UDC 332.36:355.422(477)

ANALYSIS OF SCIENTIFIC AND METHODOLOGICAL APPROACHES REGARDING ASSESSMENT OF THE IMPACT OF COMBAT ACTIONS ON LAND PRODUCTIVITY

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An overview and analysis of government methodological recommendations, scientific research institutions, groups of scientists, and public organizations related to studies of the assessment and impact of military actions on land have been conducted. Key positions in methodological recommendations related to the assessment of negative consequences on land due to technogenic pollution and damage have been selected and noted. Key positions in methodological recommendations related to the assessment of negative consequences on land due to military actions have been analyzed and noted. Studies of scientific institutions, groups of scientists, and public organizations related to the assessment and impact of military actions on land and soil have been considered. It is noted that practical research related to the assessment of the impact of military actions on the productivity of land use, particularly in the context of territorial communities, is currently limited. It is noted that government methodological recommendations generally focus on agricultural land or in the context of forest land, and do not consider other categories of land. The necessity of continuing scientific research and the development of methodological recommendations for the assessment and restoration of land due to military actions is emphasized, and corresponding directions are proposed.

Keywords: *methodological recommendations, land quality assessment, soil quality assessment, consequences of military actions on lands and soils.*

Formulation of the problem. Problem statement. The full-scale military operations that took place in Ukraine in 2022 have exacerbated the economic, ecological, and social issues of humanity both within the country and globally. Apart from war, which is the biggest danger to humanity, equally pressing issues are the food crisis and the negative consequences of military actions on the environment. In particular, unexploded mines and ordnance, territories where intense military operations have taken place with subsequent chemical contamination, pose a serious threat to agricultural producers and the population of these areas. These dangers limit access to land and prevent agricultural producers from using their fields, reducing land productivity and leading to a shortage of agricultural products. Today, this has already led to a disruption of local food production in communities and means of existence for people.

There is a need to search for solutions for the restoration of territories that have been negatively affected by military actions. The most effective way during the wartime and post-war reconstruction of such territories should be scientific research covering the issues of environmental and ecological consequences of war, the impact of military actions on various components of nature such as soil, water resources, forests, and possible methods for restoring different types of ecosystems.

Analysis of recent scientific research and publications. The assessment of the impact of military operations on land use and their restoration for agricultural use has not escaped the attention of the scientific community, as well as state, private institutions and civil society organizations. Foreign scientists such as James B., Glen R. Gibson, Eklund L., Dejerald M., Brandt M., Prishchepov O. Piletsyo P. were involved in the study of the consequences of the food crisis and the impact of military operations on land productivity.

The study by Gibson, Campbell, and Zipper (2015) focused on assessing the impact of military operations on farmland and agricultural production in Iraq before, during, and after the active phase of the war from 2003-2011. During the study, the

authors analyzed UN data and remote sensing to track changes in soil cover and crop structure in agricultural fields in Iraq (Gibson, Campbell, and Zipper, 2015) [1].

Similar studies for the territories of Syria and Iraq were conducted by Eklund L., Degerald M., Brandt M., Prishchepov A., Pilesjö P., who used satellite-derived time series data to quantitatively determine the areas of agricultural land cultivated from 2000 to 2015. Their study emphasizes the importance of understanding these diverse changes in the land system related to the impact of conflict [2]. Similar studies were carried out with the support of the United Nations by experts from the Food and Agriculture Organization (FAO), who determined various losses in areas affected by armed conflict.

The productive potential of land in Ukraine was studied by such scientists as Dorosh Y.M., Dorosh O.S., Kupriyanchyk I.P., Butenko Ye.V., Kharytonenko R.A., and others. They highlighted the essence of the concept of productive potential of land, the prerequisites for its emergence, and the necessity of assessment. The main indicators for evaluating the productive potential of agricultural land, taking into account the qualitative characteristics of soils and agro-technologies, were proposed. The problems of increasing the productive potential in Ukraine were described. The need for forecasting in assessing the productive potential of the territory through the creation of economic-mathematical modeling was also discussed. [3,4]. The national report "On the Policy of Integration of Ukrainian Society in the Context of Challenges and Threats of Events in Donbas" [5], conducted under the leadership of Libanova E.M., presented ecological and natural resource losses due to military actions in the Luhansk and Donetsk regions during 2014-2015. In particular, scientists determined the area of land resources by land use categories according to administrative districts located in temporarily uncontrolled Ukrainian territories. The report also provided a normative monetary assessment of agricultural land in the Donetsk and Luhansk regions, which are under the control of illegal armed groups during the ATO in eastern Ukraine. The report emphasized that this led to the prohibition of access to large areas of agricultural land, resulting in a decrease in food production. Another important problem is the destruction of arable land, which becomes unsuitable for cultivation after shelling, as

well as damage or destruction of forest protection strips that are important for agriculture.

It can be said that although scientists may use similar research methods in different regions of the world, the legislative, natural and cultural characteristics of each area may change the nature of their work. Data from the work of scientists (Gibson, Campbell and Zipper, 2015; Eklund et al., 2017). is a practical example for further research . Ukrainian territories have differences in natural environment and legislative provisions compared to Asian countries. Also, the intensity and scale of military operations require improving the methods of assessing economic losses from military actions, particularly in agriculture, taking into account current capabilities.

The purpose of the study there is an analysis of scientific papers and methodological recommendations dedicated to the assessment and restoration of land use productivity, including those affected by military operations in Ukraine.

Materials and methods of scientific research. The scientific article applied methods of scientific knowledge: monographic, analysis, and generalization. The monographic method was used to analyze scientific works of domestic and foreign researchers, government methodological recommendations on the issue of assessing land losses due to emergencies, including armed conflicts. The analysis method was used to analyze relevant government methodological recommendations and regulatory acts regarding the assessment of land losses due to emergencies and armed conflicts, which affected land use. The generalization method proposed the improvement or development of methodological recommendations or corresponding measures for assessing the consequences and restoring the territories affected by armed conflicts.

Research results and discussion. According to the "Ministry of Environmental Protection and Natural Resources of Ukraine," as of mid-February 2023, "over 280,000 square meters of land have been damaged and contaminated with hazardous substances, 14 million square meters of land have been littered with debris from destroyed objects and ammunition, and more than 59,000 hectares of forests and other plantations have been burned by rockets and shells" due to hostilities in Ukraine [6]. Unfortunately, there

is no exact data on the number of landmines in Ukraine, as a large portion of the mines are laid in areas that are not recorded by official sources. However, according to the State Emergency Service of Ukraine, "currently, 30% of its territory has potential risks of explosive objects and mines" [7]. These areas may be located in 17 regions of Ukraine (Figure1)[8].

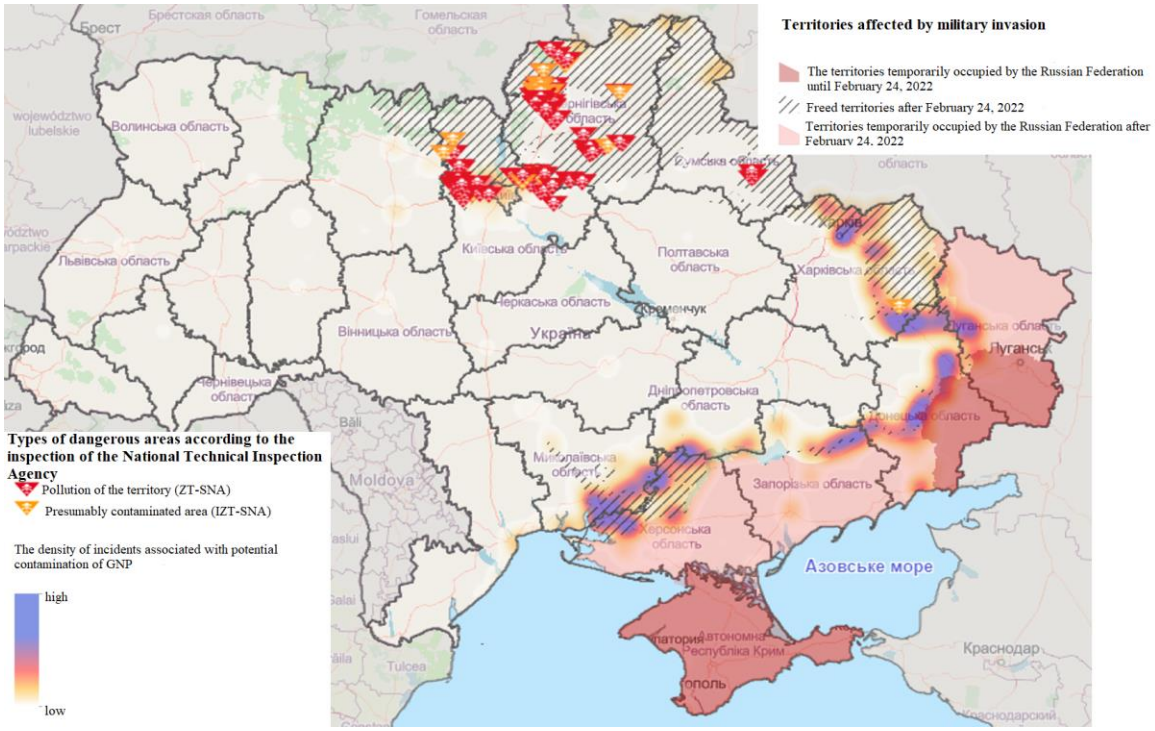

Fig. 1. Interactive map "Information on the dangers of explosive objects (EO) and training on risk prevention" [8]

Currently it is difficult to provide official figures on the overall losses of land, ecology, and soil in Ukraine due to the ongoing conflict, as the state of war is defined by the moving military front and varies in different areas depending on who controls the territory. However, there are some estimates and statistics from conflict zones. As for the losses of soil quality and overall land, the number of affected land plots has not yet been assessed. The most probable damage to land was suffered by landowners and land users in the Kyiv, Chernihiv, Poltava, Sumy, Kherson, Kharkiv, Mykolaiv, Zaporizhia, Dnipropetrovsk, Donetsk, and Luhansk regions.

To assess the damage caused by emergencies and other disasters that had a negative impact on the land of Ukraine, especially agricultural land, a number of studies were conducted by government agencies and scientific institutions, and corresponding methodological recommendations were proposed.

The Ministry of Environmental Protection and Nuclear Safety of Ukraine approved the "Methodology for determining the size of damage caused by pollution and littering of land resources due to violations of environmental legislation" with order No. 171 of October 27, 1997 [9].

– The appropriate methodology for determining the loss of land resources has an expanded terminological apparatus, in particular the concept of the terms - "the depth of percolation of the pollutant, ground water, grounding, land pollution, ground pollution, land clogging, land resources, land (lands), open land, built-up land" ". , aeration zone, control sample, control content of substances in the soil, normative monetary assessment of land plots, soil fertility, soil quality" [9]. Methodology No. 171 dated 10/27/1997 defines the sequence, coefficients and criteria for land pollution assessment [9]:

– "procedure for determining soil pollution (contamination)" [9];
– "determination of damages caused by soil pollution" [9];
– "determination of damages caused by land littering" [9];
– "hazard coefficients of pollutants" [9];
– "scale of ecological and economic significance of land" [9];
– "correction factor for the depth of penetration of pollutants" [9];
– "relative density of certain pollutants at +20 °C" [9];
– "coefficients of land littering" [9];
– "formulas for calculating damages caused by soil pollution" [9];
– "formulas for calculating damages caused by land littering" [9];
– "pollution level coefficients" [9];
– "correction factors for the depth of penetration of pollutants" [9].

"The methodology for assessing damages from the consequences of man-made and natural emergencies is approved by the Resolution of the Cabinet of Ministers of Ukraine" [10] No. 175 dated 02.15.2002. The relevant methodology allows you to calculate the following indicators related to land and land plots:

-"confiscation or violation of agricultural land" [10];

-"pollution of surface and underground waters, as well as sources and inland waters" [10];

-"pollution of marine waters and territorial seas" [10];

-"pollution of non-agricultural land" [10].

In particular, this methodology divides the types of losses by the nature and level of emergencies. The methodology establishes norms for losses for different types of agricultural land in regions. The methodology emphasizes that the detection of the fact of direct land pollution is carried out visually and with the help of chemical-analytical studies of soil samples.

The rules for developing working land management projects for the reclamation of damaged land have been approved by the Resolution of the Cabinet of Ministers of Ukraine "On Approval of the Rules for Developing Working Land Management Projects" [11] dated February 2, 2022, No. 86. However, the aforementioned Resolution of the Cabinet of Ministers of Ukraine specifies that the relevant working land management projects for the reclamation of damaged land belong to damaged land - "in connection with the construction of industrial facilities, the development of deposits, the extraction of minerals, the performance of other work, materials of geodetic surveys conducted during the formation of a land plot and the preparation of construction projects may be used" [11]. This working project does not take into account all the specifics that may be necessary for land reclamation, in particular, "they were damaged as a result of hostilities, construction, improvement and maintenance of engineering and fortification structures, fences, border signs, border cuts, communications for arranging the state border" [11].

With the onset of hostilities in eastern Ukraine in 2014 and later the large-scale military aggression of the Russian Federation on the territory of Ukraine from February 24, 2022, new challenges arose for assessing the damage to land and land plots due to the hostilities. The process of determining the extent of the damage was approved by the government through a series of methodological recommendations.

The Resolution of the Cabinet of Ministers of Ukraine "On the regulation of certain issues of the activity of economic entities that suffered losses due to the

temporary occupation of territories in Donetsk and Luhansk regions" [12], No. 326 of March 20, 2022, regulates the issue of compensation for losses incurred by economic entities in temporarily occupied territories. This Resolution of the Cabinet of Ministers of Ukraine establishes the main indicators for assessing losses, including those related to land use, land plots, and soils:

-"Expenses for the restoration of lands that were damaged as a result of military operations, construction, installation, and maintenance of engineering and fortification structures, fences, border markers, border clearings, communications for the arrangement of the state border" [12];

-"Losses inflicted on owners (land users) of agricultural land plots" [12];

-"Expenses for the restoration of reclamation systems" [12];

-"Damage caused to soils and land plots due to contamination of soils by substances that have a negative impact on their fertility and other useful properties" [12];

-"Damage caused to soils and land plots due to littering of land plots with foreign objects, materials, waste, and/or other substances" [12].

In addition, the Cabinet of Ministers of Ukraine Resolution No. 326 of March 20, 2022 defines the main indicators for forestry production, protected natural areas, water resources, and the rights restrictions of land users in the use of these land plots.

The following Cabinet of Ministers of Ukraine Resolution "On the collection, processing and accounting of information on damaged and destroyed immovable property as a result of hostilities, terrorist acts, sabotage, caused by the military aggression of the Russian Federation" [13]No. 380 of March 26, 2022 does not contain specific provisions on land, land plots and land use. However, it is stated that the "cartographic basis of the State Land Cadastre, information of the urban cadastre and cadastres of other natural resources, other maps (plans), as well as products of remote sensing and Earth observation" are used for collecting, processing, and accounting of information on damaged property, including land plots [13]. Taking into account the requirements of Resolution of the Cabinet of Ministers of Ukraine No. 326 of March 20, 2022, the Ministry of Agrarian Policy and Food of Ukraine approved Order No. 295 of

May 18, 2022, with the corresponding methodology "on determining the damage and losses caused to the land fund of Ukraine as a result of armed aggression by the Russian Federation" [14]. According to paragraph 5 of this methodology, "the costs of landowners and land users for land reclamation that was disturbed as a result of hostilities are determined based on the estimated cost of the planned works of the corresponding implemented projects of land management for the reclamation of the disturbed lands" [14]. Additionally, the methodology states that the costs of restoring reclamation land and related engineering infrastructure systems are determined based on the estimated cost of works in accordance with the State Building Code of Ukraine DBN V.2.4-1-99 "Meliorative Systems and Structures" [14].

The Ministry of Environmental Protection and Natural Resources of Ukraine approved by order No. 167 dated 04.04.2022 the "Methodology for determining the amount of damage caused to land and soil as a result of emergencies and/or armed aggression and hostilities during martial law". These guidelines specify:

-"Procedure for determining the damage caused by soil contamination and land pollution resulting from emergencies and/or armed aggression and hostilities during martial law" [15];

-"Determination of the amount of damage caused by soil contamination" [15];

-"Determination of the amount of damage caused by land pollution" [15];

-"Use of calculations to determine the amount of damage caused by soil contamination and land pollution" [15].

It is worth noting that the conceptual framework in this methodology is represented by the terms "soil pollution" and "land contamination", and does not reflect the term "technogenically polluted lands", which also characterizes lands that are polluted with heavy metals, radioactive and other chemical elements, etc.

Further recommendations for assessing the impact of military operations on land and land plots and determining losses and damages involve research by scientific institutions and individual groups of scientists and international organizations.

Scientists from the O.N. Sokolovsky Institute of Soil Science and Agrochemistry of the National Academy of Agrarian Sciences of Ukraine conducted surveys of land

plots "that suffered from various types of damage as a result of aviation and artillery shelling" [16]. They proposed recommendations for the reclamation of soils affected by military actions. Researchers recommend carrying out reclamation work only after checking the area for explosive objects and demining it. Based on the survey of land plots that suffered from various types of damage due to aviation and artillery shelling, scientists found that the content of macroelements (nitrogen, phosphorus, and potassium) in the soil did not undergo significant changes. However, to assess the condition of soil after destruction caused by military actions, soil-agrochemical survey of the area is proposed in order to determine the degree of deterioration of the soil and develop a plan of measures for its reclamation. Depending on the extent of soil damage, it is proposed to level the soil surface or excavate deep pits and fill them with parent rock and soil mass. Scientists from the Institute of Soil Science and Agrochemistry named after O.N. Sokolovsky NAS of Ukraine "recommend removing large fragments of shells after demining for safe work of agricultural machinery and workers in the fields" [16]. In case of extensive damage in terms of depth and area, restoration work may require adding soil mass to subsided areas and leveling the surface within 2-5 years after reclamation [16]. The "German-Ukrainian Agro-Political Dialogue (APD)" project conducted a study on the challenges and the need for clearing territories of explosive hazards, as well as the threats posed by explosive hazards on agricultural land in Ukraine caused by military operations in 2022. In particular, they examined weapon systems and ammunition that will subsequently affect the contamination of territories with explosive hazards after military operations. They proposed a priority for clearing territories of explosive hazards and emphasized the danger of the presence of explosive hazards on agricultural land [17].

A group of scientists led by Tretiak A.M. has established that the norms for calculating the damage caused to land resources and land use as a result of Russian military aggression, approved by the Cabinet of Ministers of Ukraine, can be used. However, it is urgently necessary to develop and approve additional regulatory and methodological documents for assessing losses. These documents should include land inventory, determination of land rights and other natural resources destroyed or

damaged as a result of emergencies, hostilities, terrorist acts, technical documentation for inventorying land plots and identifying land rights and other natural resources, methodological recommendations for conducting accounting. They emphasized the "need to determine direct damage to the productive potential of land, methods and procedures for assessing the value of damage, and the development of comprehensive plans for territorial and spatial restoration and land use development in affected areas" [18].

Conclusions and suggestions. After reviewing and analyzing government guidelines, research from scientific institutions, groups of scholars, and civic organizations related to the study of assessing and measuring the impact of armed conflict on land, it was determined that they provide a solid theoretical foundation for further research in practical settings.

However, practical research related to assessing the impact of combat operations on the productivity of land use, particularly in the context of territorial communities, is still limited and often lacks a systematic approach. There is also a need to select the most objective methodology for conducting such research. Government methodological recommendations generally focus on lands in general or on lands for agricultural or forestry purposes, and do not consider other land categories. It should be emphasized that territorial communities are independent administrative units where residents of villages, towns, and cities live and engage in their production activities, which are generally associated with community lands. Therefore, research on the assessment and restoration of lands affected by combat operations should be conducted in the context of these territories. Based on the above, we propose continuing scientific research and developing methodological recommendations for assessing and restoring lands affected by combat operations along the following directions:

-Approaches to assessing the productive potential of land in terms of relevant land categories affected by combat operations;

-Methodological recommendations for determining and assessing losses of productive potential of lands in territorial communities affected by negative impacts of combat operations;

-Methodological recommendations for analyzing Earth satellite imagery to identify lands damaged by armed aggression;

-Methodological recommendations for inventorying and analyzing lands that have been damaged by combat operations;

-Methodological recommendations for assessing losses to landowners and land users whose land plots have been damaged by combat operations;

-Land reclamation project for restoring lands affected by combat operations;

-Proposals for introducing restrictions on the use of lands and land plots affected by combat operations;

-Distinctive and supplementary terminology related to assessing and determining losses to lands due to combat operations;

-Predictive proposals on the effectiveness of proposed measures to restore the productive potential of lands in communities affected by combat operations.

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АНАЛІЗ НАУКОВО-МЕТОДИЧНИХ ПІДХОДІВ ЩОДО ОЦІНКИ ВПЛИВУ БОЙОВИХ ДІЙ НА ПРОДУКТИВНІСТЬ ЗЕМЕЛЬ

Проведено огляд та аналіз державних методичних рекомендацій, досліджень наукових установ, колективів науковців та громадських організацій щодо вивчення оцінки та впливу бойових дій на місцях. Виділено та зазначено ключові положення методичних рекомендацій щодо оцінки негативних наслідків на землі внаслідок техногенного забруднення та шкоди. Проаналізовано та зазначено ключові положення методичних рекомендацій щодо оцінки негативних наслідків на місцях внаслідок бойових дій.

Розглянуто дослідження наукових установ, колективів науковців та громадських організацій, пов'язаних з дослідженнями оцінки та впливу бойових

дій на землі та ґрунти. Вказується, що практичні дослідження на сьогоднішній день, пов'язані з оцінкою впливу бойових дій на продуктивність землекористування, зокрема, в розрізі територій територіальних громад, є точковими. Зазначається, що методичні рекомендації уряду, присвячені земельним ділянкам загалом або в розрізі земель сільськогосподарського призначення, лісового фонду та не враховують інші категорії земель. Наголошено на необхідності продовження наукових досліджень та розробки методичних рекомендацій щодо оцінки та відновлення земель внаслідок бойових дій та запропоновано відповідні напрямки.

Ключові слова: *бонітет земель, бонітет ґрунтів, наслідки бойових дій на землях і ґрунтах, продуктивний потенціал.*