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LAND MANAGEMENT OF RECLAIMED LANDS: CURRENT STATUS AND DEVELOPMENT PROSPECTS

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Abstract. *In the context of sustainable development, climate change, and post-war recovery, this study addresses the challenges of land management for reclaimed (ameliorated) lands in Ukraine. It is substantiated that land reclamation, aligned with the concept of sustainable development, integrates economic, social, and environmental aspects over the long term for the benefit of current and future generations in agricultural land use. Effective approaches to integrated water and land resource management are examined, with an emphasis on employing modern land-monitoring technologies such as geographic information systems (GIS) and remote sensing. Open data on the status of reclaimed lands in Ukraine, including irrigation and drainage infrastructure, as well as their registration in accordance with existing legislation, are systematized.*

Improvements in legal norms on land management for reclaimed lands are proposed, taking into account the need to adapt reclamation systems to climate change. The importance of specialized land management projects is highlighted, as they

account for the specific characteristics of reclaimed lands. Such projects will foster the practical implementation of integrated land and water resource management, ensuring land restoration and productivity gains, and contributing to the socio-economic and environmental objectives of agricultural land use.

Particular attention is given to integrated land and water resource management aimed at restoring reclaimed areas in the post-war period by engaging local communities, investors, and government agencies. Implementing the proposed measures, aimed at climate change adaptation and mitigating its adverse effects, will also help combat land degradation and desertification, thereby expanding the acreage of productive agricultural land.

Key words: *reclaimed (ameliorated) lands, sustainable development, integrated land and water resource management, geographic information systems (GIS), land management (land use planning), climate change adaptation, irrigation systems, drainage systems, post-war recovery, infrastructure modernization, regulatory framework, socio-economic development, land management (land use) projects, organization of reclaimed lands*

Problem Statement. Melioration is a crucial instrument for implementing the concept of sustainable development, as set forth in the final document of the Rio+20 Conference, particularly in the context of land resource management, aligning with the "principles of a green economy in the context of sustainable development and poverty eradication" [1]. Land reclamation increases agricultural productivity, mitigates negative impacts on ecosystems, and supports food security, thus addressing the global challenges of our time. Achieving this goal requires the consolidation of efforts by all nations, aimed at filling gaps in implementation and ensuring the harmonious integration of the three main pillars of sustainable development: economic, social, and environmental. While rainfed agriculture produces over 60% of global food supply on 80% of cultivated land, irrigated land delivers 40% of world food production while occupying only 20% of agricultural areas [18].

FAO has developed a Conceptual Framework for Integrated Land and Water Resources Management, aimed at ensuring the sustainable use of these resources by harmonizing economic, social, and environmental interests. This aligns with the demonstrated fact that "climate change and water scarcity constrain both rainfed and irrigated agriculture, with warming trends posing growing risks, uncertainties, and challenges for agricultural production and food security" [16]. According to FAO, integrated land and water resources management provides: proper governance at all levels (local, national, regional, and global); protection, restoration, and sustainable use of land, soil, and water resources; enhanced adaptation and resilience to climate change, along with a reduction in greenhouse gas emissions; integrated solutions for land, soil, and water—supporting a transition to sustainable agri-food systems; and optimized land, soil, and water data and information systems to transform these systems [16].

Climate change poses a serious threat to agriculture, including by reducing water availability. Rising temperatures and increased evaporation will lead to water resource deficits, thereby negatively affecting food security - even in Ukraine, where irrigation is becoming critical due to droughts and uneven spatial rainfall distribution.

Analysis of Recent Scientific Research and Publications. Reclaimed (ameliorated) lands and their use, industry-specific legal regulation, irrigation specifics, and monitoring approaches have been examined by various scholars, including Teshale Tadesse Danbara, Moltot Zewdi, O. Vlasov, A. Shevchenko, I. Shevchenko, O. Kozytskyi, T. Matiash, Y. Butenko, A. Krucheniuk, A. Salyuk, N. Soroka, Ye. Matiash, Yilkal Gebeyehu Mekonnen, Tena Alamirew, Kassahun Birhanu Tadesse, Abebe Demissie Chukalla, and others [2–7, 14, 15]. International institutions also highlight reclamation issues in their latest environmental and land policies, including the UN, FAO, the World Bank, and the European Parliament [16–19].

In particular, Sufan Zhu, Yin Liu, and Kun Xu investigated a method for mapping irrigated cultivated lands in Nebraska, introducing an Irrigation Probability Index (IPI) that enabled them to identify irrigated lands by factoring in meteorological and agricultural drought. The study employed spatial distribution techniques and remote

sensing, revealing that IPI exhibits high correlation with the actual irrigated area and can be effectively used in arid regions. Furthermore, the Crop Water Stress Index (CWSI), IPI, and vegetation indices (EVI and NDVI) are essential for mapping irrigated lands [2].

O. Vlasova et al., investigating the monitoring of water bodies and reclaimed (ameliorated) lands damaged by military actions - exemplified by the flooding of the Irpin and Dnipro rivers following the destruction of hydraulic structures - revealed significant changes in soil cover and an increase in marshy areas. They employed remote sensing and field studies using the SAVI, NDWI, and NDVI indices. However, the authors recommend continuing monitoring with high-resolution imagery and on-site research to make final decisions regarding the prospects for using reclaimed lands affected by hostilities [3].

Teshale Tadesse Danbara and Moltot Zewdie, assessing land suitability for surface irrigation with spatial information systems (in the Bilate River basin, Rift Valley lakes region of Ethiopia), examined factors such as vegetation index, soil, and slope, using a weighted overlay tool in ArcGIS. Based on the normalized difference vegetation index, where slope proved the most significant limiting factor, they found that only 28.46% of the studied basin area is suitable for irrigation [4].

T. Matiash et al., identifying areas where irrigation systems were destroyed and evaluating irrigated agriculture via remote sensing data, concluded that most irrigation systems in Ukraine were severely impacted by military hostilities and the destruction of the Kakhovka Hydroelectric Plant, rendering them unusable. On a regional scale, they zoned the territory according to the intensity of hostilities, using the NDVI index to assess biomass and damage to irrigation infrastructure [5].

Yilkal Gebeyehu Mekonnen et al. conducted a remote sensing-based performance monitoring study of small-scale irrigation for 2021/22 and 2022/23, analyzing the efficiency of minor irrigation schemes using the Shimburit scheme in northwestern Ethiopia (Blue Nile basin), where wheat is cultivated. Remote sensing data, as well as indicators of water consumption and productivity - including evaporation - revealed effective water use, despite reduced yields caused by untimely rainfall [6].

Research [7] indicates that remote sensing (Sentinel, Landsat) is effective for assessing flood impacts and waterbody boundaries, which confirms the high utility of GIS in monitoring the state of reclaimed lands and water resources. The aforementioned findings from a broad range of reclamation issues - spanning different natural-geographical settings for various management objectives - demonstrate that GIS is a powerful tool for spatial and analytical data processing. It integrates diverse data layers and identifies areas affected by adverse factors influencing reclaimed lands.

Despite the significance of GIS and remote sensing instruments in studying reclaimed lands - especially when statistical data are lacking or in wartime conditions that demand post-war agricultural recovery in Ukraine - another crucial aspect of land management for reclaimed lands involves accounting for the existing legislative framework, which also influences the investment attractiveness of each specific territory and land plot.

Hence, notwithstanding numerous studies, there remains a need to assess the current state of reclaimed lands and analyze legal provisions governing the development of related land management documentation in the post-war period.

Research Objective. To analyze the organizational and legal foundations of land management (land use planning) for reclaimed (ameliorated) lands in Ukraine and to develop proposals for their regulation.

Materials and Methods. The study employs a comprehensive set of general scientific methods to analyze the current state of reclaimed (ameliorated) lands and the legal norms governing their use, including land legislation related to land management. The monographic method was applied to conduct a detailed review of scientific publications dedicated to the study of reclaimed land use. The analytical method facilitated the systematization of information on the structure of these lands and the identification of key factors influencing their utilization and legal status. The forecasting method was used to assess the prospects for land management development and the strategic directions for the use of reclaimed lands in the post-war period.

Research Results and Discussion. According to [8], as of 2021, Ukraine accounted for 5,485.3 thousand hectares of reclaimed (ameliorated) lands, including

2,178.3 thousand hectares of irrigated and 3,307 thousand hectares of drained lands, along with the corresponding reclamation infrastructure. This total area encompasses all infrastructure elements such as reservoirs, main and distribution canals, protective dikes, pumping stations, pipelines, daily regulation basins, collector-drainage networks, and other hydraulic engineering facilities.

In Ukraine, reclaimed land is recorded by the State Statistics Service of Ukraine, the State Agency of Water Resources of Ukraine (Derzhvodagentstvo), and the State Service of Ukraine for Geodesy, Cartography, and Cadastre (Derzhgeokadastr).

From 1999 to 2016, in accordance with the Order of the State Statistics Committee of Ukraine No. 377 dated November 5, 1998, Derzhgeokadastr recorded reclaimed lands based on state statistical reporting forms for land resources No. 6a-zem "Report on the Availability of Irrigated Lands and Their Distribution by Landowners, Land Users, and Land Types" (annual) and No. 6b-zem "Report on the Availability of Drained Lands and Their Distribution by Landowners, Land Users, and Land Types" (annual) [9].

Between 2016 and 2021, pursuant to the Order of the Ministry of Regional Development, Construction, and Housing and Communal Services of Ukraine No. 337 dated December 30, 2015, quantitative land accounting was carried out under reporting forms No. 15-zem (quarterly), "Report on Lands and Land Plots by Designated Use and Land Types," and No. 16-zem (annual), "Report on Lands and Land Plots by Owners and Land Types." This accounting included irrigated and drained networks for protection from soil erosion, drought, and other adverse climatic factors, as well as inter-farm drainage and irrigation canals [10]. However, in practice, this reporting did not ensure comprehensive land accounting due to the reorganization and functional changes within Derzhgeokadastr over 2016–2021.

Under amendments to the Law of Ukraine "On the State Land Cadastre," introduced pursuant to the Law of Ukraine No. 2079-IX of February 17, 2022, "On Water User Organizations and the Promotion of Hydraulic Land Reclamation," the State Land Cadastre has been supplemented with new objects for registration and accounting - "reclamation networks" and "components of reclamation networks."

Reclaimed land is also recorded by the State Agency of Water Resources (Derzhvodagentstvo) at the regional level, which carries out systematic monitoring of irrigated lands in accordance with Order No. 206/638 of November 2, 2006, issued by the State Committee of Ukraine for Water Resources and the Ministry of Agrarian Policy of Ukraine, entitled “On the Procedure for the Use of Reclaimed Funds and Reclaimed Lands” [11].

Consequently, reclaimed lands are accounted for by various state authorities based on different criteria: in particular, Derzhgeokadastr records “reclamation networks” and their “components” for land parcels registered in the State Land Cadastre, whereas Derzhvodagentstvo maintains records within irrigation or drainage units. This difference in approaches affects the overall system of reclaimed land accounting and, consequently, the rational and efficient management of such lands. It is worth noting that the State Statistics Service of Ukraine’s accounting of reclaimed lands is grounded in data provided by Derzhvodagentstvo.

Most of Ukraine’s existing reclamation systems were established between 1961 and 1990, thus necessitating their revision and modernization. In this context, particular attention must be paid to systematizing technical solutions, primarily for upgrading irrigation systems, improving irrigation methods, and adapting sector-specific legal norms to contemporary challenges, notably the impact of warfare and the need for restoration and rational land use. The creation of comprehensive reclamation systems requires addressing technical, organizational, social, economic, and environmental considerations. Adherence to these aspects will ensure the sustainable development of land reclamation and rural areas, fostering efficient management of water and land resources [14].

An analysis of the parameters and functioning of Ukraine’s existing irrigation systems, predominantly concentrated in the southern regions, demonstrates their gradual technological advancement while also revealing significant variations in engineering solutions related to hydraulic structures, networks, and irrigation methods. These systems were developed over different periods, resulting in structural heterogeneity and the need for standardization in line with modern integrated land and

water resource management approaches. A crucial aspect in this context is accounting for regional specificities, where infrastructure modernization is required to ensure compliance with contemporary environmental and technical irrigation standards. Additionally, in light of climate change, there is an increasing need to expand irrigation coverage and effectively integrate these systems into existing agricultural landscapes (Fig. 1) [12, 13].

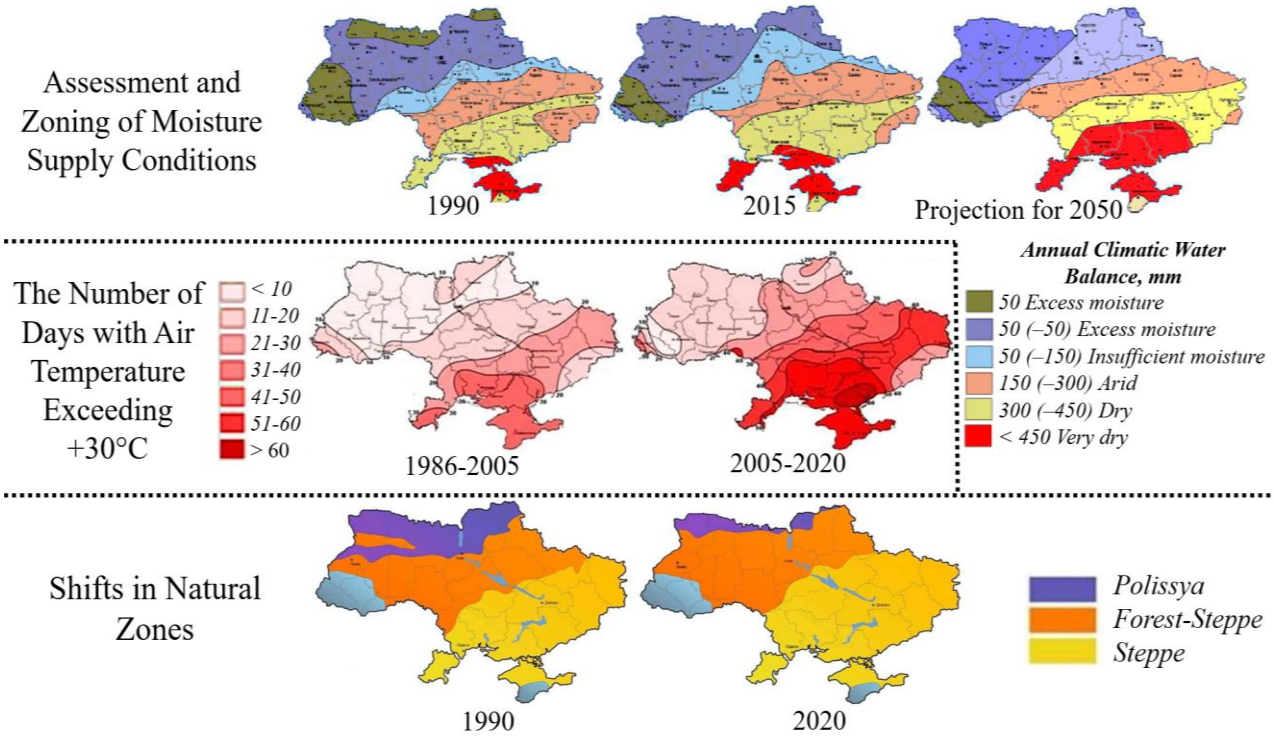

Fig. 1 The Impact of Climate Change on the Dynamics of Natural Zones and the Moisture Supply Zoning of Ukraine's Territory [12, 13]

An analysis of the legal norms regulating the relationships that directly or indirectly involve reclaimed lands indicates that the effectiveness of irrigation systems is hindered by ineffective legislation and centralized water resource management. The lack of water users' participation in decision-making hampers the development of self-financing mechanisms, while insufficient investment tools constrain infrastructure modernization and the expansion of irrigated areas. In this context, land management (land use planning) measures can offer key solutions. Specifically, land management allows for the structuring of territories, clear delineation of irrigation zones, the formation of an appropriate legal framework, and the engagement of water users in

governance. Pursuant to Article 5 of the Law of Ukraine “On Land Management,” reclamation networks and their components are objects of land management. Moreover, these measures will promote governance decentralization, the creation of infrastructure development plans, and the attraction of investments for system modernization.

The organization of reclaimed (ameliorated) lands is a crucial prerequisite for ensuring the rational use of land resources and the sustainable development of agricultural areas. These lands form an integrated land resource management system, enabling not only efficient land use but also ecosystem conservation and the enhancement of agricultural productivity [15]. Improving the legal framework for land management of reclaimed lands in Ukraine is essential for promoting sustainable agricultural development and effectively combating land degradation and desertification. A key direction in this regard is the organization of reclaimed lands through land management projects. Currently, the existing legal framework does not provide for separate land management projects specifically for the organization of reclaimed lands, making it difficult to account for their specific characteristics. Land management projects serve as a comprehensive mechanism for integrating economic, design, and technical documentation, encompassing a system of land use and protection measures planned for implementation under such projects. To address this gap in land legislation, it is proposed to amend Part 2 of Article 52 of the Law of Ukraine "On Land Management" by introducing a provision that recognizes the organization of reclaimed lands as a component of the ecological and economic justification of crop rotation and land use planning.

Another key direction in the development of land management for reclaimed (ameliorated) lands is the integration of Geographic Information Systems (GIS), which enable the creation of detailed maps and models of these areas. The application of GIS and remote sensing technologies will facilitate not only land use planning and the design and monitoring of reclamation measures but also ensure regular land condition monitoring. This approach will allow for the timely identification of problem areas,

rapid response to changes, and improved efficiency in managing reclaimed land resources.

Another crucial aspect in developing land management for reclaimed lands lies in engaging the public and local communities in land use planning processes. By implementing strategic environmental assessments of state-planning documents at the local level, environmental principles become integrated into decision-making, ensuring environmental protection and ecosystem preservation. Improved maintenance of reclamation channels through active community involvement will also enhance the effective functioning of reclamation systems.

Thus, the development of land management for reclaimed lands in Ukraine requires a systematic approach that includes infrastructure modernization, the adoption of cutting-edge technologies (GIS, remote sensing), the revision of sector-specific legal norms, and the involvement of all interested parties, including researchers, civil society organizations, and local communities. Only under such a comprehensive framework will sustainable management of reclaimed lands and the effective utilization of their potential be achieved.

Conclusions and Recommendations. Land reclamation (melioration) plays a crucial role in ensuring sustainable development under changing climate conditions, particularly by enhancing agricultural productivity, preserving ecosystems, and strengthening food security. The analysis of research findings demonstrates the high efficiency of GIS technologies and remote sensing for monitoring the condition of reclaimed (ameliorated) lands, which is especially critical in situations with limited access to field data. At the same time, Ukraine faces significant discrepancies in the approaches to the accounting of reclaimed lands among different governmental bodies, complicating their effective utilization and planning. Furthermore, gaps in the legislative framework for land management of reclaimed lands hinder the development of a unified and efficient land-use strategy.

Given contemporary challenges, a primary necessity is the improvement of the legal framework for land management of reclaimed (ameliorated) lands in Ukraine, particularly in terms of their organization through land management projects and the

development of a unified methodology for accounting for reclaimed lands, incorporating both legal and technical aspects of their utilization. Additionally, the integration of modern GIS solutions into land management processes will enhance the efficiency of water and land resource management and facilitate the implementation of integrated resource management approaches. Considering the extent of damage to reclamation infrastructure due to the war, particularly in regions of active hostilities, it is essential to develop specialized land management projects that include comprehensive documentation on the justification of measures for the use and protection of reclaimed lands. This is seen as a prerequisite for attracting investment in irrigation restoration and modernization of reclamation systems, particularly through appropriate legal mechanisms and state support.

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ЗЕМЛЕВПОРЯДКУВАННЯ МЕЛІОРОВАНИХ ЗЕМЕЛЬ: СТАН ТА ПЕРСПЕКТИВИ РОЗВИТКУ

Анотація. *Розглянуто проблеми землевпорядкування меліорованих земель в Україні у контексті сталого розвитку, зміни клімату та післявоєнного відновлення. Обґрунтовано, що меліорація земель відповідно до концепції сталого розвитку інтегрує економічні, соціальні та екологічні аспекти довгострокового, в інтересах теперішніх і майбутніх поколінь сільськогосподарського землекористування. Досліджено ефективні підходи до інтегрованого управління водними та земельними ресурсами, акцентовано увагу на впровадженні сучасних технологій моніторингу земель, таких як геоінформаційні системи (ГІС) і дистанційне зондування. Систематизовано відкриті дані про стан меліорованих земель в Україні, зокрема інфраструктуру*

зрошувальних і осушувальних систем, а також їхній облік відповідно до чинного законодавства.

Запропоновано удосконалення норм права щодо землевпорядкування меліорованих земель з урахуванням необхідності адаптації меліоративних систем до зміни клімату. Наголошено на важливості розробки спеціалізованих проектів землеустрою для організації меліорованих земель, що враховують їхню специфіку. Такі проекти землеустрою сприятимуть практичній імплементації інтегрованого управління земельними та водними ресурсами, забезпечуючи відновлення і підвищення продуктивності земель, а в сукупності – досягнення соціально-економічних і екологічних цілей сільськогосподарського землекористування.

Особливу увагу приділено інтегрованому управлінню земельними та водними ресурсами з метою відновлення меліорованих територій у післявоєнний період із залученням місцевих громад, інвесторів і державних органів. Реалізація запропонованих заходів, спрямованих на адаптацію до зміни клімату та пом'якшення її негативних наслідків, також сприятимуть боротьбі з деградацією земель та опустелюванням, тим самим збільшуючи площі продуктивних сільськогосподарських угідь.

Ключові слова: *меліоровані землі, сталий розвиток, інтегроване управління земельними та водними ресурсами, геоінформаційні системи (ГІС), землеустрій, адаптація до зміни клімату, зрошувальні системи, осушувальні системи, післявоєнне відновлення, модернізація інфраструктури, нормативно-правова база, соціально-економічний розвиток, проекти землеустрою, організація меліорованих земель.*