly, studies using green land use efficiency models and ecosystem service valuations highlighted the role of education, infrastructure, and land governance in mediating regional differences in sustainability outcomes (Chen et al., 2025; Cui et al., 2025; Gong et al., 2025).

Urbanization and infrastructure development emerged as significant drivers of land system transformation, particularly in rapidly growing regions of Asia and Africa. Research on railway corridors in China and urban expansion in Ethiopia revealed alarming rates of cropland loss, spatial fragmentation, and ecological degradation that often outpace the ability of planning institutions to respond effectively (Feng et al., 2025; Song et al., 2025a; Zhang Q. et al., 2025). These patterns mirror global trends of urban sprawl and raise concerns about the future of food security and ecosystem health in peri-urban zones (Li X. et al., 2025; Wang et al., 2025; Yu J. et al., 2025). In response, some articles developed spatial frameworks—such as production-living-ecological space models—to support land-use integration and conflict mitigation in urbanizing regions (Liu J. et al., 2025; Liu S. et al., 2025; Sarfo et al., 2025).

The issue of land degradation neutrality (LDN) was addressed through case studies in Ukraine and mining-affected regions, where authors proposed land reclamation strategies based on industrial backfill and ecosystem service mapping (Ford-Learner et al., 2025; Song et al., 2025b; Zhong et al., 2025). These efforts illustrate how degraded lands can be reintegrated into productive landscapes when supported by appropriate policies and technologies, contributing to the goals of the UNCCD and

LDN targets (Liao et al., 2025; Martínez-Valderrama et al., 2025; Nandi et al., 2025). Other studies analyzed trade-offs among ecosystem services in tea-growing areas, showing that forested landscapes provide higher ecological value and multifunctionality than intensive agricultural systems (Castillo-Díaz et al., 2025; Wang et al., 2024; Wang Z. et al., 2025).

Finally, a subset of articles explored the integration of technology and cultural perception in shaping land governance (Liu and Zhu, 2025; Rahmawati et al., 2025; Yang, 2025). The use of fuzzy analytic hierarchy processes (FAHP), remote sensing, and carbon accounting models demonstrated how advanced tools can support sustainable land-use decision-making (Moberg, 2025; Weerasinghe et al., 2025). However, one article cautioned that cultural diversity and psychological factors also influence land-use choices, suggesting the need for participatory tools that recognize local values and mental models. In Kazakhstan, remote sensing was used to assess pasture degradation, revealing that human activities are often more significant drivers of change than climatic variability—an insight echoed in global assessments of land degradation (Amin and Romshoo, 2024; Peng et al., 2025; Yu Z. et al., 2025).

Across these contributions, a few recurring themes emerge: the value of interdisciplinary approaches; the necessity of linking local knowledge with technical tools; and the critical role of policy in translating science into practice. Collectively, these 24 articles provide a compelling narrative about the challenges and opportunities of land system management. They demonstrate that while tools and models are important, achieving sustainability ultimately depends on aligning ecological goals with social equity, institutional capacity, and long-term vision.

3 Final remarks

The 24 articles published under the Research Topic *The Sustainable Management of Land Systems* illustrate the complexity and urgency of guiding land use decisions in a changing world. Together, these studies reveal that land systems are not merely physical spaces subject to human intervention, but socio-ecological systems shaped by historical trajectories, institutional arrangements, cultural values, and environmental constraints. Their sustainability depends not only on technical and scientific innovation but also on governance, participation, and contextual adaptation.

Several key insights emerge from the collective body of work. First, land system sustainability requires a strong integration of ecological processes, socio-economic conditions, and technological capabilities. Studies that employed spatial simulation tools, ecosystem service modeling, and scenario planning proved especially useful in projecting land-use outcomes and exploring trade-offs. Such tools are most effective when combined with local knowledge and stakeholder participation, ensuring that land use strategies are both scientifically sound and socially legitimate (Baldi et al., 2013; Jukneliene et al., 2021).

Second, the challenge of land degradation, whether driven by climate stress, intensive agriculture, or extractive industries, remains a global concern. However, the contributions from countries such as Ukraine, Kazakhstan, and China demonstrate

that restoration and adaptive reuse of degraded land are possible with the right policy support and innovative land management approaches (Secretariat, 2018). The transition from reactive to proactive land governance—one that anticipates degradation and builds resilience—is increasingly seen as a priority in both policy and research communities (Alves et al., 2023; Zulkifli et al., 2015).

Third, agriculture continues to be a central element in sustainable land systems. The emphasis on integrated soil-crop systems, silvopastoral designs, and regionally optimized fertilization highlights a shift toward farming practices that balance productivity with long-term ecological viability. These findings resonate with the principles of agroecology and regenerative agriculture, which advocate for systems that enhance soil health, sequester carbon, and support biodiversity (Côte et al., 2022; Gliessman, 2014).

Urbanization, another recurring theme, illustrates the spatial and institutional tensions in land management. The rapid conversion of agricultural land to urban uses, especially in peri-urban zones, threatens food security and ecological connectivity. Planning tools such as production-living-ecological space (PLES) models and urban ecological security frameworks, featured in several contributions, provide important mechanisms for mediating competing demands in complex urban landscapes. However, their effectiveness relies heavily on integrated governance and intersectoral coordination—areas that remain weak in many regions (Angel et al., 2011).

Finally, many of the articles reaffirm that land systems cannot be managed in isolation from cultural, institutional, and psychological factors. The influence of community values, governance structures, and cognitive biases in shaping land-use decisions suggests that participatory, inclusive, and culturally sensitive approaches are essential. Land use transitions are rarely linear or purely rational; they are often the result of negotiations, power asymmetries, and contested meanings of sustainability (Alves et al., 2023; Lambin and Meyfroidt, 2011).

In sum, this Research Topic advances both the theoretical understanding and practical approaches to land system sustainability. It highlights the value of interdisciplinary and cross-scalar research, the need for robust decision-support tools, and the centrality of adaptive governance. As land pressures intensify due to climate change, population growth, and globalized markets, the path forward lies in cultivating land systems that are not only efficient and productive but also equitable, inclusive, and resilient.

We hope that this collection of studies serves as both a reference and an inspiration for future research, policy development, and collaborative action aimed at securing the long-term sustainability of land systems around the world.

Author contributions

SL: Visualization, Formal analysis, Project administration, Resources, Validation, Writing – review & editing, Methodology, Supervision, Investigation, Writing – original draft, Conceptualization.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

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