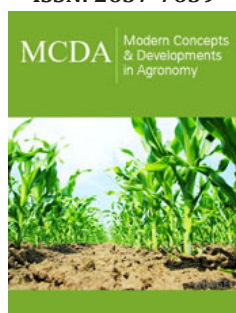


A Mini-Review of the Problem of Pollution of the Territories of Ukraine as a Result of Hostilities



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Abstract

The restoration of territories after military operations is a long, complex and expensive process that requires the joint efforts of the Government, local authorities, farmers and the help of international organizations. Most often, such recovery begins after the liberation of a certain territory from the aggressor. Full-scale reconstruction is carried out after the end of the military conflict or the complete liberation of the territories from occupation. Work should begin with research and accounting of destruction, damage, soil pollution and other negative consequences. This is an ongoing process regulated by the "International Mine Action Standards". The paper examines the main problems of restoring the territories of Ukraine, including rural ones. These problems already exist or can be predicted today. Foreign experience in this area, especially US experience, will be very important when planning the recovery process. It should be taken into account that each armed conflict is unique, therefore the restoration of territories depends on specific circumstances and for each separate territory it will consist of a different set of measures; therefore, losses and expenses can only be determined approximately, with further clarification.

Keywords: Military waste; Pollution; Environment; Rural area; Ukraine

Introduction

Until 2014 (the beginning of the Russian armed aggression against Ukraine [1]), in Ukraine there was practically no problem of contamination of territories due to hostilities, if we do not take into account the period of the Second World War, after which all spheres of life, especially agriculture, were affected. Then one of the most tangible consequences for the Ukrainian Soviet Socialist Republic was the contamination of all territories with military waste, where battles were fought. As of 1991 (the declaration of Ukraine's independence), all the consequences of the dangerous influence of military waste left after the war were eliminated, but it should be noted that cases of ammunition explosions encountered by Ukrainian agricultural machinery still occasionally occurred. Until February 24, 2022, there was a chance to settle the conflict in Donbas peacefully, even the "State Regional Development Strategy for the period 2021-2027" was developed and approved. The document noted that the regions with mainly agricultural specialization need special attention: Kirovohrad, Kherson, Khmelnytskyi, Vinnytsia, Chernihiv, Sumy and Ternopil [2]. Today, it is these regions that suffer the most from artillery and missile attacks. The unprovoked war in Ukraine, unleashed by Russia, further deepened the social, economic and environmental problems that existed in the country before that. War causes irreparable damage to demographic processes. Due to the Russian invasion of Ukraine and the departure of citizens abroad, the population of Ukraine has approximately decreased to 33.5 million people [3]. Most of these people lived in rural areas, so the post-war reconstruction may become problematic also due to the lack of workers. In addition, in the conditions of martial law, the processes of agricultural management are complicated, primarily in the occupied territories, or on the front line, which is constantly changing [4]. In the context of rebuilding the infrastructure of rural areas, the researchers indicate that the main sources can be the following: grant, targeted funding (in particular,

from international organizations, reconstruction donor countries, income from private donors through the United24 platform); state funding; accumulated funds that will undergo reparations procedures from the aggressor country; private capital, which will be directed to the economy of rural areas and the restoration of relocated or destroyed enterprises [5].

Agricultural production is a key sector of Ukrainian exports. According to data for 2021, agricultural exports amounted to \$27.8 billion, which accounted for 41 percent of the total volume of exported goods. The war started by Russia against Ukraine has left its mark on the country's economy, particularly on agriculture. The disruption of supply chains and agricultural production has already caused significant damage to the people, the economy, and the environment of Ukraine [6]. Government policy today is aimed at solving the issues of rebuilding key areas of Ukraine's economic activity, restoring its competitiveness, establishing production based on innovative approaches and technologies, raising the standard of living of people and forming a plan of measures for post-war reconstruction of the country [7]. Some researchers believe that the formation of priorities in solving the issues of post-war reconstruction of the affected rural territories requires the development of systematization of approaches to determining the economic essence of the concept of "rural territory" [8].

Thus, consideration of the damage caused to the rural areas of Ukraine as a result of military operations should be considered from 2014, from the moment of Russia's support for the conflict in Donbas and the seizure of the Crimean Peninsula, which belongs to the territory of Ukraine. However, if there were no active hostilities in Crimea, a large part of the territories of Donetsk and Luhansk regions fell into the fighting zone. Because of this, since 2014, more than 180,000 square kilometers of land have already been polluted in Ukraine, including settlements and agricultural land [9].

The Problem of Pollution of the Territories of Ukraine

Today, a third of Ukrainian land has become a zone of risky agriculture. This means that the territory is mined and is potentially dangerous for agricultural work. The total figure for losses from soil pollution and soil pollution, as of the beginning of 2023, exceeds UAH 845 billion (\$23 billion). During the war, the State Environmental Inspection recorded more than 2,300 cases of damage to the environment in the amount of about half a billion dollars [10]. Given that the armed conflict continues and the bombings, missile attacks and launching of drones continue, the area of damaged and polluted territories of Ukraine is constantly increasing, and therefore the amount of damage will be much larger.

The impact of the Russian invasion of Ukraine on the agricultural sector after one year of full-scale conflict (February 24, 2022, to February 24, 2023) is as follows: direct losses amount to \$8.7 billion, indirect losses, incl. reduced production of agricultural crops and animal husbandry, as well as disruptions in logistics and increased production costs, amount to an additional \$31 billion. Approximately \$29.7 billion is needed for reconstruction and restoration [11].

In addition, more than 20% of nature conservation areas of Ukraine were affected by the war; losses of this type are estimated at half a billion dollars. Due to forest fires, as a result of the burning of petroleum products and the burning of industrial facilities, dangerous substances enter the air. Starting from February 24, 2022, the number of such emissions exceeded 67 million tons per year. For comparison: in 2020 and 2021, they amounted to 2.2 million tons per year. In total, 3 million hectares of forests have already been affected in Ukraine (some of them have been lost forever) - This is almost a third of the entire forest fund of the state [12].

2.9 million hectares of the Emerald Network are in the risk zone - the territory that makes up a significant part of the nature protection network of Europe, which is protected within the limits of the legislation of the EU and the Council of Europe. Almost 0.6 million hectares of wetlands of international importance, which are part of 16 protected objects of the Ramsar Convention, are under threat [13]. About 20% of the territories of Ukraine are under temporary occupation or hostilities are taking place, there is large-scale pollution, its main types include:

- a. fragments of metal structures, buildings and structures.
- b. leakages of fuel and lubricants.
- c. combustion products.
- d. harmful substances of biological and chemical origin.
- e. unexploded or unused ammunition, explosive substances.

The last group is the most dangerous.

Russian troops fire 40 000 to 50000 artillery shells of all types and calibers at Ukrainian positions and settlements every day [14], of them, about 10% do not explode, some fall into forest areas and forest belts. In addition, during the retreat, Russian troops mine territories, including forest ones, set a large number of mines, stretch marks, traps. Visits to the forests in regions where hostilities have taken place or are still ongoing, as well as in occupied or liberated areas, are dangerous. For these reasons, harvesting of wild plants (berries, mushrooms, and medicinal plants), wood, maintenance of apiaries and other types of economic activities, thanks to which the inhabitants of these areas improved their well-being and diversified their diet, consumed ecologically clean products, and used folk medicine, were completely stopped. Among the most affected regions: Chernihiv region - approximately 400 thousand hectares, Sumy region - 290 thousand, Luhansk region - 200 thousand, Kyiv region, Zhytomyr region and Kharkiv region - 120-160 thousand hectares [15].

Damage to the environment from the destruction of the Kakhovskaya HPP (June 6, 2023) is estimated by independent experts at a minimum of UAH 55 billion (about \$1.5 billion) [16]. This amount does not include the costs of restoring the dam, flooded rural areas and problems with access to fresh water that will arise on the Crimean Peninsula [17].

Since Ukraine does not have sufficient experience in cleaning territories from waste of military origin, it is necessary to take into

account the experience of other countries, in particular the USA. Since the end of the Cold War, the Department of Defense has closed almost 100 major military bases and many smaller ones. Regardless of the purpose the land may be put to, these installations must all go through a process of environmental restoration to ensure the safety of the eventual users. A large amount of Unexploded Ordnance (UXO) was found artillery shells, bombs, rockets, hand grenades, etc. To estimate the total cost of munitions disposal works, a special Remedial Action Cost Engineering Requirements (RACER) program was developed in the USA, which, depending on the complexity of cleaning, determined the need to use one of the alternative protocols. The most expensive of them was estimated at \$1.1 billion, the cheapest - \$35 million. On average, for one plot of land, the cost of munitions disposal was set in the range of \$84-120 million [18].

Based on the world's developments in this field, before starting the restoration of Ukraine's environment, it will be necessary to prepare the territories. This means that the following actions will be a priority:

1. Clear the territory after hostilities:
 - a. from ammunition that is in public access (at positions, in abandoned or damaged equipment).
 - b. from ammunition on the ground (artillery shells, bombs, anti-tank mines, etc.).
2. Clear the territories of cluster munitions, which are prohibited by international conventions, but are used by Russian troops (rocket artillery) [19].
3. Carry out demining of anti-personnel mines, which are prohibited by international conventions, but are used by Russian troops [20].
4. Carry out demining of anti-tank mines, which pose a significant problem for agricultural activity.

In order to begin cleaning up areas, complex preparatory activities will first have to be carried out, in particular, surveying and accounting of areas contaminated by ammunition, explosives, biohazards and toxic substances. For this purpose, the following are used: trial soundings, historical, documentary, cartographic and other studies, interviews of eyewitnesses, etc. This activity is regulated by the International Mine Action Standards IMAS developed by the United Nations Mine Action Service.

International standards for humanitarian demining programmes were first proposed by working groups at an international technical conference in Denmark, in July 1996. Criteria were prescribed for all aspects of demining; standards were recommended, and a new universal definition of 'clearance' was agreed. In late 1996, the principles proposed in Denmark were developed by an UN-led working group and the International Standards for Humanitarian Mine Clearance Operations were developed. The first edition was issued by the UN Mine Action Service (UNMAS) in March 1997. The scope of these original standards has since been expanded to include the other components of my action and to reflect changes to

operational procedures, practices and norms. The standards were re-developed and renamed as International Mine Action Standards (IMAS) [21]. The entire IMAS package consists of 40 guidelines, all of which will need to be followed during the site clearance process.

In the conditions of martial law, significant negative trends relate to the impossibility of long-term planning of agricultural production, material and technical support, the task of forming reserves of fuel and lubricants is becoming acute. At the same time, there is a need for a clear outline of approaches to the formation of the structure of cultivated areas of agricultural crops, primarily aimed at ensuring the domestic market of food products, as well as increasing the level of adaptability of agricultural production to new economic conditions [4].

It is still too early to talk about the full-scale cleaning of the lands of Ukraine, however, in order to ensure agricultural producers access to the 2022 harvest, 70 pyrotechnicians and 27 units of special equipment worked in the Chernihiv region alone. More than 36,000 units of explosive objects were discovered and removed (disarmed), more than 37,000 hectares of territories of Chernihiv, Nizhyn and Prylutsky districts were surveyed [22]. It should be noted that these works concerned only the lands of a relatively small area, and all the territories of the regions will have to be cleaned completely. Unfortunately, today there are frequent cases of injuries to farmers and damage/destruction of agricultural machinery as a result of hitting mines massively planted by the Russian side in the fields of Ukraine and Russian shells that did not explode. In addition, harvesting in 2023 in Ukraine will be associated with even greater problems, as shelling and strikes on rural areas by Russian troops continue, and as a result, military waste accumulates, and the areas become more and more polluted.

Conclusion

The complete cleansing of the lands from the consequences of the Russian armed attack on Ukraine will require a very large effort, funds and the use of many units of specialized equipment. The problems faced by Ukrainian agrarians today due to land contamination with military waste will only intensify after the end of the war. In general, large material and labor costs can be predicted for the future, because for the cleaning of only Ukrainian agricultural lands (the contaminated area is already about 25 thousand square km), taking into account the involvement of all available resources, approximately 80 million man-hours are needed; to spend on 1 man-hour, including equipment, -\$30. Thus, the cost of demining agricultural areas of Ukraine will be estimated at more than \$2.3 billion.

Before the cessation of hostilities, it is impossible to fully determine all economic losses and assess the damage caused to the environment of Ukraine. Specialists indicate different amounts needed to restore everything that was destroyed and damaged, but considering that there are many different complicating factors, for example, no one takes into account the lost potential profits from activities related to agriculture and tourism, there is reasons to assume that the final amounts will significantly exceed the initial amounts.

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