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00552 | Analytical Article

Post-War Reconstruction of Ukraine: Environmental Aspects of State Regulation of Land Relations

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Abstract

A fundamental prerequisite for the survival of human society is sustainability. Due to the cumulative effects of violent conflicts and environmental issues, the topic of sustainable land use (SLM) is becoming increasingly important. Globally, there are many different approaches and definitions of sustainable land use development and management that are based on a range of factors. The majority of definitions emphasize that socioeconomic growth that upholds the values of sustainable land use and honors the region's natural, cultural, historical, and prospective resources is necessary for sustainable development. This article employs bibliographic analysis and case study methodology to synthesize concepts of sustainable land management (SLM) relevant to post-war reconstruction efforts in Ukraine. The study reveals the specific significance and acuteness of land relations issues for postwar reconstruction operations within the sustainability vector, as well as its contribution to attempts to avert social and economic entropy. One important aspect of sustainable land use management is the creation of optimal landscape-ecological solutions for spatial land use planning. It is shown that a conceptual framework for building sustainable land relations in post-war context of Ukraine's reconstruction, should have its foundation in strong institutional support, a participatory approach to planning processes, as well as inclusive, multilevel, and multistakeholder partnerships.

Keywords

Land management; Post-war reconstruction; Social well-being; Sustainability

Introduction

Wars and disasters have a devastating effect on cities and societies, lowering the quality of human life under unstable circumstances. However, they can also offer opportunities to advance sustainable development through strategic reconstruction efforts (Al-Samurai and Al-Qaraghuli, 2021). Today, it is widely acknowledged that sustainable land management is crucial for addressing the root causes of conflict and preventing its recurrence. Failure to prevent and remedy rights in relation to housing, land, and property rights poses risks in escalating grievances, social tensions, and new cycles of violence (Hossain, Atibudhi and Mishra, 2023; Squires and Qi, 2017). The focus of postwar reconstruction efforts is on transformational and long-term investments and not merely on reconstructing what has been destroyed. As per internal work on the Recovery Plan, Ukrainian civil society in Ukraine and other European nations have been advocating for a Green Reconstruction in post-war Ukraine for some months (Subaciene, Krutova, and Nesterenko 2023; Tahmid *et al.,* 2023).

Fundamental changes in the country's social and economic landscape brought on by wartime realities necessitate the development of new conceptual approaches to the implementation of land management. These approaches must take into account the conditions for the transformation of land ownership relations, the requirements for ensuring sustainable development, and modern trends in strengthening the growing role of regional and municipal governance (Khatun, Sazzad and Meghla, 2021; Khrushch *et al.,* 2023; Korobeinykova, 2021; Liubchych *et al*., 2023).

Ukrainian researchers like Pokalchuk, Marachuk and Shulepova (2024) noted that due to the full-scale invasion of Ukraine, the agricultural sector suffered significant losses not only due to serious damage to the soil but also due to massive crop losses caused by military operations. According to estimates by the State Ecological Inspectorate, the first four months of the invasion alone resulted in land-related damages amounting to approximately 80.5 billion hryvnias. Given the ongoing nature of hostilities, this figure continues to rise, indicating the vast and escalating toll on the country's land resources. Furthermore, the environmental recovery, particularly of soils, will be a prolonged process. Depending on natural and climatic conditions, the regeneration of just a single square centimeter of soil may take several decades to several centuries.

It should be noted, however, that land degradation was already a significant challenge for Ukraine before the war. An estimated 10 to 15 million hectares were classified as degraded or low-productive soil organic matter losses reached 20-30%; localized contamination by heavy metals, chemical compounds, and radionuclides has been detected. Additionally, some territories suffered from desertification or waterlogging (Naumchuk, 2024). Therefore, post-war reconstruction programs must integrate environmental considerations into land use and land relations development, drawing not only on current projected data and forecast analysis, but also on retrospective data. The theoretical basis of the study draws on the core principles of sustainable development. This study is grounded in the hypothesis that improving regional land use mechanisms is possible by conceptualizing them as systems of sustainable land use. Such systems encompass a set of economic, environmental, and social relations aimed at the efficient utilization of land resources to support regional growth and sustainable development.

The study aims to outline vectors and constitute conceptual framework for building sustainable land relations in post-war Ukraine.

Theoretical Framework

Definitions discourse

From a linguistic perspective, the term "reconstruction" refers both to the process of rebuilding or remaking cities and communities and to the result - The rebuilt structures and systems following destruction caused by war and/or natural disasters. According to the World Bank's definition of post-war reconstruction, the two primary components for constructing that society are (1) establishing the social and economic foundation necessary for a functional and thriving peacetime society and (2) re-establishing conditions related to governance and the rule of law (Girod, 2015). According to Lamphere's (2015) study, economic growth correlates with reconstruction. In order to facilitate project start-up, it is important to take into account job opportunities and simplify work policies and laws. It is also crucial to strengthen local institutional capacity before reconstruction by organizing administrative structures and governance and establishing anti-corruption measures from the outset.

Sustainability concerns

A study by Ismail and Halog (2017) highlighted the importance of adopting the concepts of sustainability in reconstruction processes to guarantee a resilient, environmentally friendly urban system capable of withstanding future disasters. The study illustrates the importance of integrating environmental, social, and economic sustainability into initial planning, design, construction, and maintenance stages, such as:

- Adopting sustainable planning that considers relationships between people, land uses, geography, material sources, and resource management
- Adoption of a sustainable design based on adaptability to climatic circumstances, cultural needs, and economic factors
- Adoption of sustainable building materials with a focus on waste and land management
- Adoption of sustainable maintenance processes, which include recycling, reuse, and the capacity to continually upgrade.

Sustainable Land Management (SLM) is defined by the UN as the use of land resources, such as soils, water, plants, and animals, to produce goods that adapt to shifting human needs while also maintaining the resources' long-term potential for production and environmental functions (Zhang, Kuang and Yang, 2024). According to TerrAfrica (quoted in Brouwer *et al*., 2008), SLM is the implementation of land-use systems that, when managed properly, allow land users to optimize the land's economic and social advantages while preserving or improving the ecological support functions of the land resources.

The interplay of land resources, climate, and human activity will determine a land-use system's sustainability and productivity. Choosing the appropriate land uses for specific biophysical and socioeconomic conditions and putting SLM into practice are crucial for

minimizing land degradation. Restoring degraded land, guaranteeing the sustainable use of land resources (such as soils, water, and biodiversity), and maximizing resilience, particularly in the face of threats and variability, will support a future that will minimise land degradation caused by war (Zhang, Kuang and Yang, 2024).

Because land is a limited resource, its usage should not jeopardize the capacity for future generations to enjoy and use it. This is the idea behind SLM. Utilizing land resources to promote social well-being, economic expansion, and long-term environmental sustainability is the goal (Babu *et al*., 2020). However, the application of this strategy calls for an all-encompassing perspective that takes into account how various land uses, such as forestry, urbanization, and agriculture, relate to one another as well as how human activity affects the environment.

SLM principles

SLM is based on four principles (Weith *et al*., 2021):

1. Targeted legislative and institutional assistance, including the creation of incentives for SLM adoption and revenue production at the local level;
2. Land-user-driven and participatory approaches;
3. Coordinated utilization of natural resources on farms that considers the health of surrounding ecosystems;
4. Land users, technical specialists, and policymakers all participate in multilevel, multistakeholder collaborations.

The land management paradigm, thus, can be depicted schematically as follows (see Figure 1).

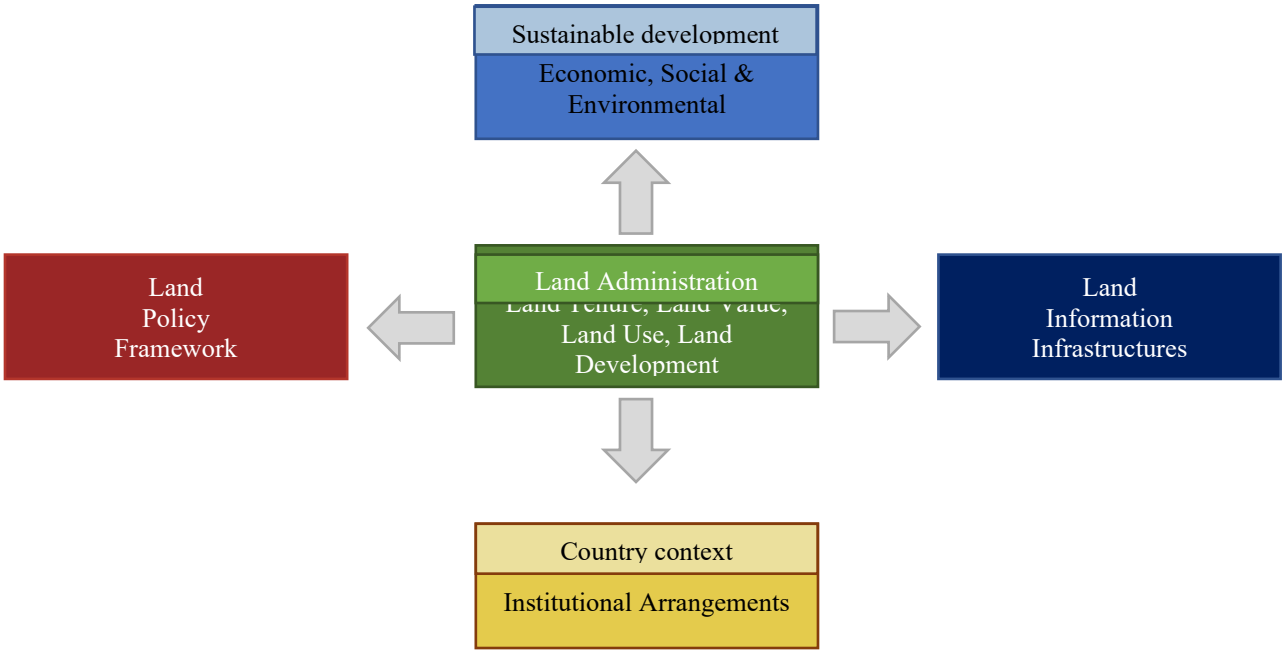

Figure 1: The land management paradigm (Squires and Qi, 2017)

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) defines SLM as land use that meets the needs for nutrition, energy, housing, and recreation, among others, of all humans living on Earth today and in the future while also respecting the boundaries and resilience of the ecological system (IPBES, 2018, p. 668). The goal of a sustainable socio-ecosystem takes into account social and cultural coherence, diversity, growth and justice, territorial cohesion, biodiversity, and efficient resource use (Monteiro, 2019).

Land regulation angle of view

As Carrilho *et al*. (2024) astutely point out, the drive for sustainable development extends beyond land tenure regularization. Co-created knowledge should be mapped, shared, and used in scenario building. Furthermore, land tenure security is critical to achieving the sustainable development aim of reducing poverty, which can be achieved by standardizing rights to land, property, and natural resources (Khrushch, Fedyk and Karpiuk, 2022; Dhanaraju *et al*., 2024). Supporting cities and human settlements to be sustainable necessitates participatory and integrated land use planning that fundamentally considers the land's potential and limitations for medium and long-term usage. Carrilho *et al*. (2024) utilized a mixed documental approach to evaluate 15 participatory community land use plans in Mozambique. It was discovered that the shared terms of reference and guidelines encouraged participation capacity and gave basic directions for community development (Avedyan, Gavkalova and Belyavtseva, 2023). However, appropriate land use planning methods, such as effective engagement in all phases, alternative scenarios for future land use, regional integration, and disaster risk management, received less attention. It is suggested that recommendations must go beyond the urgent demands of land registration.[1] to address how such interventions in rural regions impact the culture of land usage, which in turn influences sustainability in higher-level towns (Hohol and Nedilska, 2021; Pecheniuk *et al.,* 2022).

One of the factors in efficient land management necessitates a policy framework tailored to the country's context and its impact on sustainability. In this context, land administration has four primary functions: providing land tenure security; ensuring that land is used sustainably; planning for and managing land development; and regulating land valuation for individual and social benefit.

Methods and Materials

A systems approach was employed to analyze the socio-economic and environmental challenges of regional development under contemporary conditions. The significance of the study lies in the substantiation of ways to achieve sustainable land use.

The methodology combines bibliometric analysis with elements of grounded theory. In the first stage, a preliminary scoping review of publications relevant to the research field was conducted, followed by a coding and categorization process. The resulting categories informed the final selection of literature sources. The search was carried out

[1] "Land registration is the process of officially documenting and clarifying ownership rights to land, with the aim of reducing disputes" (E. Harvey (2010). *Land Law and Registration of Title: A Comparison of the Old and New Methods of Transferring Land*. Gale.)

across Google Scholar, JSTOR, and ScienceDirect databases. The research process is depicted schematically in figure 2. The keywords used for searching included the following: sustainable land management, land management, post-war reconstruction, land relations regulation, land relations stakeholders. The time frame 2006-2025 (to better trace and comprehend the dynamic of the phenomena under consideration) and the volume of article at least 3 pages were the criteria for inclusion.

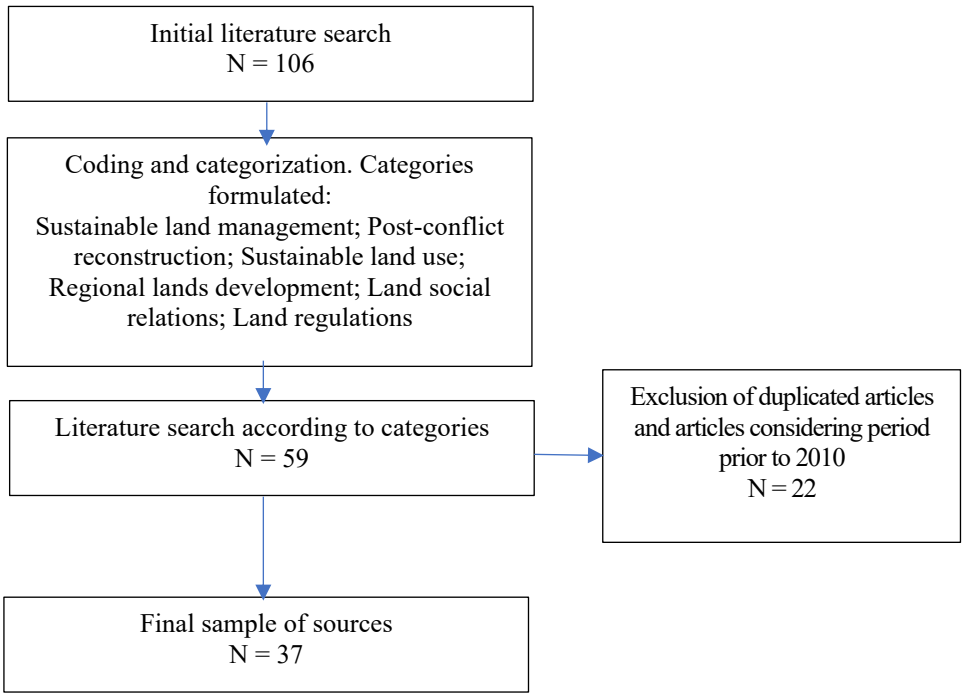

Figure 2: Methodological Framework of the Research Process

Results and Discussion

Armed conflicts' implications for SLM

According to the United Nations, approximately 100 violent conflicts have ended globally. However, post-conflict countries often face more severe economic challenges than peaceful low-income emerging countries. These include land degradation, the destruction of human and social capital, restricted access to livelihood areas due to landmines, income loss, and widespread poverty. Such conditions render land economically unviable, leading to a gradual decline in soil fertility due to nutrient depletion. These distinctions must be considered when defining post-conflict economic policy objectives. If SLM is neglected or insufficiently addressed, land degradation is likely to intensify. Gunawardana, Tantrigoda and Kumara (2018), in their study on integrating SLM into post-conflict economic recovery, highlight critical gaps in restoring livelihoods and economic recovery in a selected post-conflict region in Sri Lanka. They propose a practical and cost-effective approach to fostering long-term resilience. Based on interviews and field observations in Northern Sri Lanka, the study

found that while livelihoods were resuming in areas cleared of landmines following a prolonged ethnic conflict, current land use trends are guided by urgent commercial objectives. As a result, SLM is largely overlooked, contributing to continued land destruction (Robinson, 2024). The report proposes a paradigm for integrating SLM in post-conflict economic recovery.

The role of land relations

According to Ukrainian scholar Vasilieva (2024), the system of state administration of land relations plays a critical role in ensuring the proper use, protection, and distribution of land resources. The primary tools of this governance include legal, economic, administrative, and environmental measures. However, several contentious issues persist within the land management mechanism. These include the need to harmonize land laws with international standards; the choice between centralized and decentralized models of land governance; approaches to land taxation; balancing environmental sustainability with economic efficiency; determining the appropriate degree of centralized oversight versus localized support programs; and ensuring transparency while preventing corruption. Vasilieva (2024) also emphasizes the need to strike an optimal balance between flexible and adaptable localized planning, responsive to specific local conditions, and centralized control that ensures consistent standards (Borodin *et al*., 2023). Key areas for improving the state management mechanism of land relations include reforming the regulatory framework, building institutional infrastructure, optimizing economic tools, enhancing the monitoring and control system, fostering public-private partnerships, and incorporating sustainable development principles.

It is important to recognize that private lands both influence and respond to environmental changes, making them critical to global ecosystem transitions (Capano *et al*., 2019). In landscapes dominated by working lands, land cover outcomes are shaped by the cumulative decisions of numerous independent landowners, each making individual land management choices. Within such systems, private landowners serve as key agents of change. Based on survey responses from over 500 landowners in a landscape predominantly composed of working lands, the authors classified respondents into five distinct groups according to their sense of place, a concept that captures the nature of an individual's relationship with their land, specifically in terms of how the land contributes to their well-being and sustains their livelihood (Borysenko *et al*., 2022). Stronger stewardship-oriented management approaches were shown to be associated with good contributions to well-being; nevertheless, a combination of livelihood dependency and well-being is most strongly associated with heightened sensitivity to ecosystem change. Understanding an individual's connection to their land is crucial for assessing their adaptability and determining effective policy actions in a predominantly private land social-ecological system.

These findings are particularly relevant for Ukraine, where land relations are often characterized by a lack of transparency. Ukrainian researchers Butenko and Kononiuk (2020) have examined the potential for expanding land relations monitoring, focusing on its foundational principles, operational mechanisms, and emerging trends through the use of carefully chosen indicators and scientifically grounded methodologies. However, as Halushka, Bobrovskyi and Kharechko (2024) note, the ability to collect reliable

monitoring data is hindered by conditions in many regions, specifically the vast spatial scale and significant geographical and temporal variability. When properly applied, these technologies enable the collection of data from monitoring activities that can be used to assess both the quantitative and qualitative changes in the condition of land resources, as well as the extent to which these changes are positive. One of the primary challenges is the limited accessibility of information on land relations, which enables authorities and affiliated individuals to exploit land resources for personal gain, often at the expense of local and national public interests.

In their study on the social impacts of SLM, O'Byrne *et al*. (2022) provide a summary of the variables affecting SLM adoption, its effects on wellbeing, and the documented effects of SLM (refer to Figure 3).

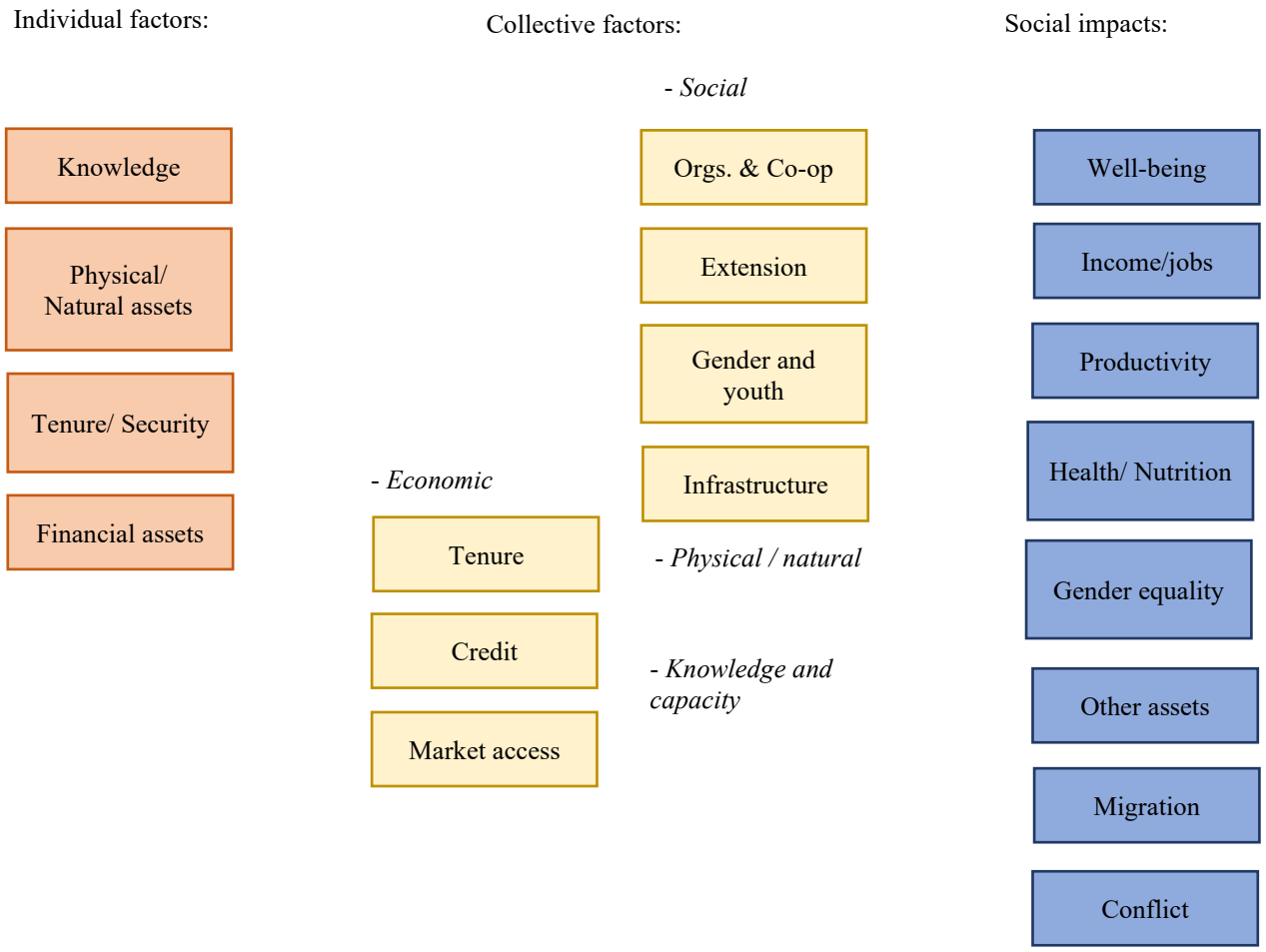

Figure 3: Overview of the factors influencing uptake of SLM and its impacts on well-being and recorded impacts of SLM (O'Byrne, 2022)

Based on a bibliometric review, Liu *et al*. (2023) identify four main research directions within the field: (1) the relationship between rural land use changes and agricultural development; (2) the impacts of land use and land cover changes on biodiversity,

adaptive capacity, and vulnerability in the context of rural sustainable development; (3) land management strategies for promoting rural sustainability; and (4) the emergence of research hotspots in three key areas - namely, the relationship between land management and its impacts, biodiversity conservation and ecosystem services, and the effects of human activity and climate change on rural sustainability. In conclusion, Liu *et al.* (2023) emphasize that future research should focus on rural land management and sustainable diversified agriculture. It is essential to consider the social dimensions of rural sustainability, as well as to underscore the significance of ecosystem services and natural capital in promoting sustainable rural development.

In order to encourage sustainable land use, public administrators must first comprehend the opportunities and challenges that exist within their authority. For example, there needs to be an assessment of the current, as well as anticipated effects on the land and its resources with regard to pollution, population expansion, urbanization, biodiversity loss, climate change, and other variables (Karpa *et al.,* 2023). Requirements, interests, and viewpoints on land use issues could be best determined through interaction with stakeholders, including local governments, communities, corporations, non-governmental organizations, and researchers. The second step would be establishing specific, quantifiable goals that complement the stakeholders' and their jurisdiction's vision and values. The sustainability tenets of equality, efficiency, resilience, and adaptability ought to be reflected in these goals (Koshova, Lytvynova and Kaliuzhna, 2022). Additionally, planning should be time-bound, relevant, quantifiable, feasible, and detailed. As an example, one goal may be to cut land-use-related greenhouse gas emissions by 20% by 2030.

Thirdly, creating and implementing programs and policies that support the goals of SLM and take advantage of the possibilities and challenges is recommended. In addition to taking into account the trade-offs and synergies between environmental, social, and economic consequences, these policies and initiatives have to be grounded in research, best practices, and innovation (Kulikov *et al.,* 2022). Additionally, they must be adaptable and sensitive to input and shifting circumstances. Zoning, incentives, rules, education, conservation, restoration, and green infrastructure are important considerations in developing policies and supporting reconstruction initiatives.

Policies discourse

Monitoring and assessing the results and effects of the policies and initiatives is the fourth step that public administrators may take to encourage sustainable land use. This entails gathering and examining data on the targets and indicators associated with the goals, including livelihoods, food security, water quality, carbon sequestration, and land cover (Razumei *et al.,* 2024). Additionally, it entails gathering and integrating stakeholder input through surveys, focus groups, interviews, and participatory techniques. Learning, accountability, and decision-making should all be influenced by the process of monitoring and assessment of outcomes.

Communicating and reporting the outcomes and lessons learned from creating policies and initiatives to the appropriate audiences and platforms is the fifth step public administrators may take to encourage sustainable land use. This entails communicating

the successes, difficulties, effects, and suggestions on policies and programs using language and images that are clear, succinct, and captivating for diverse audiences (Vasylevska *et al.,* 2022). Furthermore, this approach entails the use of suitable and easily available platforms and frameworks, which could include webinars, podcasts, social media, websites, reports, and newsletters. The goal of the reporting and communication should be to raise both support for sustainable land use as well as awareness, comprehension, and encourage participation.

The sixth and final action public administrators can take to promote sustainable land use is to build partnerships with stakeholders who share similar visions and objectives. This involves establishing and preserving networks and connections with corporations, NGOs, communities, local governments, researchers, and other public administrations across both sectors and governance levels. It also includes co-creating and co-implementing solutions as well as sharing and exchanging knowledge, resources, experiences, and best practices (Voronina, Lopushynskyi and Grechanyk, 2024). Effective collaboration in sustainable land use should be grounded in mutual benefit, trust, and group effort.

Additionally, locally tailored solutions must be developed. Fit-for-purpose solutions may include registering the combined ownership of farmland and residential structures, particularly in rural communities where one or more families reside in scattered settlements. A common challenge in implementing policies for more responsible and sustainable land administration is the conflict between private interests and the broader societal priorities, whether at the local, regional, or national level. This tension is evident in both formal land use plans and informal land use practices that are accepted socio-culturally. To address competing land uses and user demands and needs, formal land use planning models have been evolving from top-down normative suitability-based models to more participatory and allocation-based approaches that emphasize stakeholder engagement and negotiation (Metternicht, 2018). One promising approach for reconciling conflicting interests is tenure-responsive land use planning (Chigbu *et al.,* 2016).

The goal of sustainable land use planning is to strengthen connections between rural and urban areas, such as under a city-region foodshed, and to minimize the distance between the production and consumption of food, energy, and (Karg *et al.,* 2016). In addition to addressing socioeconomic risks and fostering collective resilience - particularly important during the post-war reconstruction and recovery, sustainable land use plans are anticipated to: restrict the conversion of agricultural land for urban and peri-urban expansion; limit the loss of vegetation, soil, and other vital land resources; and serve as platforms for consensus and conflict prevention and mitigation.

Conclusion

The research demonstrates particular meaning and acuteness of land relations issues for post-war reconstruction processes within the sustainability vector, moreover contributing to efforts on preventing the entropy of societal and economic processes. The practical implementation of sustainable development concepts contributes to resolving environmental challenges while balancing the use of natural resources with socioeconomic development at the local level. One of the key outcomes of sustainable

land use management is the development of optimal landscape-ecological solutions for spatial land use planning. This includes, first, identifying the best locations for human activities within a given area, and second, proposing measures to ensure the environmental integrity of those activities.

Land management in post-conflict areas presents a particularly complex challenge that demands context-specific strategies. Different countries possess distinct histories, cultures, and societal attitudes, and post-conflict circumstances might also vary and thus necessitate tailored policy responses. While certain circumstances may call for immediate emergency action, others may permit more measured and deliberate steps. Post-conflict environments are among the most difficult policy landscapes for governments, decision-makers, and communities alike. Designing a comprehensive action plan for land management and usage in post-conflict cultures is highly complex. Conventional conceptual frameworks often prove to be inadequate in post-conflict settings, where each conflict leaves behind unique environmental challenges and degrees of land degradation. Nonetheless, growing academic attention to issues surrounding residential and agricultural land, as well as property rights in post-conflict contexts, has contributed to the development of more responsive approaches. A conceptual framework for building sustainable land relations in post-war contexts does exist. In the case of Ukraine's reconstruction, this framework should be grounded in strong institutional support, a participatory approach to planning, and inclusive, multilevel, and multistakeholder partnerships. Further research is needed in the field of institutionalization landscape in land relations, based on a deep investigation of international experience of successes, failures, and pitfalls.

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Authors' Declarations and Essential Ethical Compliances

Authors' Contributions (in accordance with ICMJE criteria for authorship)

Contribution	*Author 1*	*Author 2*	*Author 3*	*Author 4*	*Author 5*
Conceived and designed the research or analysis	No	Yes	No	Yes	Yes
Collected the data	No	Yes	Yes	Yes	Yes
Contributed to data analysis & interpretation	Yes	Yes	No	No	Yes
Wrote the article/paper	Yes	Yes	Yes	Yes	Yes
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