Opinion

From Overlapping Claims to Shared Futures: Addressing Land Use Conflicts through Spatially-Explicit Scenario Planning

Eduardo Gomes

Centre of Geographical Studies (CEG), Associate Laboratory TERRA, Institute of Geography and Spatial Planning (IGOT), Universidade de Lisboa, 1600-276 Lisbon, Portugal; eduardojonas@edu.ulisboa.pt

Abstract: Land use conflicts are increasingly widespread and complex, driven by overlapping spatial claims, intensifying competition over natural resources, and growing socio-environmental vulnerabilities. These conflicts are particularly acute in territories where economic, ecological, and social priorities intersect, and where planning systems often lack the spatial sensitivity and participatory mechanisms necessary to mediate competing interests. This study focus on spatially-explicit scenario planning as a key approach for anticipating, identifying, and managing land use conflicts. Grounded in geospatial analysis, participatory foresight, and sustainability science, this approach enables the co-production of spatially grounded narratives of possible futures, while enhancing territorial governance, stakeholder engagement, and transparency in decision-making processes. Emphasis is placed on the dual role of spatial scenarios: both as technical tools for mapping conflict dynamics and as platforms for dialogue among actors with divergent claims. This study advocates a paradigm shift in land use planning that is forward-looking, spatially informed, and socially inclusive. Such a shift is essential to support sustainability transitions and promote more resilient, and negotiated territorial futures.

Keywords: land use conflicts; spatially-explicit scenario planning; participatory planning; territorial governance; sustainable land management

1. Introduction

Land use conflicts are not new, but their scale, complexity, and intensity are increasing in the context of rapid urbanization, climate change, and socio-political transformations [1–4]. From agricultural expansion into forest frontiers, to urban sprawl encroaching upon peri-urban farmland, and the siting of renewable energy infrastructure in conservation areas, the spatial footprint of human activity is expanding [5,6]. Recent studies indicate that land use conflicts have intensified significantly. For example, between 2001 and 2020 approximately 86 million hectares of forest were converted to agriculture globally, with Brazil, Indonesia, and the Democratic Republic of Congo accounting for over 50 percent of this transformation, often associated with conflicts between agribusiness, smallholder farmers, and indigeneous people [7]. In Europe, more than 28 percent of documented territorial disputes recorded between 1990 and 2019 have been linked to urban expansion pressures over agricultural land, particularly in Spain, Italy, and Portugal [8–10]. Additionally, the expansion of renewable energy infrastructure has generated new territorial tensions, with around 65 percent of planned wind energy projects in Latin America between 2010 and 2022 encountering opposition from local communities over land rights and cultural impacts [11,12]. These quantitative indicators illustrate both the severity and growing spatial incidence of land-use conflicts across different regions. These expansions increasingly overlap in ways that provoke disputes. These conflicts often reflect deeper structural inequalities and

Gomes

Earth Environ. Sustain. **2026**, *2*(1), 16–28

competing visions for the future of land [13–15]. Understanding the nature of land use conflicts requires looking beyond isolated disputes and considering the broader systemic drivers that shape them, including unequal access to resources, weak territorial governance, and divergent socio-environmental values. Conflicts are not merely technical or spatial mismatches, but manifestations of political and institutional tensions that are spatially expressed.

Conventional land use planning tools, rooted in regulatory zoning or economic forecasting, are ill-equipped to address these challenges. They tend to be reactive, linear, and politically constrained, failing to capture the dynamics of land systems or the diversity of stakeholders involved [16,17]. In this context, scenario planning emerges as a compelling alternative. By exploring multiple plausible futures, it allows decision-makers and communities to navigate uncertainty and complexity. The value of this method, however, increases significantly when it becomes spatially explicit, grounding narratives of change in tangible geographies and enabling direct engagement with the territorial dimension of conflict. Spatially-explicit scenario planning (SESP) offers a forward-looking, integrative methodology that explicitly maps trade-offs and enables dialogue among competing interests [18,19]. More than a forecasting tool, SESP is a participatory and anticipatory practice that creates space for negotiation, shared learning, and the reimagining of land futures. This study argues that SESP should be at the heart of any effort to understand and mitigate land use conflicts, particularly in contexts where multiple actors claim overlapping rights and where decisions have long-term territorial consequences. The discussion unfolds in four parts: first, by deepening the understanding of what land use conflicts are and what drives them; second, by presenting the rationale for scenario planning in this context; third, by clarifying what makes a scenario planning process spatially-explicit; and finally, by reflecting on how SESP contributes to conflict resolution and the co-creation of more just and sustainable territorial futures.

2. Reframing Land Use Conflicts through Scenario Thinking

Land use conflicts occur when different stakeholders pursue incompatible objectives for the same geographical area [20]. These conflicts may take various forms: they can be material, such as disputes between mining operations and agricultural land uses [21]; symbolic, as in the tension between protecting cultural heritage and accommodating urban development [22]; or procedural, arising from the absence of transparency or inclusive participation in decision-making processes [23,24]. At the root of these conflicts are a range of driving forces, including pressures linked to economic development, such as infrastructure expansion [25], real estate speculation [26], and agribusiness interests [27,28], as well as goals associated with environmental protection, including biodiversity conservation, rewilding, and climate change mitigation [29,30]. In parallel, social justice claims, especially those connected to indigenous rights, food sovereignty, and the distribution of urban resources, add further complexity [2,31]. Although these tensions often play out within specific spatial boundaries, their origins and consequences typically extend beyond administrative jurisdictions. More than just disputes over land as a physical resource, these conflicts are deeply entangled with power relations, cultural identities, and competing visions for the future. Successful applications of scenario-based spatial analysis demonstrate the potential to anticipate and mitigate such conflicts in a variety of contexts worldwide. For example, scenario modelling in a Latvian biosphere reserve compared business-as-usual, sustainable development and conservation-oriented futures and identified pathways that improve biodiversity outcomes while reducing pressure on vulnerable land parcels, providing concrete guidance to managers on how to reduce land-use tensions [32]. In the Gaoligong Mountain Region a spatially explicit model under different development scenarios showed that the ecological-protection scenario generated the lowest extent and severity of conflict zones [33]. In North America, spatially explicit scenario exercises have been used to generate alternative futures for northwestern Virginia that directly informed conservation planning and helped reconcile development pressures with biodiversity objectives, a process that reduced disagreement by making trade-offs spatially explicit and policy-relevant [34]. In South America, comparative scenario work for the Quillota/Valparaíso region (Chile) contrasted urban regional growth pathways and identified spatial-planning scenarios that lower the risk of urban encroachment into agricultural and high-value natural areas, giving planners concrete options to prevent future conflicts [35]. In African frontier contexts (e.g., Mozambique) strategic spatial planning and stakeholder-driven scenario processes have been shown to create negotiating spaces that reconcile large-scale investment with community livelihoods and ecological protection, thereby reducing the incidence and intensity of land-use disputes [36]. However, it should be acknowledged that scenario-based analysis may not fully resolve land-use conflicts but rather shift them elsewhere. For example, the establishment of protected areas or strict conservation measures in one location may lead to displacement of agricultural, forestry, or development pressures to adjacent or distant regions, a phenomenon often referred to as leakage. This can result in unintended consequences such as carbon emissions increases, habitat loss, or biodiversity decline in areas not directly managed under the scenario [37,38]. Furthermore, the influence of international trade and life-cycle impacts should also be considered in scenario-based land-use analyses. For instance, events such as the U.S.-China soybean trade war have contributed to farmland expansion and carbon stock losses in

the Amazon, illustrating how global market dynamics can amplify or redistribute local land-use pressures. Therefore, while scenario-based approaches can inform decision-making and reduce conflicts locally, their broader socio-ecological impacts must be carefully considered, and complementary policies may be needed to prevent the externalization of pressures. Taken together, these cases show that scenario thinking (when paired with spatial modelling and inclusive participation) does not merely map possible futures but can shape trajectories toward less conflictual land-use outcomes [39,40].
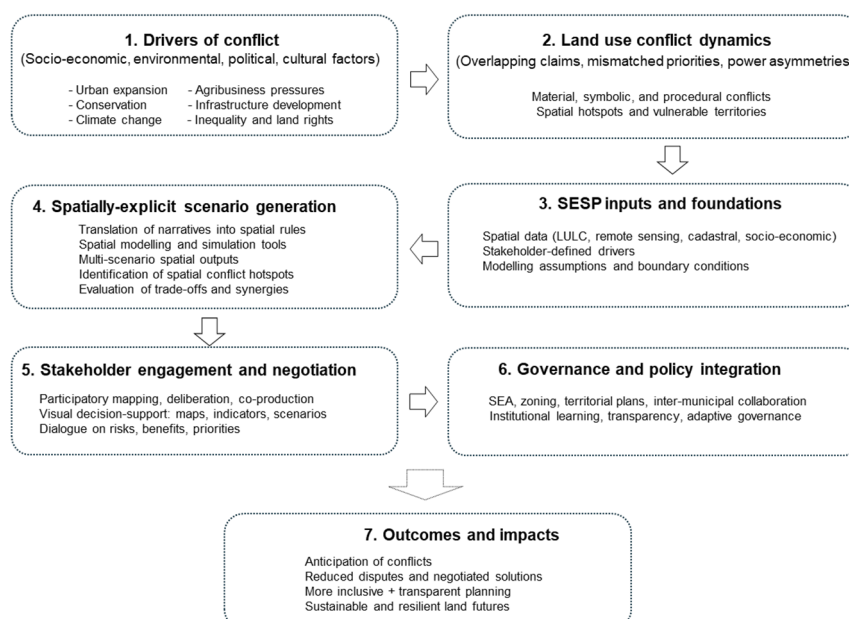
Scenario planning is a structured method for exploring multiple plausible futures, especially useful in contexts marked by uncertainty and complexity [41,42]. Originally developed for military and corporate strategic planning, this approach has increasingly found relevance in environmental governance, spatial planning, and sustainability science [43,44]. At its core, scenario planning helps actors move beyond linear projections and instead consider a range of alternative trajectories based on varying assumptions, drivers, and decisions [45]. However, traditional scenario planning often remains abstract, dominated by qualitative narratives and generalised visions [41,46]. While these narratives are important for framing uncertainties and stimulating strategic thinking, they frequently lack spatial specificity. This absence of geographical detail can make scenarios less actionable in territorial governance processes, where land use decisions require concrete, place-based information. Without a spatial dimension, it becomes difficult to identify where change is likely to occur, which stakeholders will be affected, or how trade-offs between land uses might materialise in specific locations [47,48]. SESP addresses this limitation by integrating scenario thinking with spatial analysis techniques. By leveraging Geographic Information Systems (GIS), remote sensing, land change modelling, and participatory mapping, SESP translates narratives into visual, geographically grounded representations of alternative futures [49,50]. This approach not only enhances the credibility and usability of scenario outputs but also provides a bridge between storytelling and evidence-based territorial planning. Through maps, and spatial simulations stakeholders can visualise the distribution of land use change, identify potential conflict areas, and co-design strategies that are more resilient, inclusive, and context-sensitive [51,52].

SESP is defined by its combination of qualitative foresight methods with quantitative spatial data and modelling [46]. The process typically begins with the identification of key drivers of change, such as shifts in policy, economic trends, demographic dynamics, or climate variability [53,54]. These drivers, often articulated through stakeholder consultations or expert workshops, are used to construct contrasting scenario storylines, such as business-as-usual, sustainable transformation, or high-growth development [55,56]. The novelty of SESP lies in its capacity to transform these storylines into spatial outputs [57,58]. To achieve this, several components are integrated, namely: (i) land use and land cover data, often derived from remote sensing technologies, satellite imagery, or cadastral and administrative land databases, provide the foundational spatial layer within the SESP framework. These datasets represent the current configuration of the landscape in terms of both how land is used (e.g., urban development, agriculture, conservation) and how it is covered (e.g., vegetation, built-up surfaces, water bodies) [59,60]; (ii) stakeholder-defined drivers play a central role in the SESP framework by ensuring that scenario development is socially grounded, locally relevant, and responsive to context-specific priorities and perceptions. These drivers refer to the economic, political, environmental, or cultural forces identified directly by stakeholders, such as local governments, community groups, landowners, NGOs, or planning authorities, as being influential in shaping land use trajectories [61,62]; (iii) spatial modelling tools, such as CLUE-S (Conversion of Land Use and its Effects at Small regional extent), Dinamica EGO, GAMA (GIS Agent-based Modeling Architecture), or CORMAS (COmmon-pool Resources and Multi-Agent Simulations) are integral components of the SESP framework, as they allow for the simulation of land use dynamics under different scenarios. These tools enable the translation of qualitative narratives and stakeholder-defined drivers into quantitative, spatially explicit projections. Each of these models brings specific capabilities, but within the SESP, they are used with a common purpose: to simulate how, where, and under what conditions land use change may occur, given a set of assumptions and boundary conditions [15,61,63]; and (iv) participatory methods are a cornerstone of the SESP framework, ensuring that the modelling process is deeply rooted in local knowledge, values, and priorities. Rather than treating land use change as a purely technical or expert-driven process, SESP emphasizes the importance of co-producing knowledge through inclusive engagement with stakeholders [44,47,61].

Combining these components, SESP generates visual and analytical outputs that are both scientifically robust and socially meaningful. Maps produced under each scenario can reveal hotspots of potential conflict, for example, areas where agricultural expansion may encroach on protected ecosystems, as well as areas of opportunity, such as brownfield sites suitable for urban regeneration [64,65]. Additionally, spatial scenarios can highlight synergies or trade-offs between land use objectives, enabling more informed negotiation between stakeholders [66,67]. Ultimately, SESP empowers planners and communities to move beyond vague preferences or generic development paths. It supports a deeper engagement with spatial consequences, fostering deliberation on whose interests are prioritised, what risks are distributed where, and how different futures might be more or less just, sustainable, or

feasible [68,69]. Rather than treating space as a neutral backdrop, SESP acknowledges the political, ecological, and social dimensions of land use change, making it a critical tool for navigating complex territorial transformations.

SESP plays a vital role in both anticipating and addressing land use conflicts by enhancing foresight, transparency, inclusiveness, and negotiation capacity in territorial decision-making [70,71]. Unlike traditional planning tools that often react to conflicts after they emerge, SESP offers a proactive framework to detect tensions early, make underlying assumptions visible, and promote dialogue among competing interests [72]. First, SESP contributes to anticipation by identifying areas where land use tensions are likely to escalate [73]. Through spatial simulations, planners and stakeholders can visualise where future pressures, such as urban expansion, infrastructure development, or conservation initiatives, may overlap or clash with existing land uses [74,75]. These spatial insights make it possible to flag "conflict hotspots" in advance and consider alternative strategies before tensions become entrenched or irreversible [76]. Second, SESP enhances transparency by making the assumptions, trade-offs, and value judgments behind planning decisions explicit. Scenario maps and spatial models reveal how choices about land use allocation affect different sectors or communities. For example, stakeholders can clearly see how one scenario might prioritise economic development at the expense of ecological integrity, while another may promote conservation but limit housing availability [77]. This openness encourages accountability and supports evidence-based deliberation. Third, the participatory nature of SESP promotes inclusiveness, ensuring that diverse voices are involved in shaping scenarios [78]. By engaging local communities, government actors, developers, farmers, and environmental organisations in the co-production of narratives and spatial outputs, SESP advances mutual understanding and builds legitimacy [79]. Stakeholders not only express their preferences but also learn about the perspectives and constraints of others. This shared learning process helps reduce polarisation and creates conditions for more collaborative planning [42]. Fourth, SESP creates a negotiation space by opening up a range of future alternatives, rather than locking into a single deterministic path. The visualisation of contrasting scenarios allows stakeholders to compare the consequences of different decisions and to identify potential synergies or areas of compromise. This capacity to explore "what if" questions spatially stimulate creative thinking and encourages more flexible, adaptive, and integrative solutions [79,80]. A concrete illustration of these benefits can be found in peri-urban areas, where land use conflicts are often most acute [61]. In such areas, rapid urban growth frequently threatens agricultural livelihoods, natural habitats, and cultural landscapes. Using SESP, planners can simulate different urban expansion trajectories, such as compact growth versus low-density sprawl, and assess their implications for food production, ecosystem services, and access to infrastructure [81,82]. For instance, one scenario might reveal that urban densification could accommodate housing needs without consuming high-value farmland, while another may show how green infrastructure corridors could act as buffers between residential and agricultural areas, reducing land use friction. In this way, SESP helps align urban development with broader sustainability goals, while minimising displacement, fragmentation, and conflict. Despite these trade-offs, SESP does not eliminate land use conflicts, but it equips stakeholders with the tools to understand, negotiate, and navigate them more constructively. Through promoting spatial awareness, dialogue, and shared responsibility, it contributes to more democratic and durable territorial governance [83,84] (Figure 1).

Figure 1. SESP for anticipating and managing land use conflicts.

3. Towards Transformative Land Governance: Policy and Research Pathways

For SESP to realize its full potential as a tool for conflict anticipation, mitigation, and land governance, it must be more than a methodological choice. It needs to be embedded structurally and culturally within the institutions, practices, and mindsets that shape territorial development. This requires targeted interventions at multiple levels, from education and capacity building to governance reform and research collaboration. A first and foundational step is to mainstream SESP in planning education and professional training. Many land use planners, public officials, and community leaders still receive limited exposure to scenario planning methods, let alone spatially explicit ones [85,86]. Embedding SESP modules into university curricula, vocational courses, and continuing education programmes would equip new generations of practitioners with the conceptual understanding and technical competencies needed to apply these tools effectively. Such efforts should emphasize not only software skills, but also ethical considerations, stakeholder facilitation, and the politics of spatial knowledge production [87,88]. Second, governments should incentivize inter-municipal cooperation around scenario planning, particularly in conflict-prone or rapidly changing regions. Land use challenges, such as urban sprawl, ecosystem degradation, or infrastructure development, rarely respect administrative boundaries. Encouraging municipalities to jointly develop and coordinate spatial scenarios can reveal synergies, avoid contradictory policies, and promote integrated governance [89]. Regional planning bodies and metropolitan forums could act as facilitators, providing methodological guidance, data infrastructure, and platforms for dialogue. At the same time, existing policy frameworks often suffer from fragmentation, limited enforcement, or insufficient integration of long-term future thinking. Highlighting these shortcomings, such as the lack of harmonized data systems, inconsistent cross-sector coordination, or the marginalization of local communities in decision-making, helps clarify the institutional barriers that currently hinder effective SESP implementation [90,91]. Third, the wider adoption of SESP, especially in low-resource settings, requires accessible, user-friendly, and open-source tools [92]. Commercial software and data products are often expensive or technically complex. Public investment in open-access platforms for spatial scenario building, coupled with community-based training and documentation in multiple languages, can dramatically lower barriers to entry. Initiatives such as participatory web mapping tools, or simplified land change models hold particular promise for expanding the reach of SESP beyond academic circles [93]. Successful experiences, for example, participatory scenario initiatives in regions facing rapid land transformation or community-led visioning processes embedded in local development plans demonstrate that SESP can generate actionable, socially legitimate outcomes when supported by responsive institutional environments. These examples provide concrete models that help strengthen the policy context of SESP and illustrate the conditions under which it can thrive [94,95]. Fourth, strategic environmental assessments (SEA) and spatial development frameworks should incorporate scenario thinking as a formal requirement. These instruments often guide large-scale investments, zoning plans, and infrastructure decisions, yet are frequently limited to static snapshots of current conditions or linear trend projections. Integrating spatial scenarios into SEA processes allows for more dynamic, forward-looking evaluations of environmental impacts under different policy pathways [96,97]. Likewise, scenario-informed spatial frameworks can make planning more adaptive, responsive, and inclusive of uncertainty and diverse futures. However, many SEAs and planning frameworks continue to underperform due to limited data integration, weak public participation, or overly technocratic procedures. Recognizing these weaknesses while drawing on positive policy examples such as national or regional frameworks that formally embed scenario exploration in land-use decision cycles helps clarify both the gaps and opportunities for institutional reform [98,99].

Finally, embedding SESP in governance also demands a transdisciplinary research agenda. The challenges of land use conflict and future uncertainty cannot be addressed through technical modelling alone. Integrating insights from social sciences, environmental justice, conflict studies, and participatory design is essential to ensure that scenario processes are not only technically robust but also socially grounded [71,100]. Bridging disciplines such as geoinformatics, urban studies, ecology, and public administration enables richer understandings of spatial conflict dynamics and more responsive planning practices. Funding bodies and research institutions should support collaborative projects that explicitly link these fields and involve both academic and non-academic stakeholders. Therefore, institutionalizing SESP as a routine component of land governance requires aligned efforts across education, policy, practice, and research. When these dimensions are addressed in concert, SESP can move from a project-based innovation to a structural pillar of just and forward-looking territorial planning [101–103].

The increasing volatility of land systems, driven by climate change, economic uncertainty, demographic shifts, and political instability, demands a fundamental rethinking of how we plan, govern, and inhabit land. In this context, SESP emerges not only as a technical innovation, but as a powerful framework for reimagining the very purpose and process of land use planning [104,105]. SESP encourages a paradigmatic shift in planning logic: from

a paradigm of control to one of co-creation; from linear prediction to reflexive anticipation; and from top-down technocratic models to more deliberative, participatory, and adaptive approaches [106,107]. It resonates with broader calls for planning systems that are more inclusive, future-oriented, and responsive to complexity. By visualizing multiple plausible futures in concrete spatial terms, SESP helps planners and communities move beyond reactive decision-making and toward proactive engagement with uncertainty and transformation [108]. Crucially, this shift is not merely methodological. It is deeply political and normative. At its core, SESP challenges narrow conceptions of land as a passive resource or mere commodity. Instead, it invites us to see land as a living space imbued with meaning, contested values, and overlapping rights. Practicing SESP with integrity means confronting power asymmetries, redistributing voice in decision-making processes, and recognizing the legitimacy of diverse knowledge systems, from scientific to experiential. Beyond methodological perspectives, SESP also encourages the adoption of multifunctional land-use practices, such as agroforestry systems or integrated crop–livestock systems, which can actively contribute to mitigating land-use conflicts while enhancing ecological, social, and economic benefits. In this sense, SESP is more than a toolbox for future planning. It is a mode of engagement, a way of collectively imagining, negotiating, and shaping shared futures through space [57,109]. It calls for institutions that are open to experimentation, for planners who are facilitators rather than gatekeepers, and for processes that honor both data and dialogue. As land use conflicts grow more complex and urgent, SESP provides not only a method, but one that is grounded in collaboration, oriented toward justice, and animated by the possibility of more sustainable territorial futures [18,110,111].

4. Limitations and Challenges

While SESP holds significant promise for navigating complex land use conflicts and planning for uncertain futures, it is important to recognize that it is not a panacea. Like any planning approach, SESP operates within political, institutional, and technical constraints that may limit its effectiveness or even generate unintended consequences [112,113]. Scenario-based analysis may also shift rather than eliminate land-use conflicts, particularly when interventions displace pressures to other regions or sectors.

One of the most persistent challenges lies in the limited availability of high-quality, up-to-date spatial data. Although satellite imagery is increasingly accessible, it often lacks the level of classification required for meaningful local planning [114]. Similarly, cadastral or socio-economic datasets are frequently incomplete, outdated, or fragmented across agencies. Such data gaps constrain the development of credible, evidence-based scenarios and risk skewing planning outcomes toward sectors or territories that are better documented [115,116]. Moreover, the incomplete understanding of international supply chains and trade-related spillovers adds another layer of complexity, underscoring the need for more integrated and interoperable datasets.

Another major limitation concerns the technical demands of SESP. Sophisticated spatial modelling tools, or even basic GIS operations require skills and software access that are not always available within local governments, especially in smaller municipalities or under-resourced institutions [117]. This creates a reliance on external consultants or academic partners, which, while sometimes necessary, can reduce local ownership of the process and limit long-term sustainability. In some cases, technical complexity can even obscure the planning process from non-experts, reducing transparency and stakeholder engagement. Moreover, SESP does not inherently overcome power asymmetries in territorial governance. Even when participatory methods are employed, decision-making can remain dominated by some actors, such as developers, landowners, or politically connected stakeholders, while marginalised groups, including low-income residents, or informal land users, may be excluded. Without explicit attention to who is included, whose knowledge counts, and who ultimately benefits from scenario outcomes, SESP risks reproducing existing inequalities under the guise of inclusive planning [70,118]. A more subtle but no less important risk is what has been termed "scenario fatigue". In many settings, stakeholders have participated in multiple rounds of planning workshops, visioning exercises, or consultative processes, often with little tangible follow-up or policy impact. When scenario planning becomes a routine exercise without clear links to implementation or political commitment, it can foster frustration, disengagement, and scepticism [119]. This is particularly problematic when SESP is framed as a tool for empowerment but fails to produce meaningful change. Addressing these limitations requires a multi-pronged approach. Capacity building must be seen not as a one-off training event but as a continuous process of strengthening local technical expertise, analytical literacy, and critical engagement with spatial tools. This includes investing in staff, infrastructure, and collaborative networks between local governments, universities, and civil society [62]. Simultaneously, there is a need for data democratization: ensuring that key spatial and socio-economic datasets are made publicly available, interoperable, and usable by non-experts. Open data platforms, transparent metadata standards, and citizen-generated data can all contribute to this goal. Equally important is the institutional embedding of scenario planning. For SESP to move beyond isolated

projects, it must be integrated into the formal planning cycle, budget allocations, and legal frameworks. This means aligning scenario outputs with regulatory instruments such as municipal master plans, environmental licensing, or land use zoning [120,121]. It also requires political will and long-term funding to ensure continuity across electoral cycles and administrative changes. Ultimately, recognising the limitations of SESP is not a reason to abandon it, but rather a call to strengthen the conditions under which it can fulfil its transformative potential. When grounded in robust data, driven by inclusive processes, and supported by sustained institutional commitment, SESP can serve as a powerful mechanism for anticipating conflicts, negotiating alternatives, and shaping more just territorial futures [122,123].

5. Conclusions

Land use conflicts are an intrinsic feature of contemporary societies. In a world marked by finite resources, overlapping claims, and competing visions of development, such conflicts are not only inevitable, but they are also a reflection of pluralism, diversity, and change. However, inevitability does not imply ungovernability. These conflicts, while complex, are not beyond management or resolution. What they demand is a planning ethos that moves beyond rigid zoning or reactive regulation and toward a more nuanced, forward-looking, and participatory form of governance. SESP offers such a framework. SESP links spatial analysis with participatory foresight to provide planners, stakeholders, and communities with the tools to anticipate where and how land use tensions might arise, understand the interests and values involved, and collaboratively design practical and balanced pathways. Its strength lies not only in visualizing what the future might look like, but also in structuring the dialogue, deliberation, and negotiation required to shape that future collectively. In an era where land systems are increasingly shaped by global forces, climate instability, market volatility, migration, technological disruption, traditional planning instruments are proving insufficient. The challenges are too complex, the uncertainties too profound, and the stakes too high to rely solely on incremental or siloed approaches. We need tools that bridge knowledge domains, facilitate cross-sector dialogue, and center inclusive spatial governanc as a core planning principle. SESP is not a universal solution, but it is a crucial part of the response. It enables a more grounded and transparent understanding of territorial dynamics, highlights potential points of convergence and conflict, and supports the formulation of integrated strategies that reflect diverse perspectives and long-term visions. As land systems become more contested and fragile, the demand for such integrative and anticipatory approaches has never been more critical. For researchers, planners, and policymakers embracing SESP should no longer be seen as an added benefit reserved for academia or experimental labs. It must become a normative and operational pillar of territorial governance. Investing in the capacities, technologies, and institutional frameworks that make SESP possible is not only desirable but is also essential for ensuring that land use planning contributes meaningfully to a more sustainable future.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

This study did not generate or analyze new datasets. All information used is based on previously published sources or methodological development; therefore, no datasets are available for sharing.

Conflicts of Interest

The authors declare no conflict of interest.

Use of AI and AI-Assisted Technologies

No AI tools were utilized for this paper.

References

1. Qin, S.; Wang, C.; Yan, Y. Identification of Conflict and Its Evolution between Land Use and Land Suitability during Urban Expansion: A Case of Guangzhou, China. *Ecol. Front.* **2024**, *44*, 1306–1319. https://doi.org/10.1016/j.ecofro.2024.08.006.

2. Froese, R.; Schilling, J. The Nexus of Climate Change, Land Use, and Conflicts. *Curr. Clim. Chang. Rep.* **2019**, *5*, 24–35. https://doi.org/10.1007/s40641-019-00122-1.

3. Mijailoff, J.D.; Giessen, L.; Burns, S.L. Local to Global Escalation of Land Use Conflicts: Long-Term Dynamics on Social Movements Protests against Pulp Mills and Plantation Forests in Argentina and Uruguay. *Land Use Policy* **2023**, *134*, 106884. https://doi.org/10.1016/j.landusepol.2023.106884.

4. Meyfroidt, P.; De Bremond, A.; Ryan, C.M.; et al. Ten Facts about Land Systems for Sustainability. *Proc. Natl. Acad. Sci. USA* **2022**, *119*, e2109217118. https://doi.org/10.1073/pnas.2109217118.

5. Wang, C.; Wu, J.; Li, M.; et al. Evaluation of Spatial Conflicts of Land Use and Its Driving Factors in Arid and Semiarid Regions: A Case Study of Xinjiang, China. *Ecol. Indic.* **2024**, *166*, 112483. https://doi.org/10.1016/j.ecolind.2024.112483.

6. Cegielska, K.; Różycka-Czas, R.; Gorzelany, J.; et al. Land Use and Land Cover Conflict Risk Assessment Model: Social and Spatial Impact of Suburbanisation. *Landsc. Urban Plan.* **2025**, *257*, 105302. https://doi.org/10.1016/j.landurbplan.2025.105302.

7. Curtis, P.G.; Slay, C.M.; Harris, N.L.; et al. Classifying Drivers of Global Forest Loss. *Science* **2018**, *361*, 1108–1111. https://doi.org/10.1126/science.aau3445.

8. Ahani, S.; Dadashpoor, H. Land Conflict Management Measures in Peri-Urban Areas: A Meta-Synthesis Review. *J. Environ. Plan. Manag.* **2021**, *64*, 1909–1939. https://doi.org/10.1080/09640568.2020.1852916.

9. Abrantes, P.; Fontes, I.; Gomes, E.; et al. Compliance of Land Cover Changes with Municipal Land Use Planning: Evidence from the Lisbon Metropolitan Region (1990–2007). *Land Use Policy* **2016**, *51*, 15–26. https://doi.org/10.1016/j.landusepol.2015.10.023.

10. García-Martín, M.; Quintas-Soriano, C.; Torralba, M.; et al. Landscape Change in Europe. In *Sustainable Land Management in a European Context*; Weith, T., Barkmann, T., Gaasch, N., et al., Eds.; Springer International Publishing: Cham, Switzerland, 2021; pp. 17–37. https://doi.org/10.1007/978-3-030-50841-8_2.

11. Ramirez, J.; Böhm, S. Transactional Colonialism in Wind Energy Investments: Energy Injustices against Vulnerable People in the Isthmus of Tehuantepec. *Energy Res. Soc. Sci.* **2021**, *78*, 102135. https://doi.org/10.1016/j.erss.2021.102135.

12. Dunlap, A.; Arce, M.C. 'Murderous Energy' in Oaxaca, Mexico: Wind Factories, Territorial Struggle and Social Warfare. *J. Peasant Stud.* **2022**, *49*, 455–480. https://doi.org/10.1080/03066150.2020.1862090.

13. Morgado, P.; Gomes, E.; Costa, N. Competing Visions? Simulating Alternative Coastal Futures Using a GIS-ANN Web Application. *Ocean Coast. Manag.* **2014**, *101*, 73–83. https://doi.org/10.1016/j.ocecoaman.2014.09.022.

14. Gomes, E.; da Costa, E.M.; Abrantes, P. *Spatial Planning and Land-Use Management*; MDPI: Basel, Switzerland, 2024. https://doi.org/10.3390/books978-3-7258-0139-8.

15. Gomes, E.; Inácio, M.; Bogdzevič, K.; et al. Future Scenarios Impact on Land Use Change and Habitat Quality in Lithuania. *Environ. Res.* **2021**, *197*, 111101. https://doi.org/10.1016/j.envres.2021.111101.

16. Gregory, A.J.; Atkins, J.P.; Midgley, G.; et al. Stakeholder Identification and Engagement in Problem Structuring Interventions. *Eur. J. Oper. Res.* **2020**, *283*, 321–340. https://doi.org/10.1016/j.ejor.2019.10.044.

17. Dick-Sagoe, C.; Lee, K.Y.; Odoom, D.; et al. Stakeholder Perceptions on Causes and Effects of Public Project Failures in Ghana. *Humanit. Soc. Sci. Commun.* **2023**, *10*, 1–9. https://doi.org/10.1057/s41599-022-01497-7.

18. Acosta, L.; Klein, R.J.T.; Reidsma, P.; et al. A Spatially Explicit Scenario-Driven Model of Adaptive Capacity to Global Change in Europe. *Glob. Environ. Chang.* **2013**, *23*, 1211–1224. https://doi.org/10.1016/j.gloenvcha.2013.03.008.

19. Duguma, D.W.; Schultner, J.; Abson, D.J.; et al. From Stories to Maps: Translating Participatory Scenario Narratives into Spatially Explicit Information. *Ecol. Soc.* **2021**, *27*, art13. https://doi.org/10.5751/ES-13200-270213.

Gomes

Earth Environ. Sustain. **2026**, *2*(1), 16–28

20. Gomes, E.; Banos, A.; Abrantes, P.; et al. Chapter 2—Future Land Use/Cover Changes and Participatory Planning. In *Mapping and Forecasting Land Use*; Pereira, P., Gomes, E., Rocha, J., Eds.; Elsevier: Amsterdam, The Netherlands, 2022; pp. 29–53. https://doi.org/10.1016/B978-0-323-90947-1.00001-6.

21. Hilson, G. An Overview of Land Use Conflicts in Mining Communities. *Land Use Policy* **2002**, *19*, 65–73. https://doi.org/10.1016/S0264-8377(01)00043-6.

22. Abouelmagd, D.; Elrawy, S. Cultural Heritage and Sustainable Urban Development: The Case of Port Said city in Egypt. *Cogent Soc. Sci.* **2022**, *8*, 2088460. https://doi.org/10.1080/23311886.2022.2088460.

23. Reed, J.; Ros-Tonen, M.A.F.; Adeyanju, S.; et al. From Conflict to Collaboration through Inclusive Landscape Governance: Evidence from a Contested Landscape in Ghana. *Glob. Environ. Chang.* **2024**, *88*, 102909. https://doi.org/10.1016/j.gloenvcha.2024.102909.

24. Antwi, S.H.; Stephens, C.G.; Rolston, A.; et al. Public Participation in Environmental Decision-Making: A Water Sector Perspective. *Environ. Sustain. Indic.* **2025**, *26*, 100656. https://doi.org/10.1016/j.indic.2025.100656.

25. Magsi, H.; Sabir, M.; Torre, A.; et al. Management Practices to Minimize Land Use Conflicts on Large Infrastructure Projects: Examples of Dams Construction in Pakistan. *GeoJournal* **2022**, *87*, 4851–4861. https://doi.org/10.1007/s10708-021-10532-0.

26. Ma, J.; Tian, L.; Zhang, Y.; et al. Global Property Rights and Land Use Efficiency. *Nat. Commun.* **2024**, *15*, 8525. https://doi.org/10.1038/s41467-024-52859-5.

27. Milczarek-Andrzejewska, D.; Zawalińska, K.; Czarnecki, A. Land-Use Conflicts and the Common Agricultural Policy: Evidence from Poland. *Land Use Policy* **2018**, *73*, 423–433. https://doi.org/10.1016/j.landusepol.2018.02.016.

28. Bekele, A.E.; Drabik, D.; Dries, L.; et al. Large-Scale Land Investments and Land-Use Conflicts in the Agro-Pastoral Areas of Ethiopia. *Land Use Policy* **2022**, *119*, 106166. https://doi.org/10.1016/j.landusepol.2022.106166.

29. Bontempi, A.; Venturi, P.; Del Bene, D.; et al. Conflict and Conservation: On the Role of Protected Areas for Environmental Justice. *Glob. Environ. Chang.* **2023**, *82*, 102740. https://doi.org/10.1016/j.gloenvcha.2023.102740.

30. Bousfield, C.G.; Morton, O.; Edwards, D.P. Climate Change Will Exacerbate Land Conflict between Agriculture and Timber Production. *Nat. Clim. Chang.* **2024**, *14*, 1071–1077. https://doi.org/10.1038/s41558-024-02113-z.

31. Kennedy, C.M.; Fariss, B.; Oakleaf, J.R.; et al. Indigenous Peoples' Lands are Threatened by Industrial Development; Conversion Risk Assessment Reveals Need to Support Indigenous Stewardship. *One Earth* **2023**, *6*, 1032–1049. https://doi.org/10.1016/j.oneear.2023.07.006.

32. Krumins, J.; Klavins, M. Scenario-Based Modeling of Land-Use and Land-Cover Changes to Promote Sustainability in Biosphere Reserves: A Case Study from North Vidzeme, Latvia. *Front. Remote Sens.* **2025**, *6*, 1567002. https://doi.org/10.3389/frsen.2025.1567002.

33. Wu, B.; Wang, S.; Zou, Y.; et al. Multi-Scenario Simulation of Land Use Spatial Conflicts: A Spatially Explicit Model Integrating Conflict Risk and Ecological Impact. *Environ. Dev. Sustain.* **2025**. https://doi.org/10.1007/s10668-025-06329-7.

34. Lacher, I.; Fergus, C.; McShea, W.J.; et al. Modeling Alternative Future Scenarios for Direct Application in Land Use and Conservation Planning. *Conserv. Sci. Pract.* **2023**, *5*, e12940. https://doi.org/10.1111/csp2.12940.

35. Henríquez, C.; Morales, M.; Qüense, J.; et al. Future Land Use Conflicts: Comparing Spatial Scenarios for Urban-Regional Planning. *Environ. Plan. B Urban Anal. City Sci.* **2023**, *50*, 332–349. https://doi.org/10.1177/23998083221111404.

36. Oliveira, E.; Meyfroidt, P. Strategic Spatial Planning in Emerging Land-Use Frontiers: Evidence from Mozambique. *Ecol. Soc.* **2022**, *27*, art5. https://doi.org/10.5751/ES-13001-270205.

37. D'Alberto, R.; Zavalloni, M.; Pagliacci, F. The Environmental and Socioeconomic Impacts of the Italian National Parks: Time and Spillover Effects across Different Geographical Contexts. *Glob. Environ. Chang.* **2024**, *86*, 102838. https://doi.org/10.1016/j.gloenvcha.2024.102838.

38. de Assis Barros, L.; Venter, M.; Ramírez-Delgado, J.P.; et al. No Evidence of Local Deforestation Leakage from Protected Areas Establishment in Brazil's Amazon and Atlantic Forest. *Biol. Conserv.* **2022**, *273*, 109695. https://doi.org/10.1016/j.biocon.2022.109695.

39. Lambin, E.F.; Furumo, P.R. Deforestation-Free Commodity Supply Chains: Myth or Reality? *Annu. Rev. Environ. Resour.* **2023**, *48*, 237–261. https://doi.org/10.1146/annurev-environ-112321-121436.

40. da Silva, R.F.B.; Moran, E.F.; Millington, J.D.A.; et al. Complex Relationships between Soybean Trade Destination and Tropical Deforestation. *Sci. Rep.* **2023**, *13*, 11254. https://doi.org/10.1038/s41598-023-38405-1.

41. Cordova-Pozo, K.; Rouwette, E.A.J.A. Types of Scenario Planning and Their Effectiveness: A Review of Reviews. *Futures* **2023**, *149*, 103153. https://doi.org/10.1016/j.futures.2023.103153.

42. Abou Jaoude, G.; Mumm, O.; Carlow, V.M. An Overview of Scenario Approaches: A Guide for Urban Design and Planning. *J. Plan. Lit.* **2022**, *37*, 467–487. https://doi.org/10.1177/08854122221083546.

43. Schwarz, J.O.; Ram, C.; Rohrbeck, R. Combining Scenario Planning and Business Wargaming to Better Anticipate Future Competitive Dynamics. *Futures* **2019**, *105*, 133–142. https://doi.org/10.1016/j.futures.2018.10.001.

Gomes

Earth Environ. Sustain. **2026**, *2*(1), 16–28

44. Galang, E.I.N.E.; Bennett, E.M.; Hickey, G.M.; et al. Participatory Scenario Planning: A Social Learning Approach to Build Systems Thinking and Trust for Sustainable Environmental Governance. *Environ. Sci. Policy* **2025**, *164*, 103997. https://doi.org/10.1016/j.envsci.2025.103997.

45. Hao, H.; Wang, Y.; Chen, J. Empowering Scenario Planning with Artificial Intelligence: A Perspective on Building Smart and Resilient Cities. *Engineering* **2024**, *43*, 272–283. https://doi.org/10.1016/j.eng.2024.06.012.

46. Symstad, A.J.; Fisichelli, N.A.; Miller, B.W.; et al. Multiple Methods for Multiple Futures: Integrating Qualitative Scenario Planning and Quantitative Simulation Modeling for Natural Resource Decision Making. *Clim. Risk Manag.* **2017**, *17*, 78–91. https://doi.org/10.1016/j.crm.2017.07.002.

47. Ariza-Álvarez, A.; Soria-Lara, J.A. Participatory Mapping in Exploratory Scenario Planning: Necessity or Luxury? *Futures* **2024**, *160*, 103398. https://doi.org/10.1016/j.futures.2024.103398.

48. Weck, S.; Ali, M.; Schmitt, P. Place-Based Development and Spatial Justice. *Eur. Plan. Stud.* **2022**, *30*, 791–806. https://doi.org/10.1080/09654313.2021.1928038.

49. Hessel, R. et al. Linking Participatory and GIS-Based Land Use Planning Methods: A Case Study from Burkina Faso. *Land Use Policy* **2009**, *26*, 1162–1172. https://doi.org/10.1016/j.landusepol.2009.02.008.

50. Pereira, P.; Gomes, E.; Rocha, J. Preface. In *Mapping and Forecasting Land Use*; Pereira, P., Gomes, E., Rocha, J., Eds.; Elsevier: Amsterdam, The Netherlands, 2022; pp. xvii–xviii. https://doi.org/10.1016/B978-0-323-90947-1.00023-5.

51. Brown, G.; Raymond, C.M. Methods for Identifying Land Use Conflict Potential Using Participatory Mapping. *Landsc. Urban Plan.* **2014**, *122*, 196–208. https://doi.org/10.1016/j.landurbplan.2013.11.007.

52. Wang, D.; Wang, M.; Zheng, W.; et al. A Multi-Level Spatial Assessment Framework for Identifying Land Use Conflict Zones. *Land Use Policy* **2025**, *148*, 107382. https://doi.org/10.1016/j.landusepol.2024.107382.

53. Star, J. et al. Supporting Adaptation Decisions through Scenario Planning: Enabling the Effective Use of Multiple Methods. *Clim. Risk Manag.* **2016**, *13*, 88–94. https://doi.org/10.1016/j.crm.2016.08.001.

54. Waldick, R.; Bizikova, L.; White, D.; et al. An Integrated Decision-Support Process for Adaptation Planning: Climate Change as Impetus for Scenario Planning in an Agricultural Region of Canada. *Reg. Environ. Chang.* **2017**, *17*, 187–200. https://doi.org/10.1007/s10113-016-0992-5.

55. Nygrén, N.A. Scenario Workshops as a Tool for Participatory Planning in a Case of Lake Management. *Futures* **2019**, *107*, 29–44. https://doi.org/10.1016/j.futures.2018.10.004.

56. Van Wynsberghe, R.; Moore, J.; Tansey, J.; et al. Towards Community Engagement: Six Steps to Expert Learning for Future Scenario Development. *Futures* **2003**, *35*, 203–219. https://doi.org/10.1016/S0016-3287(02)00054-X.

57. Rigo, R.; Martin, P.; Verburg, P.H.; et al. Contributions of Local LUCC Spatially Explicit Scenarios for Water Management: Lessons Learned from an Ex-Post Evaluation. *Futures* **2022**, *139*, 102937. https://doi.org/10.1016/j.futures.2022.102937.

58. Karner, K.; Cord, A.F.; Hagemann, N.; et al. Developing Stakeholder-Driven Scenarios on Land Sharing and Land Sparing—Insights from Five European Case Studies. *J. Environ. Manag.* **2019**, *241*, 488–500. https://doi.org/10.1016/j.jenvman.2019.03.050.

59. Hersperger, A.M.; Oliveira, E.; Pagliarin, S.; et al. Urban Land-Use Change: The Role of Strategic Spatial Planning. *Glob. Environ. Chang.* **2018**, *51*, 32–42. https://doi.org/10.1016/j.gloenvcha.2018.05.001.

60. Lü, G.; Michael, B.; Josef, S.; et al. Reflections and Speculations on the Progress in Geographic Information Systems (GIS): A Geographic Perspective. *Int. J. Geogr. Inf. Sci.* **2019**, *33*, 346–367. https://doi.org/10.1080/13658816.2018.1533136.

61. Gomes, E.; Banos, A.; Abrantes, P.; et al. Future Land Use Changes in a Peri-Urban Context: Local Stakeholder Views. *Sci. Total Environ.* **2020**, *718*, 137381. https://doi.org/10.1016/j.scitotenv.2020.137381.

62. Bonnevie, I.M.; Hansen, H.S.; Schrøder, L.; et al. Engaging Stakeholders in Marine Spatial Planning for Collaborative Scoring of Conflicts and Synergies within a Spatial Tool Environment. *Ocean Coast. Manag.* **2023**, *233*, 106449. https://doi.org/10.1016/j.ocecoaman.2022.106449.

63. Verburg, P.H.; Soepboer, W.; Veldkamp, A.; et al. Modeling the Spatial Dynamics of Regional Land Use: The CLUE-S Model. *Environ. Manag.* **2002**, *30*, 391–405. https://doi.org/10.1007/s00267-002-2630-x.

64. Zhao, J.; Cao, Y.; Yu, L.; et al. Future Global Conflict Risk Hotspots between Biodiversity Conservation and Food Security: 10 Countries and 7 Biodiversity Hotspots. *Glob. Ecol. Conserv.* **2022**, *34*, e02036. https://doi.org/10.1016/j.gecco.2022.e02036.

65. Neugarten, R.A.; Chaplin-Kramer, R.; Sharp, R.P.; et al. Mapping the Planet's Critical Areas for Biodiversity and Nature's Contributions to People. *Nat. Commun.* **2024**, *15*, 261. https://doi.org/10.1038/s41467-023-43832-9.

66. de Jong, J.; Spaans, M. Trade-Offs at a Regional Level in Spatial Planning: Two Case Studies as a Source of Inspiration. *Land Use Policy* **2009**, *26*, 368–379. https://doi.org/10.1016/j.landusepol.2008.04.005.

67. Carvalho Ribeiro, S.; Fereira, E.; Paula, L.G.; et al. What Can Be Learned from Using Participatory Landscape Scenarios in Rio Doce State Park, Brazil? *Landsc. Ecol.* **2024**, *39*, 65. https://doi.org/10.1007/s10980-024-01860-w.

68. Davret, J.; Trouillet, B. How Do Stakeholders Engage with Critical Cartography in Planning? Analysis of a Decision-Making Process in Marine Governance. *Environ. Sci. Policy* **2025**, *169*, 104083. https://doi.org/10.1016/j.envsci.2025.104083.

Gomes

Earth Environ. Sustain. **2026**, *2*(1), 16–28

69. Wang, A.; Zheng, W.; Tan, Z.; et al. Synergies and Trade-Offs in Achieving Sustainable Targets of Urban Renewal: A Decision-Making Support Framework. *Environ. Plan. B Urban Anal. City Sci.* **2024**, *52*, 490–508. https://doi.org/10.1177/23 998083241261750.

70. Marondedze, A.K.; Mutanga, O.; Cho, M.A. Promoting Inclusion in Urban Land Use Planning Using Participatory Geographic Information System (PGIS) Techniques: A Systematic Review. *J. Environ. Manag.* **2024**, *370*, 123099. https://doi.org/10.1016/j.jenvman.2024.123099.

71. Asante-Yeboah, E.; Koo, H.; Ros-Tonen, M.A.F.; et al. Participatory and Spatially Explicit Assessment to Envision the Future of Land-Use/Land-Cover Change Scenarios on Selected Ecosystem Services in Southwestern Ghana. *Environ. Manag.* **2024**, *74*, 94–113. https://doi.org/10.1007/s00267-024-01943-z.

72. Lingua, V.; Caruso, E. Futures Literacy as a Reading Key for Strategic Spatial Planning: A Community Learning Process for Defining Shared Futures in the Ombrone River Agreement. *Futures* **2022**, *140*, 102935. https://doi.org/10.1016/j.futures.2022.102935.

73. Cieślak, I. Identification of Areas Exposed to Land Use Conflict with the Use of Multiple-Criteria Decision-Making Methods. *Land Use Policy* **2019**, *89*, 104225. https://doi.org/10.1016/j.landusepol.2019.104225.

74. Tress, B.; Tress, G. Scenario Visualisation for Participatory Landscape Planning—A Study from Denmark. *Landsc. Urban Plan.* **2003**, *64*, 161–178. https://doi.org/10.1016/S0169-2046(02)00219-0.

75. Galparsoro, I.; Montero, N.; Mandiola, G.; et al. Assessment Tool Addresses Implementation Challenges of Ecosystem-Based Management Principles in Marine Spatial Planning Processes. *Commun. Earth Environ.* **2025**, *6*, 55. https://doi.org/10.1038/s43247-024-01975-7.

76. Gomes, E.; Costa, E.M.; Abrantes, P. Spatial Planning and Land-Use Management. *Land* **2024**, *13*, 94. https://doi.org/10.3390/land13010094.

77. Lerouge, F.; Gulinck, H.; Vranken, L. Valuing Ecosystem Services to Explore Scenarios for Adaptive Spatial Planning. *Ecol. Indic.* **2017**, *81*, 30–40. https://doi.org/10.1016/j.ecolind.2017.05.018.

78. Bacău, S.; Domingo, D.; Palka, G.; et al. Integrating Strategic Planning Intentions into Land-Change Simulations: Designing and Assessing Scenarios for Bucharest. *Sustain. Cities Soc.* **2022**, *76*, 103446. https://doi.org/10.1016/j.scs.2021.103446.

79. Suchá, L.; Vaňo, S.; Jančovič, M.; et al. Collaborative Scenario Building: Engaging Stakeholders to Unravel Opportunities for Urban Adaptation Planning. *Urban Clim.* **2022**, *45*, 101277. https://doi.org/10.1016/j.uclim.2022.101277.

80. Kariuki, R.W.; Munishi, L.K.; Courtney-Mustaphi, C.J.; et al. Integrating Stakeholders' Perspectives and Spatial Modelling to Develop Scenarios of Future Land Use and Land Cover Change in Northern Tanzania. *PLoS ONE* **2021**, *16*, e0245516. https://doi.org/10.1371/journal.pone.0245516.

81. Andersen, P.D.; Hansen, M.; Selin, C. Stakeholder Inclusion in Scenario Planning—A Review of European Projects. *Technol. Forecast. Soc. Chang.* **2021**, *169*, 120802. https://doi.org/10.1016/j.techfore.2021.120802.

82. Cheng, J.; Richter, A.; Cong, W.F.; et al. Stakeholder Perspectives on Ecosystem Services in Agricultural Landscapes: A Case Study in the North China Plain. *Agric. Syst.* **2025**, *223*, 104187. https://doi.org/10.1016/j.agsy.2024.104187.

83. Vitálišová, K.; Murray-Svidroňová, M.; Jakuš-Muthová, N. Stakeholder Participation in Local Governance as a Key to Local Strategic Development. *Cities* **2021**, *118*, 103363. https://doi.org/10.1016/j.cities.2021.103363.

84. Mussehl, M.L.; Horne, A.C.; Webb, J.A.; et al. Purposeful Stakeholder Engagement for Improved Environmental Flow Outcomes. *Front. Environ. Sci.* **2022**, *9*, 770272. https://doi.org/10.3389/fenvs.2021.770272.

85. Geneletti, D. Environmental Assessment of Spatial Plan Policies through Land Use Scenarios: A Study in a Fast-Developing Town in Rural Mozambique. *Environ. Impact Assess. Rev.* **2012**, *32*, 1–10. https://doi.org/10.1016/j.eiar.2011.01.015.

86. Karimi, A.; Adams, V.M. Planning for the Future: Combining Spatially-Explicit Public Preferences with Tenure Policies to Support Land-Use Planning. *Land Use Policy* **2019**, *82*, 497–508. https://doi.org/10.1016/j.landusepol.2018.12.033.

87. Bouw, E.; Ilya, Z.; de Bruijn, E. Multilevel Design Considerations for Vocational Curricula at the Boundary of School and Work. *J. Curric. Stud.* **2021**, *53*, 765–783. https://doi.org/10.1080/00220272.2021.1899290.

88. Lin, T.J.; Buckley, J.; Gumaelius, L.; et al. The Potential for Spatial Ability Development through the Swedish Technology and Craft Compulsory Curricula. *Int. J. Technol. Des. Educ.* **2025**, *35*, 1409–1427. https://doi.org/10.1007/s10798-024-09958-7.

89. Banaszewska, M.; Bischoff, I.; Bode, E.; et al. Does Inter-Municipal Cooperation Help Improve Local Economic Performance?—Evidence from Poland. *Reg. Sci. Urban Econ.* **2022**, *92*, 103748. https://doi.org/10.1016/j.regsciurbeco.2021.103748.

90. Di Gregorio, M.; Fatorelli, L.; Paavola, J.; et al. Multi-Level Governance and Power in Climate Change Policy Networks. *Glob. Environ. Chang.* **2019**, *54*, 64–77. https://doi.org/10.1016/j.gloenvcha.2018.10.003.

91. Ros-Tonen, M.A.F.; Reed, J.; Sunderland, T. From Synergy to Complexity: The Trend Toward Integrated Value Chain and Landscape Governance. *Environ. Manag.* **2018**, *62*, 1–14. https://doi.org/10.1007/s00267-018-1055-0.

Gomes

Earth Environ. Sustain. **2026**, *2*(1), 16–28

92. Weber, M.; Strijbis, J.; Osner, N.; et al. An Open-Source Method for Spatially and Temporally Explicit Herbivory Monitoring in Semi-Arid Savannas. *J. Environ. Manag.* **2025**, *377*, 124690. https://doi.org/10.1016/j.jenvman.2025.124690.

93. Boeing, G.; Higgs, C.; Liu, S.; et al. Using Open Data and Open-Source Software to Develop Spatial Indicators of Urban Design and Transport Features for Achieving Healthy and Sustainable Cities. *Lancet Glob. Health* **2022**, *10*, e907–e918. https://doi.org/10.1016/S2214-109X(22)00072-9.

94. López-Rodríguez, M.D.; Oteros-Rozas, E.; Ruiz-Mallén, I.; et al. Visualizing Stakeholders' Willingness for Collective Action in Participatory Scenario Planning. *Ecol. Soc.* **2023**, *28*, art5. https://doi.org/10.5751/ES-14101-280205.

95. Soria-Lara, J.A.; Ariza-Álvarez, A.; Aguilera-Benavente, F.; et al. Participatory Visioning for Building Disruptive Future Scenarios for Transport and Land Use Planning. *J. Transp. Geogr.* **2021**, *90*, 102907. https://doi.org/10.1016/j.jtrangeo.2020.102907.

96. Crispim-Mendes, T.; Marques, A.T.; Valerio, F.; et al. Using Spatially Explicit Individual-Based Models to Prioritize Conservation Strategies: A Case Study on the Little Bustard. *J. Environ. Manag.* **2025**, *379*, 124790. https://doi.org/10.1016/j.jenvman.2025.124790.

97. Pan, H.; Zhang, L.; Cong, C.; et al. A Dynamic and Spatially Explicit Modeling Approach to Identify the Ecosystem Service Implications of Complex Urban Systems Interactions. *Ecol. Indic.* **2019**, *102*, 426–436. https://doi.org/10.1016/j.ecolind.2019.02.059.

98. Muiderman, K.; Zurek, M.; Vervoort, J.; et al. The Anticipatory Governance of Sustainability Transformations: Hybrid Approaches and Dominant Perspectives. *Glob. Environ. Chang.* **2022**, *73*, 102452. https://doi.org/10.1016/j.gloenvcha.2021.102452.

99. Bina, O. A Critical Review of the Dominant Lines of Argumentation on the Need for Strategic Environmental Assessment. *Environ. Impact Assess. Rev.* **2007**, *27*, 585–606. https://doi.org/10.1016/j.eiar.2007.05.003.

100. Wedding, L.M.; Pittman, S.J.; Lepczyk, C.A.; et al. Integrating the Multiple Perspectives of People and Nature in Place-Based Marine Spatial Planning. *NPJ Ocean Sustain.* **2024**, *3*, 43. https://doi.org/10.1038/s44183-024-00071-9.

101. Palacios-Agundez, I.; Onaindia, M.; Potschin, M.; et al. Relevance for Decision Making of Spatially Explicit, Participatory Scenarios for Ecosystem Services in an Area of a High Current Demand. *Environ. Sci. Policy* **2015**, *54*, 199–209. https://doi.org/10.1016/j.envsci.2015.07.002.

102. Butler, A.; Sinclair, K.A. Place Matters: A Critical Review of Place Inquiry and Spatial Methods in Education Research. *Rev. Res. Educ.* **2020**, *44*, 64–96. https://doi.org/10.3102/0091732X20903303.

103. Koldasbayeva, D.; Tregubova, P.; Gasanov, M.; et al. Challenges in Data-Driven Geospatial Modeling for Environmental Research and Practice. *Nat. Commun.* **2024**, *15*, 10700. https://doi.org/10.1038/s41467-024-55240-8.

104. Ren, Y.; Lü, Y.; Comber, A.; et al. Spatially Explicit Simulation of Land Use/Land Cover Changes: Current Coverage and Future Prospects. *Earth Sci. Rev.* **2019**, *190*, 398–415. https://doi.org/10.1016/j.earscirev.2019.01.001.

105. Forsius, M.; Kujala, H.; Minunno, F.; et al. Developing a Spatially Explicit Modelling and Evaluation Framework for Integrated Carbon Sequestration and Biodiversity Conservation: Application in Southern Finland. *Sci. Total Environ.* **2021**, *775*, 145847. https://doi.org/10.1016/j.scitotenv.2021.145847.

106. Rădulescu, M.A.; Wim, L.; Arts, J. Co-Creation in Spatial Planning: Analysing the Different Forms and Natures of Interactions between Multiple Actors. *Eur. Plan. Stud.* **2025**, 1–22. https://doi.org/10.1080/09654313.2025.2490121.

107. Lazurko, A.; Schweizer, V.; Pintér, L.; et al. Boundaries of the Future: A Framework for Reflexive Scenario Practice in Sustainability Science. *One Earth* **2023**, *6*, 1703–1725. https://doi.org/10.1016/j.oneear.2023.10.023.

108. Kankam, S.; Koo, H.; Inkoom, J.N.; et al. Modeling Coastal Land Use Scenario Impacts on Ecosystem Services Restoration in Southwest Ghana, West Africa. *NPJ Ocean Sustain.* **2025**, *4*, 13. https://doi.org/10.1038/s44183-025-00105-w.

109. Finch, M.; Older, M.; Mahon, M.; et al. Climate Action and the Vantage Point of Imagined Futures: A Scenario-Based Conversation. *NPJ Clim. Action* **2024**, *3*, 45. https://doi.org/10.1038/s44168-024-00123-3.

110. La Rosa, D.; Pappalardo, V. Planning for Spatial Equity—A Performance Based Approach for Sustainable Urban Drainage Systems. *Sustain. Cities Soc.* **2020**, *53*, 101885. https://doi.org/10.1016/j.scs.2019.101885.

111. Pickerill, J.; Chitewere, T.; Cornea, N.; et al. Urban Ecological Futures: Five Eco-Community Strategies for More Sustainable and Equitable Cities. *Int. J. Urban Reg. Res.* **2024**, *48*, 161–176. https://doi.org/10.1111/1468-2427.13209.

112. Volkery, A.; Ribeiro, T. Scenario Planning in Public Policy: Understanding Use, Impacts and the Role of Institutional Context Factors. *Technol. Forecast. Soc. Chang.* **2009**, *76*, 1198–1207. https://doi.org/10.1016/j.techfore.2009.07.009.

113. Aro, K.; Jyrki, A.; Ville, L.; et al. The Use of Scenarios in Climate Policy Planning: An Assessment of Actors' Experiences and Lessons Learned in Finland. *Clim. Policy* **2023**, *23*, 199–211. https://doi.org/10.1080/14693062.2022.2123773.

114. Eilola, S.; Käyhkö, N.; Fagerholm, N. Lessons Learned from Participatory Land Use Planning with High-Resolution Remote Sensing Images in Tanzania: Practitioners' and Participants' Perspectives. *Land Use Policy* **2021**, *109*, 105649. https://doi.org/10.1016/j.landusepol.2021.105649.

Gomes

Earth Environ. Sustain. **2026**, *2*(1), 16–28

115. Zhong, Y.; Yan, B.; Yi, J.; et al. Global Urban High-Resolution Land-Use Mapping: From Benchmarks to Multi-Megacity Applications. *Remote Sens. Environ.* **2023**, *298*, 113758. https://doi.org/10.1016/j.rse.2023.113758.

116. Sabri, S.; Witte, P. Digital Technologies in Urban Planning and Urban Management. *J. Urban Manag.* **2023**, *12*, 1–3. https://doi.org/10.1016/j.jum.2023.02.003.

117. Piniarski, W. Challenges of a GIS-Based Physical-Geographical Regionalization of Poland. *Environ. Monit. Assess.* **2023**, *195*, 1125. https://doi.org/10.1007/s10661-023-11734-4.

118. Duckett, D.G.; McKee, A.J.; Sutherland, L.A.; et al. Scenario Planning as Communicative Action: Lessons from Participatory Exercises Conducted for the Scottish Livestock Industry. *Technol. Forecast. Soc. Chang.* **2017**, *114*, 138–151. https://doi.org/10.1016/j.techfore.2016.07.034.

119. Perez, T.S. Anticipating Workshop Fatigue to Navigate Power Relations in International Transdisciplinary Partnerships: A Climate Change Case Study. *Curr. Sociol.* **2020**, *69*, 1051–1068. https://doi.org/10.1177/0011392120927778.

120. Avin, U.; Robert, G.; Murnen, L. From Exploratory Scenarios to Plans: Bridging the Gap. *Plan. Theory Pract.* **2022**, *23*, 637–646. https://doi.org/10.1080/14649357.2022.2119008.

121. Gomes, E.; Banos, A.; Abrantes, P.; et al. Agricultural Land Fragmentation Analysis in a Peri-Urban Context: From the Past into the Future. *Ecol. Indic.* **2019**, *97*, 380–388. https://doi.org/10.1016/j.ecolind.2018.10.025.

122. Colombi, C.; Zindato, D. Design Scenarios and Anticipation. In *Handbook of Anticipation: Theoretical and Applied Aspects of the Use of Future in Decision Making*; Poli, R., Ed.; Springer International Publishing: Cham, Switzerland, 2019; pp. 821–842. https://doi.org/10.1007/978-3-319-91554-8_52.

123. Kuzdas, C.; Wiek, A. Governance Scenarios for Addressing Water Conflicts and Climate Change Impacts. *Environ. Sci. Policy* **2014**, *42*, 181–196. https://doi.org/10.1016/j.envsci.2014.06.007.