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ON THE QUESTION OF THE PROBLEM OF DISTURBED LANDS UNDER THE CONDITIONS OF THE STATE OF WAR AND THEIR RESTORATION

The main component of the natural environment and the biosphere in general is soil - a limited, irreplaceable and difficult-to-renew natural resource that performs important functions: productive (biomass production, nutrition), ecological (biogeochemical, geohydrological, bioenergetical, biological), social, informational, and others. "Land is the main national wealth under the special protection of the state" - the Article 14 of the Constitution of Ukraine was established.

Due to the full-scale Russian invasion of Ukraine about a third of all chernozems of the European continent and 9% of the world's chernozems significantly disturbed by military action. More than 20% of all Ukrainian lands and protected areas of Ukraine occupied, and about 1 million hectares a total area damaged. Shell craters, steel parts from air bombs, artillery shelling and drone attacks, explosions, oil leaks and pollution from burnt military equipment, compaction and burning of fertile soil and vegetation lead to complex land damage (mechanical, physical, chemical and biological). Restoration of lands can take a long time. According to the Operational Headquarters at the State Environmental Inspectorate of Ukraine, the total environmental (land, water, landscape, nature reserve) damages as a result of the armed aggression of the Russian Federation amount to about 2 trillion UAH., and the estimated area of disturbed soil reaches about 900,000 hectares.

The total amount of damage caused to the soils of Ukraine (taking into account the costs of reclamation, restoration of reclamation systems, cleaning of contaminated soils and littered land plots, direct and indirect losses) amounts to almost 1.2 trillion UAH, or 34 billion dollars USA [1].

One of the most acute problems of the Ukraine is the mine contamination of the territories, the area of which, according to the State Emergency Service, is about 170,000 km² (almost two Moldova or two Austria). According to the UN Office for the Coordination of Humanitarian Affairs, since 2014, almost 2 million residents of Ukraine have already lived surrounded by landmines. During this period, hundreds of civilian casualties recorded due to incidents involving explosive ordnance. At the same time, the demining of territories will remain a priority in the work of the State Service of Ukraine for Emergency Situations for a long period. The post-war experience of the Balkan countries shows that it can last more than 20 years, and the estimated cost of complete demining of Ukrainian lands can reach 50 billion US dollars.

The special danger of environmental terrorism today is the use of large dangerous objects (atomic, electronic, chemical and environmental), such as: the targeted destruction by the RF military of the Kakhovska HPP and the Kakhovka reservoir, the real threat of damage to Zaporizhska NPP and the use of nuclear weapons.

Modern military aggressions are environmental terrorism, that is, a manifestation of serious crime that can affect not only public safety and public order, but also the peace and security of humanity on a global scale. Today, a number of methods of active influence on the environment for military purposes already been created. For example, the artificial destruction of the ozone layer, the scattering and formation of clouds and fog, the initiation of earthquakes, the creation of tsunami-type tidal waves, the influence of tropical cyclones, the use of atmospheric currents for the transfer of radioactive and other substances, the creation of disturbance zones in the ionosphere. Each method poses a danger both to the participants in the armed conflict and to other states. According to the IAEA, more than 10 million sources of ionizing radiation used in the world today. Now, the nuclear confrontation of the parties may be replaced by a less visible, but no less dangerous ecological confrontation with the use of the following types of environmental weapons (according to the structure of natural spheres): meteorological, hydrobiospheric, lithospheric, climatic [2].

Industrially developed regions with a high population density are the most vulnerable to the impact of damaging factors of a military nature and environmental/technological terrorism. Technological terrorism can be defined as a set of innovative ways of carrying out military/terrorist actions (which today also include aerospace and information terrorism).

The danger increases as the ability of military aggressors/terrorists to use industrial toxic substances increases. Ukraine has already accumulated a huge amount of radioactive waste. The total volume of radioactive waste is about 3,300-4,600 thousand m³, and 13 thousand m³ of liquid radioactive waste and 28 thousand m³ of solid radioactive waste generated annually at the nuclear power plant alone. The current

state of affairs in the field of radioactive waste management does not provide the necessary level of protection, which increases the likelihood of military attacks and terrorist acts.

All the considered processes, which are further intensified and complicated by military actions on the territory of Ukraine, are to one degree or another related to physical and geographical conditions.

Based on the analysis of hydrophysical and biotic disturbances during land use, the features of their parameterization are determined as the basis of innovative technologies in land restoration (Table 1).

Table 1. The list of land disturbances due to the influence of the main hydrophysical, biotic phenomena and hostilities and the features of their parameterization in land use

<i>Land use</i>	
<i>Disturbances of lands</i>	<i>Restoration of lands</i>
<i>Influence of the main hydrophysical phenomena and military operations and the features of their parameterization</i>	
Rehabilitation of technogenically disturbed lands	Formation of a secondary surface to prevent gravity, surface runoff, wind erosion, solar radiation
Disturbances of landscapes	Partly – the reproduction of landscapes, partly – a change in the type of land use
Land erosion	Changes in the morphological structure of the surface, distribution of precipitation flows, aggregation of granulometric particles
Physical degradation, decrease in water permeability	Soil compaction
Presence of mines and contamination from weapons	Demining territories and mechanical land clearing
<i>Influence of the main biotic phenomena and features of their parameterization</i>	
Destruction of forests and natural reserve lands	Restoration of forests and lands of the nature reserve fund
Depletion of soils	Application of biotic technologies for restoration of soil fertility
Soil fertility decline	Introduction of innovative technologies in selection work
Wind erosion	Applying plants for strengthening the soil
Rehabilitation of technogenically disturbed lands	Returning natural soil fertility through artificial plantings and changing the type of agricultural use

Technogenic losses of land include: extraction of mineral raw materials, oil, gas, amber; cutting down forest belts in the south of Ukraine (will lead to huge losses of land due to lack of protection against soil erosion); deforestation (especially in mountainous areas), military operations, etc. We observe the emergence of particularly acute contradictions between industrial technologies and the environment in the process of functioning of mining and processing enterprises.

Over many decades of operation of Kryvbas mining and processing enterprises, huge masses of beneficiation waste have accumulated in the tailings, covering an area of about 10,000 hectares and estimated at about 8 billion tons. The total iron content in them is 15-18%, so they can be considered as Technogenic deposits [3, 4].

The analysis of parameters of Kryvbas tailings dumps also shows that they have a resource potential of solar generation comparable to their energy consumption (Table 2).

Table 2. Energy consumption and generation potential of solar power plants located on lands disturbed by mining enterprises of Kryvbas

Mining and processing enterprises	Production volume, million tons	Required power, MW*	Area of disturbed land, ha	Potential power of SPPs, MW
Northern mining and processing enterprises	14,2	493	2590	1290
Central mining and processing enterprises	8,9	309	3300	1650
Southern mining and processing enterprises	10,1	351	1870	935
Novokryvorizkyi mining and processing enterprises	9,6	333	1760	880
Inguletskyi mining and processing enterprises	14	486	1530	760
TOTAL (all in all):	56, 8	1972	11050	5515

Note.* - The Required power was calculated based on the indicators of the best available mining technologies (The information and technical handbook of the best available technology, 2017).

Rehabilitation of disturbed lands includes the following main directions, as formation of secondary ecosystems; reclamation; melioration. Reclamation, by definition, is a set of works aimed at restoring the productivity of disturbed lands. The technology of activating the formation of secondary soils allows for the disposal of organic waste from municipal, forestry, agriculture and processing industries.

Examples of the use of innovative ecologically oriented strategies in developed economies demonstrate the manifestation of the catalytic effect and the advantages of the effect of dynamic efficiency from their implementation. Taking into account the formation of sustainable development priorities, the green economy can be considered the most common strategy.

Innovative green development strategies focus on a combination of important goals such as economic efficiency and appropriate environmental and social standards. It was determined that the use of low-carbon technologies contributes to the reduction of CO₂ emissions by 1.5 t/ha [5]. This allows you to avoid additional CO₂ emissions during the operation of machines and mechanisms at the mining-technical and biological stages of reclamation.

In general, the methodology for combating environmental risks and environmental terrorism or military threats is a systemic approach. The main measures for environmental restoration include the assessment of damage to the environment caused during military operations, determination of the scope of restoration works, including demining and land reclamation, forest rehabilitation, and landscapes restoration.

According to the estimates of authoritative international experts (for the period until 2030) the implementation of green projects in the world will require attracting additional financing in amount of 90 trillion US dollars, which may make it difficult for Ukraine to obtain similar funds on the period of martial law and restoration [2].

In the coming years, a significant part of the existing fixed assets will be replaced due to their obsolescence or due to destruction during military operations or extreme climatic events. In the context of the development of a green economy, this will allow for more intensive implementation of innovative technologies.

Enterprises of the metallurgical complex and mechanical engineering of Ukraine are especially in need of such an update, since the latest technical equipment will be extremely important for the reconstruction of the energy complex, agricultural and chemical industries, logistics networks, as well as for the further strengthening of the defense complex. The state can mainly help in this, using the mechanism of public orders.

The foundation of Ukraine's high competitive status and influence should be a research, educational and law-making strategy, coordinated with the goals of sustainable development, standards of environmental, social and corporate responsibility, recognized and supported at the state level.

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