CADASTRAL ACCOUNTING OF LAND POLLUTED AS A RESULT OF MILITARY OPERATIONS IN UKRAINE

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Abstract. The authors analyzed the cadastral instruments of land management. The necessity of updating the data of land registration in the State Land Cadastre is proved. The approaches to spatial development management and the formation of a new land management system in settlements that have suffered the devastating effects of war are analyzed. For Ukraine, spatial planning should become a key tool for territory management. The article proposes mechanisms for the creation and functioning of cadastral data for such planning. The implementation of state control over the use and protection of land using information products of remote sensing will allow to identify land plots used for their intended purpose and, thus, to establish taxation of contaminated areas. The purpose of the study was to create a system and methods for obtaining cadastral indicators that will become the basis for identifying and using contaminated areas. The research materials are the data of the State Land Cadastre and the State Emergency Service of Ukraine, based on the methodological techniques of synthesis and analysis of individual elements. The research methodology consisted of three stages: 1) identification of the main components of land accounting, in particular, complete, up-to-date data on mined and demined land; 2) analysis of the methodological basis for the formation of a database of contaminated areas; 3) identification of the most optimal ways to integrate digital information from various entities as a crucial component of effective demining management. As a result of the research, it was found that it is extremely important to update data on contaminated areas. Land registration as a component of the State Land Cadastre should primarily reflect data from war-contaminated areas. The importance of constant exchange of information between the Information Management System for Mine Action and the State Land Cadastre to determine the status of contaminated areas and facilitate the application of tax benefits is proved.

Keywords: cadastre, polluted land, accounting of land plots, agricultural land, land use.

Introduction

An analysis of recent research and publications shows that the public and scientists are concerned about the negative impact of the hostilities on Ukraine's soil. According to the Kyiv School of Economics, 186,000 square kilometres of land, which is almost 31% of Ukraine's territory, are at risk of damage and contamination. More than 20 thousand square kilometres were damaged by more than 75%. Total losses from damage to territories and soil disturbance as a result of military operations are estimated at USD 9.8 billion [1]. This jeopardizes the use of damaged land and requires reclamation, demining, and munitions disposal.

The restoration of soils that have suffered the devastating effects of war is possible through the creation of "red zones" in areas where intense hostilities have taken place. This initiative is proposed by experts from the Ukrainian Nature Conservation Group. This will help fulfil the requirements of Ukrainian legislation on land conservation and prevent the transformation of these territories into desert, as well as the European Biodiversity Strategy until 2030, namely the withdrawal of 30% of all agricultural land from cultivation [2; 3].

The damage caused by the war is estimated at tens of billions of euros, much of which is needed to eliminate the effects of soil pollution. As a result of the war, about 30% of all protected areas in Ukraine are under threat. This poses a threat to the strategic goals of biodiversity conservation, leads to a decrease in the potential for greenhouse gas absorption, and intensifies the process of desertification [4; 5].

Some researchers also point to the direct destructive effect of various mechanical impacts on the soil cover. In particular, bombing and tunnelling also have a negative impact on the soil, causing increased degradation and formation processes by changing the components of the soil cover [6]. Fires have an equally destructive effect, causing soil erosion, reducing or destroying vegetation and soil cover. Biological reclamation of lands that have suffered significant damage is a priority measure [7; 8].

In order to develop effective measures, it is important to conduct a detailed survey and qualitative assessment of the affected areas. Most scientists point out the importance of conducting geoinformation monitoring of land [7; 9; 10].

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Results and discussion

The socio-economic changes caused by the war require a review of pre-war approaches to spatial development management and new land management in 285 communities in 9 oblasts. The war has led to irreversible security, economic, and demographic changes in the frontline regions that affect the land use system. The need for housing, industrial and commercial real estate has changed, which will require unpopular but necessary spatial solutions for the limited reconstruction of affected settlements and the restoration of their economic complex.

Different systems of land classification and land use in Ukraine have historically been developed and implemented primarily for the purposes of maintaining the State Land Cadastre, preparing land management project documentation, monetary valuation of land and other purposes of regulating land relations. Current land classification systems in Ukraine: Classification of types of land plots; Classification of types of designated purpose of land plots; Classification of types of functional purpose of territories; Classification of crops. The Classification of Land Types (CLT) is the closest to the Corine Land Cover classes. These classifications do not include the classification of contaminated areas, as according to the Law of Ukraine "On the State Land Cadastre", land is recorded in the State Land Cadastre by quantity and quality of land and land plots. Accounting for the quality of land reflects data characterizing land by natural and acquired properties that affect its productivity and economic value, as well as the degree of man-made soil pollution. Along with this definition, there is no methodology for accounting for contaminated areas, including soils. Therefore, it is necessary to develop detailed recommendations for accounting and monitoring of such lands.

Potentially contaminated with explosive remnants of war are 17.4 million hectares of land where hostilities have been or are ongoing, territories under temporary occupation, and areas that have been attacked. As of the beginning of 2023, 2.59 million hectares of agricultural land needed to be surveyed. Additionally, 2.91 million hectares will need to be surveyed after the end of active hostilities. The National Mine Action Authority has approved an action plan for demining 470.9 thousand hectares of agricultural land for 2023, which provides for coordination of actions of state authorities, mine action operators, local governments and business entities. The SESU pyrotechnic units have already defused more than 319 thousand explosive items, inspected and cleared 79.1 thousand hectares of explosive hazards. The Mine Action Service provides an interactive map of the territories that could potentially be contaminated with explosive ordnance (Fig. 1).

Explosive ordnance (landmines, unexploded ordnance) makes real estate unsafe and unusable. Contaminated areas remain inaccessible to owners and users until they are inspected and declared safe.

The integration of digital technologies is a crucial component of effective demining management. A digital demining management system should be established that integrates data from various actors, including the Ministry of Defense, the State Emergency Service of Ukraine, the State Land Cadastre and communities. The main components of the digital demining management system include: a geographic information system for tracking mined and demined land; integration of data from different demining operators; digital tools for managing the demining process.

The payment of taxes for unusable real estate contaminated with explosive ordnance (land tax, environmental tax, rent for state and municipal land plots, minimum tax liability, single tax of the 4th group, etc.) is illogical and unfair. Before the war, land payments amounted to UAH 36 billion per year and were the second most important source of local budget revenues (after personal income tax). The amount of such tax benefits can reach UAH 15 billion.

Fig. 1. **Interactive map of areas potentially contaminated by explosive ordnance, source: SES Mine Action Service**

The public cadastral map and the portal of the national geospatial data infrastructure are disabled under martial law. During the war, non-governmental services for disseminating land cadastral information are intensively used (Figure 2).

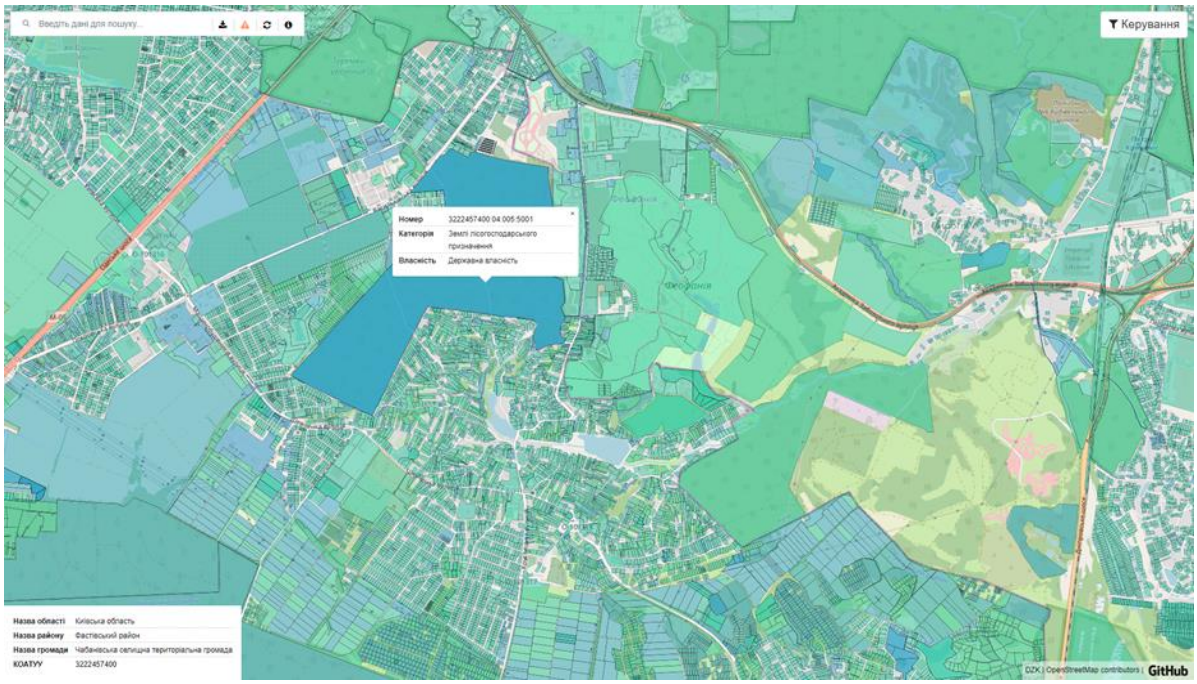

Fig. 2. **Informative resource for displaying cadastral data**

The protection of agricultural land should be one of the main measures to regulate land relations in Ukraine, and for the rational use of land it is important to study a set of soil indicators in specific natural and climatic conditions [11]. As of 2021, degradation processes are reflected in the classification

presented in Table 1. This classification, which was used to record land quality in the pre-war period in Ukraine, does not take into account the contamination of territories. The exception was the areas contaminated with cesium and strontium residues from the Chornobyl accident. To monitor the condition of the soil, systematic research is needed to identify land degradation and determine the necessary measures to restore fertility. Recording soil conditions before and after the war is important for analyzing changes caused by damage. Laboratory research conducted in craters and adjacent areas will help assess the extent of the damage and contribute to the development of restoration technologies.

Table 1

Prevalence of land degradation processes in Kyiv region, 2021

Types of degraded lands	Area of land affected, thousand hectares	% of the total area of the territory
Deflationary hazardous lands (agricultural lands)	667.7	47.7
Lands (agricultural lands) subject to water erosion	134.6	4.8
Lands (agricultural lands) exposed to combined action of water and wind erosion	-	-
Lands (agricultural lands) with acidic soils	514.1	36.7
Lands (agricultural lands) with saline soils	41.2	2.9
Land (agricultural land) with saline complexes		
Land (agricultural land) with waterlogged soils	35.2	2.5
Land (agricultural land) with swampy soils	28.2	2.0
Land (agricultural land) stony	-	-
Polluted land (agricultural land) that is not used in agricultural production	83.3	8.2

To develop the Ukrainian soil information system, it is necessary to take into account national peculiarities of soil data collection and methods of determining their parameters. Ukraine's soil information system should be based on the principles of European systems. It is advisable to use the experience of other databases and systems, such as WoSIS, SOTER and others [12]. To determine the state of polluted territories in a timely manner, it is necessary to improve land quality accounting with up-to-date land cadastre data, agrochemical certification of agricultural land, and land monitoring.

Conclusions

Effective exchange of information between the Mine Action Information Management System (IMSMA) and the State Land Cadastre will allow for accurate determination of the status of contaminated sites and facilitate the application of tax benefits, force majeure, etc. It is also necessary to cover areas with fortifications and minefields created by the Ukrainian Defence Forces, which also impede the use of land plots.

State control over the use and protection of land with the use of remote sensing information products will allow identifying land plots used for their intended purpose and thus avoiding unjustified tax benefits.

Author contributions

Both authors have contributed equally to the study and preparation of this publication. Authors have read and agreed to the published version of the manuscript.

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