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PRESERVATION OF SOIL RESOURCES WHICH WERE DESTROYED AS A RESULT OF MILITARY OPERATIONS BY MEANS OF LAND MANAGEMENT

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Abstract. *It is proved that soil protection has become a national environmental problem, so the contradictions between socio-economic needs of people and environmental safety requirements must be overcome. The existence of standards for the qualitative state of soils and their maximum permissible pollution in the legislative field indicates that they reflect only the chemical nature of anthropogenic loads, but there are no standards at all for such types of loads as physical, mechanical, reclamation and man-made, which is of particular importance in the context of military operations in Ukraine. It is substantiated that when assessing the level of damaged land and soil as a result of hostilities and determining the degree of suitability for their further use, it is necessary to take into account: the level of damage to the land plot as a percentage of its area; the degree of suitability; characteristics of contaminated land; proposals for further use of the land plot and measures to reduce the level of pollutants entering the soil. It is also proposed to implement measures to protect land and soil by means of land management through the development of appropriate land management documentation. Given the anthropogenic load on soils due to the impact of hostilities, the need to develop a working land management project for the reclamation of disturbed lands as a result of hostilities and a working land management project for the conservation of degraded, unproductive and technogenically polluted lands has been proved, which requires amendments to the Resolution of the Cabinet of Ministers of Ukraine of February 2, 2022, No. 86 "On Approval of the Rules for Developing Working Land Management Projects".*

Key words: *soils, impact of military operations, anthropogenic footprint, soil conservation agriculture, land reclamation, land management*

Problem statement

According to agrochemical surveys, the annual decline in humus content in Ukrainian soils ranges from 500 to 600 kg/ha, resulting in a shortfall in agricultural production of 3 million tons of grain units. In the context of the state over the past two decades, the humus content has decreased by 0.22% and is estimated at 453.4 billion UAH. [1]. There is also an increase in the area of land affected by wind (6 million hectares) and water (13.3 million hectares) erosion. The amount of contaminated and unproductive soils in our country reaches 15 million hectares [2]. The point is that soil protection has become a national environmental problem, and therefore the contradictions between the socio-economic needs of people and the requirements of environmental safety must be overcome.

This raises the question of withdrawing degraded arable land from agricultural use, as this will become the foundation for conservation agriculture and ensure its productivity. The results of scientific research show that the withdrawal of 9 to 12 million hectares of such lands will reduce the plowed area of Ukraine by up to 40%, increase the total forest cover to 20% and field protection to 4% [3].

With the intention to join the European integration processes in the field of environmental protection, including land and soil, it is timely for Ukraine to adapt its national legislation "...to standards, regulations, guidelines and other normative documents..." on land use rationalization [4, p. 21]. Ignoring environmental laws, rules and regulations of nature and land use has become one of the priority reasons for the rapid deterioration of the quality of soil cover.

Assessing the legally enshrined standards for the quality of soil and its maximum permissible pollution, there are grounds to assert that they reflect only the chemical nature of anthropogenic loads. And there are no standards for such types of stress as physical, mechanical and reclamation. The Cabinet of Ministers of Ukraine is responsible for establishing these standards, as stipulated by the Law of Ukraine "On Land Protection," but the mechanism for their creation has not been developed. In this regard, the legal regulation in the field of land protection should be improved in order to fill gaps in the relevant legal field, eliminate layers in legal acts and systematize land protection norms available in laws and bylaws [5].

At the same time, today we have to talk about another type of soil degradation - man-made pollution as a result of military operations, which will have terrible consequences for the state of the soil, the environment, human health, and the agricultural potential of the state. This also applies to the act of ecocide at the Kakhovka hydroelectric power plant, which threatens unprecedented environmental consequences - a catastrophe for the southern part of Ukraine and the entire Black Sea region. Perhaps it is time to make decisions on a global scale to prevent a global catastrophe. There is an objective need to take measures to solve environmental and economic problems at all levels of government - global, national, regional and local.

Analysis of recent research and publications

Given the special status of soils in the land resource potential of the country, soil fertility as the basis for ensuring the country's food security, a significant number of scientists have devoted their works to the study and scientific substantiation of these issues. In particular, S.Y. Bulygin, V.I. Burakov, M.M. Kotova [6] dealt with the issues of designing soil protection and reclamation measures in agricultural landscapes. A.V. Barvinsky studied in depth the changes in the agrophysical properties of soils under the influence of fertilizers and ameliorants [7]. O.G. Tarariko and M.G. Lobas were engaged in the development of standards for soil protection contour reclamation systems of agriculture [8]. The work of Y.M. Dorosh, M.Y. Garbuz, O.S. Osipchuk was aimed at studying soil erosion and providing proposals for measures to combat it in the regional context (within the Kyiv region) [9]. The publications of D.S. Dobriak, O.P. Kanash, I.A. Rozumnyi are devoted to the development of scientific and methodological principles for optimizing land use, classification of agricultural land as a scientific prerequisite for their environmentally friendly use [10; 11].

The purpose of the study. To assess the impact of mechanical, physical, chemical and man-made damage on the destruction of soil structure as a result of military operations and to scientifically substantiate the prevention of negative consequences by land management.

Materials and methods of the study

In the course of realization of the research goal, the well-known methods of scientific cognition were used, such as: analysis, monographic, generalization. The monographic method was used to study scientific works related to soil protection, on the basis of which the choice of land reclamation technology was justified. The method of analysis was used to study the current legislative standards for the quality of soils and their maximum permissible pollution. The method of generalization was used to substantiate and propose amendments to the Resolution of the Cabinet of Ministers of Ukraine No. 86 "On Approval of the Rules for Developing Working Land Management Projects" dated February 2, 2022.

Research results and discussion

The problems of ecological and economic security in the current environment are of particular relevance. After all, the loss of valuable land for the state from the point of view of realizing its limitations should be considered as a threat to both economic independence and national security of Ukraine, and their restoration and rational use should be a guarantee of its sustainable socio-economic development. Therefore, issues related to the protection of land and soil, optimization of their use and restoration "...should be raised to the level of state priorities in the socio-economic development of Ukraine, the most important areas of state policy..." both in the economic sphere and in the field of environmental protection [12, p. 22-23].

What do we have now from the hostilities? Shelling (both authorized and prohibited) is carried out daily, resulting in sinkholes, new mined areas, military equipment being destroyed, resulting in oil leaks, burning of land, etc. Accord-

ing to the official data of the Ministry of Agrarian Policy of Ukraine, more than 485,000 hectares in ten Ukrainian regions are mined and contaminated with ammunition and explosive substances and devices. This causes soil contamination, negatively affects the country's economy and, above all, human health. And the longer the hostilities continue, the greater the damage will become.

As a result of military operations, soil structure is destroyed by mechanical, physical and chemical damage.

As for the mechanical impact on the soil cover, its deformation is caused by the movement of military equipment, troops, construction of defensive structures, bombing craters, and demining of territories. As a result, the soil cover is subject to compaction, waterlogging, and contamination by the products of warfare. Compaction results in a disturbance of the soil's water balance, which leads to the spread of wind and water erosion. Under the influence of man-made stress from military operations, the soil structure is destroyed due to the displacement of particles of one layer relative to another. The destruction of the humus horizon, loss of physical and chemical properties of the soil, and changes in its particle size distribution and aggregate state occur as a result of de-mining. Detonation causes soil contamination with explosive residues and metal fragments, the consequences of which can be interpreted as "absolute loss of soil resources."

The natural physical and chemical parameters of the soil cover are subject to changes when it is chemically affected (we are talking about soil pH, cation exchange and humus content). This is caused by the ingress of fuel, lubricants, electroplating waste, heavy metals (cadmium, lead, zinc, copper), explosive residues, decontamination agents, etc. into the soil. Consequently, the concentration of toxic substances in soils increases, and there is a risk of various local landscape and geochemical anomalies. This means that such soils cannot be used in the near future.

Changes in the physical parameters of the soil occur as a result of vibration, radioactive and thermal effects from the use of weapons and military equipment, which leads to a cumulative negative effect (this includes the loss of soil regeneration capacity, loss of humus, and a decrease in natural fertility).

In most cases, the migration of pollutants occurs through groundwater, but vegetation also absorbs them (explosive compounds penetrate the roots and settle in the plant).

The military operations in Ukraine have caused many problems, among which soil degradation and contamination are prominent. In order to make decisions about their suitability for agricultural use, there is a need to analyze the contaminating particles in the soil, as it will be impossible to determine the method of treatment. This process can be initiated on de-occupied lands by first carrying out demining. To do this, the state should introduce systematic monitoring of soil conditions and conduct an ecological and biochemical assessment to assess the degree of soil damage. Such an assessment will allow us to determine an individual approach to each case, depending on the degree of damage (it is likely that some areas will be found to be unsuitable for agriculture at all).

Currently, the law allows for this problem to be solved through land remediation or conservation. The best option for Ukraine is to set aside contaminated land for natural re-natural-

ization and temporary or permanent conservation. The most valuable of the conserved lands can be transferred to a nature reserve fund.

Conversion of contaminated land for further use involves land remediation. Before choosing a technology for land reclamation, it is necessary to analyze the consequences of hostilities. Such actions are carried out in stages (Fig. 1).

Based on the results of the analysis, the optimal option for land and land plot remediation is selected.

The following treatment methods are used to clean up (remediate) contaminated soils: physical (electrolytic technology, disposal, stabilization), chemical (chemical extraction, chemical leaching), and biological (phytoremediation, phytostabilization, phytoextraction).

When assessing the level of damaged land as a result of hostilities in Ukraine and determining the degree of suitability for their further use, the following is taken into account: the level of damage to the land plot as a percentage of its area; the degree of suitability; the characteristics of the contaminated land; proposals for its further use; and measures to reduce the level of pollutants entering the soil. In this regard, the proposed measures for the protection of land and soil should be implemented through the land management mechanism (Table 1).

As for changes in the physical parameters of the soil as a result of vibration, radioactive and thermal effects from weapons hits and the use of military equipment, this is a cumulative negative effect that leads to the loss of humus in the soil, a decrease in its natural fertility and a loss of soil regeneration capacity in general.

In this regard, land protection measures should primarily be implemented through land management, combining environmental and economic instruments. We are talking about developing a working land management project for the conservation of degraded, unproductive and technologically polluted land. After all, the conservation-transformation of agricultural land is projected through its conversion into fodder land or withdrawal of such land with subsequent reforestation or transformation into other types of non-agricultural land.

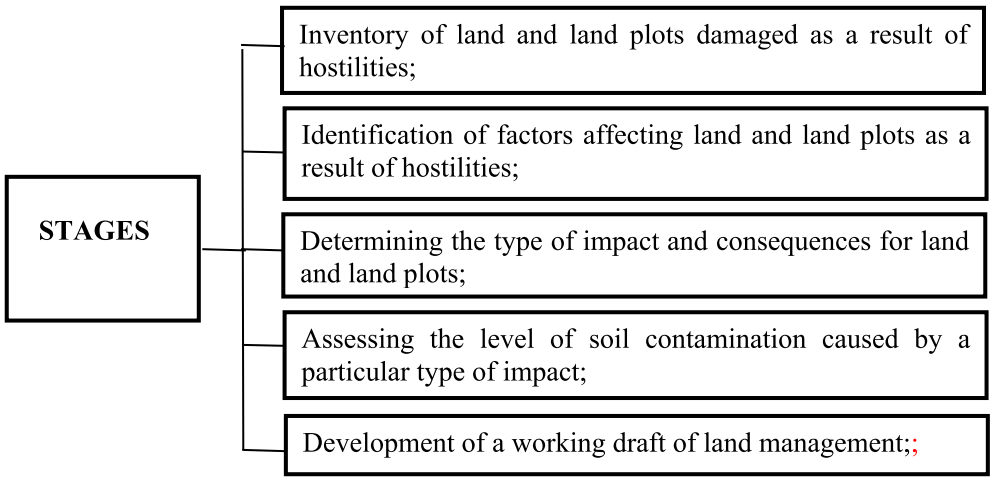

Figure 1. Stages of determining the consequences of hostilities for the selection of land reclamation technology

Formed and supplemented by the authors according to [13].

Table 1: Assessment of the level of damaged land as a result of hostilities in Ukraine according to the degree of land suitability for use and the types of land management documentation to be developed (supplemented by the authors [13])

Level of damage (% of land area)	Degree of suitability	Characteristics of contaminated land	Possible utilization	Anticipated measures	Type of land management documentation to be developed
less than 10%	suitable	the content of chemicals in the soil is within the background values	suitable for growing all crops	-	land management projects that provide an environmental and economic justification for crop rotation and land management;
from 10 to 25%	suitable	the content of chemicals in the soil exceeds the background value, but not above the TLK	suitable for growing all agricultural crops, subject to quality control	agrotechnical measures (to reduce the level of metals in products)	land management projects that provide an environmental and economic justification for crop rotation and land management;
from 25 to 50%	moderately suitable	the content of chemicals in the soil exceeds the TLK at the limiting translocation index	suitable for growing industrial crops with further use for hayfields and pastures with normalized grazing	growing crops that do not absorb pollutants; agrotechnical measures	a working draft of land management for the reclamation of disturbed land as a result of hostilities
from 50 to 75%	conditionally suitable	the content of chemicals in the soil exceeds the TLK for most of the pollutants studied	use for cultivated pastures; cultivation of essential oil crops	Cultivation of crops for food purposes is not allowed; carrying out anti-erosion and hydro-technical measures; physical and chemical reclamation of land	a working draft of land management for the reclamation of disturbed land as a result of hostilities
from 75 to 100%	unsuitable	the content of chemicals in the soil exceeds the TLK for all indicators	withdrawal from agricultural use (conservation)	natural recovery	a working draft of land management for the conservation of degraded and unproductive land;

The importance and value of developing this land management documentation is that it provides for priorities for cost-effective and environmentally sound land use, measures aimed at slowing down their degradation to achieve a neutral level in this process, finding ways to restore soil fertility, etc.

The development of a working land management project for the conservation of degraded, unproductive and technologically contaminated land should become an important tool for landowners and land users in the current environment, as they will play an important role in the restoration of contaminated land. Communities will also play an important role in the restoration, as it is the responsibility of all parties to take care of the damaged land, and it is likely that communities will become leaders in this process on the ground. Therefore, local community development programs must take into account the issue of soil restoration (this means assessing it, determining the level of damage, conducting systematic monitoring of its condition, and allocating funds for its implementation).

If we are talking about landowners and land users for the implementation of land protection measures, the legislation should "...determine the sources, grounds, procedure for payment of compensation payments and their amount for the implementation of these measures in each case in particular" [14, p. 111]. However, there is no legal formalization of such an important compensation instrument "...as a specifically operating mechanism..." [15, с. 59].

Conclusion

The analysis of the existing standards for the quality of soil and its maximum permissible pollution shows that they reflect only the chemical nature of anthropogenic loads, but there are no standards for such types of loads as reclamation, physical, mechanical and man-made, which is of particular importance in the context of military operations. When assessing the level of damaged land as a result of hostilities and determining the degree of suitability for their further use, the following is taken into account: the level of damage to the land plot as a percentage of its area; the degree of suitability; the characteristics of the contaminated land; proposals for its further use; and measures to reduce the level of pollutants entering the soil. In this regard, measures to protect land and soil by land management should be implemented primarily through the development of a working land management project for the reclamation of disturbed land as a result of hostilities and a working land management project for the conservation of degraded, unproductive and technologically polluted land, which requires amendments to the Resolution of the Cabinet of Ministers of Ukraine of February 2, 2022 No. 86 "On Approval of the Rules for Developing Working Land Management Projects".

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ЗБЕРЕЖЕННЯ ҐРУНТОВИХ РЕСУРСІВ МЕТОДОМ ЗЕМЛЕВПОРЯДКУВАННЯ, ЩО ЗАЗНАЛИ РУЙНУВАННЯ ВНАСЛІДОК ВЕДЕННЯ ВІЙСЬКОВИХ ДІЙ

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Анотація. *Доведено, що охорона ґрунтів стала національною екологічною проблемою, тому мають бути подолані протиріччя між соціально-економічними потребами людини та вимогами екологічної безпеки. Наявність нормативів якісного стану ґрунтів та їх гранично допустимого забруднення у законодавчому полі свідчить про те, що вони відображають лише хімічну природу антропогенних навантажень, проте взагалі відсутні нормативи щодо таких видів навантажень, як фізичний, механічний, меліоративний і техногенний, що набуває особливого значення в умовах ведення військових дій в Україні. Обґрунтовано, що при оцінюванні рівня пошкоджених земель і ґрунтів унаслідок ведення бойових дій із визначенням ступеню придатності до їх подальшого використання необхідно враховувати: рівень пошкодження земельної ділянки у відсотковому співвідношенні до її площі; ступінь придатності; характеристику забруднених земель; надання пропозицій щодо подальшого використання земельної ділянки й заходів з метою зниження рівня надходження забруднювальних речовин у ґрунт. Запропоновано також реалізовувати заходи з охорони земель і ґрунтів методом землевпорядкування шляхом розроблення відповідної землевпорядної документації. Зважаючи на техногенне навантаження на ґрунти внаслідок впливу військових дій доведено потребу розроблення робочого проекту землеустрою щодо рекультивації порушених земель унаслідок бойових дій та робочого проекту землеустрою щодо консервації деградованих, малопродуктивних і техногенно забруднених угідь для чого потрібно ввести зміни до постанови КМ України від 2 лютого 2022 р. № 86 «Про затвердження Правил розроблення робочих проектів землеустрою.*

Ключові слова: *ґрунти, вплив воєнних дій, антропогенне навантаження, ґрунтозахисне землеробство, рекультивація земель, землеустрій*