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ЕКОЛОГІЯ ТА РАЦІОНАЛЬНЕ ПРИРОДОКОРИСТУВАННЯ: ОСВІТА, НАУКА І ПРАКТИКА

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Treść / Зміст

INTELLIGENT INFORMATION SYSTEMS FOR MONITORING AND MANAGING ENVIRONMENTAL SAFETY IN THE FOCUS OF THE EUROPEAN GREEN DEAL

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Статтю присвячено позиціюванню інтелектуальних інформаційних систем моніторингу і управління екологічною безпекою в контексті імплементації Європейського зеленого курсу. Доведено доцільність розробки зелених стратегій повоєнного відновлення регіонів України на підставі відповідних інтелектуальних систем моніторингу довкілля. Ідентифіковано їх місце в системі управління екологічної безпекою на всіх рівнях (глобальний, регіональний, локальний). Визначено компонентний склад інтелектуальних інформаційних систем моніторингу довкілля, їх особливості та переваги застосування у якості інформаційного базису стратегій розвитку та гармонізації співіснування людини і природи.

Ключові слова: військова агресія, екологічна безпека, управління, інформаційні системи моніторингу довкілля, Європейський Зелений Курс.

The article is devoted to the positioning of intelligent information systems for monitoring and managing environmental safety in the context of the implementation of the European Green Deal. The expediency of developing green strategies for the post-war restoration of the regions of Ukraine on the basis of appropriate intelligent environmental monitoring systems is proved. Their place in the environmental safety management system at all levels (global, regional, local) is identified. The component composition of intelligent information systems for environmental monitoring, their features and advantages of using them as an information basis for strategies for the development and harmonization of the coexistence of man and nature are determined.

Keywords: military aggression, environmental security, management, environmental monitoring information systems, European Green Deal.

Problem statement. The global military aggression, in the epicenter of which Ukraine found itself, has had the worst impact on the environment through the destruction of natural landscapes and ecosystems (which is still ongoing) and has provoked the emergence of crisis phenomena in the global economy. The state of the natural environment in many regions of the country is under the threat of terrible degradation, when it becomes impossible for it to regenerate and reproduce itself.

Missiles, artillery shells of various types, high-explosive bombs, drones, shells of various types of MLRS, "vacuum" bombs, contamination with explosive objects, etc. destroy the top fertile layer of soil. The destruction of critical infrastructure and buildings, fires, huge craters, construction of fortifications and the movement of heavy equipment lead to the generation of large amounts of military waste containing ozone-depleting substances and cause terrible changes in the natural landscape. Vegetation degradation, increased wind and water erosion, and soil contamination with fuels and lubricants and other oil products are occurring. Soils soaked in fuels and lubricants reduce water permeability, displace oxygen, and disrupt biochemical and microbiological processes. As a result, water, air, and nutrient cycling deteriorate, root nutrition of plants is impaired, and their growth and development are inhibited, leading to death. Endemic species of plants and animals face a critical threat, and their extinction will have catastrophic consequences for global biodiversity. Unfortunately, this is only part of the overall problem of environmental degradation and vital losses caused to the natural environment and the population of Ukraine and humanity as a whole. In the context of a systemic solution to this problem, the issues of stopping environmental hazards in the context of hostilities, compensation for damage and restoration of environmental balance on an innovative basis within the framework of the European Green Deal are of great importance. Their successful solution requires appropriate information support and actualizes the study of intelligent information systems for monitoring and managing environmental safety at all levels of management.

Analysis of recent research and publications. The issue of environmental monitoring in the management of environmental safety, in particular under martial law, is the subject of close attention of modern scientists. The works of I.I. Karakash, P.F. Kulinich, O.I. Liubynskyi, O.M. Semernia, A.M. Tretiak, V.M. Tretiak, Zh.O. Rudnytska, I.V. Fedorchuk, S.V. Khominets, S.V. Sharapova, etc. [1-8]. However, the urgency of environmental safety issues at various levels (global, regional, local) requires deepening research on information support for decision-making in the field of environmental restoration, environmental protection measures and rational use of natural resources, and the development of a system for monitoring the environment and individual natural resources.

Formulation of the objectives of the article. The purpose of the study is to position intelligent information systems for environmental monitoring in the management of environmental safety through the prism of the implementation of the European Green Deal.

Summary of the main research material. Currently, it is impossible to talk about restoring and maintaining an acceptable state of the environment in isolation from the tenets of the green economy. Implementation of the European Green Deal [9] in the context of current challenges is a difficult task, as the military conflict directs resources, attention and efforts to address immediate needs and security issues. However, even in these difficult circumstances, maintaining environmental awareness and taking steps towards green development should be a priority.

The drivers of positive post-war change should be strategies focused on preserving the environment and reducing the environmental impact of the conflict, which are already being developed and implemented [10]. They should include a number of measures to:

- waste management and environmental threats to minimize emissions, explosives and other threats to the ecosystem, and implement measures to protect nature and water resources;

- promoting environmentally friendly practices in military operations through the use of technologies that reduce the environmental footprint of military operations (in particular, efficient use of resources, use of environmentally friendly means of communication, etc;);

- support environmental initiatives during military operations by facilitating assistance to environmental organizations or projects aimed at restoring ecosystems and helping those affected environmentally;

- developing plans for the future through forward-looking planning aimed at restoring ecosystems after the end of the conflict and transitioning to green recovery.

The identified promising areas are general, but extremely important for the preservation of ecology and natural resources in wartime and ensuring long-term environmental sustainability. In order to develop appropriate and effective measures with the prerogatives of environmental safety and military needs, reliable information must be available and the specific circumstances of the war must be taken into account.

The information platform for developing green strategies for the post-war recovery of the country is formed by developed intelligent environmental monitoring systems. They are critical in times of war, as they allow for the rapid collection, analysis, and interpretation of environmental data, which is important for responding to possible environmental crises, detecting pollution, explosive situations, or other threats. Such systems use various sources of information, such as satellite data, on-site sensors, drones, etc. They can provide important information to military commands and public services for strategic decision-making, protection of the population and the environment. In wartime, the use of such systems requires high accuracy, data processing speed, and reliability, as they can have a direct impact on human safety and the environment.

These systems are also crucial in the post-war period to assess the state of the environment after a conflict. This can include the detection of contamination, explosive remnants, radiation or chemical residues, destroyed infrastructure, and other environmental or human consequences of war. This information is useful for understanding the extent of the damage and planning rehabilitation measures. Intelligent information systems can provide analytics and detailed data that can help prioritize environmental restoration, assist in ecosystem restoration, monitor pollution levels, and facilitate the rebuilding of destroyed infrastructure.

Thus, intelligent environmental monitoring information systems play an important role in environmental safety management at all levels (global, regional, local). They allow collecting, analyzing, systematizing and using large amounts of data to ensure sustainable and environmentally friendly solutions. The main components of such systems are:

– data collection (includes sensors, detectors, monitoring systems to collect information on pollution levels, resource use, etc;);

– analytics (use of artificial intelligence and machine learning methods to analyze accumulated data to identify trends, forecast risks and propose optimal solutions);

– decision-making support (formulation of recommendations on best practices for environmental safety management, as well as assistance in choosing strategies to reduce environmental impact);

– monitoring and management (automation of processes for monitoring compliance with environmental safety standards, detecting violations and taking necessary measures);

– compliance tracking (assistance in tracking compliance with environmental standards, adjusting and regulating management impacts).

Regional intelligent information systems (RIIS) are designed to create the information space necessary to ensure the functioning of state departments of ecology and natural resources and their bodies in the territories under their jurisdiction. They are a complex consisting of a regional monitoring system, a regional cadastral system, a regional geographic information system (GIS), other information systems and a regional information infrastructure, integrated into a single whole and interconnected with other structural elements of environmental management.

The development of regional information systems is envisaged by the state environmental policy of Ukraine. In the current circumstances, the role of regional intelligent information systems is significantly increasing, in particular due to the need to generate objective data to assess the region's potential in order to determine the directions of its post-war recovery and harmonize the coexistence of society and nature. By the way, conducting a comprehensive assessment of resource potential with a characterization of the state and forecast estimates of land, water, forest, mineral, health and recreational resources, the state of the environment, and the level of natural and technological safety is a priority in the development of regional strategies for environmental safety and development. Its implementation is ensured by regional intelligent information systems and involves a comprehensive assessment of the natural resource potential of the region's development based on the main estimates:

– land resources (carried out on the basis of determining the level and efficiency of land resources use according to the land cadastre data, the level of economic use, distribution of the land fund; the level of land development, the share of land in the ecological network; the quality and level of bioproductive land and the efficiency of their use;

– water resources (conducted by determining their volumes, quality, possibilities of increase, degree and efficiency of use;

– mineral resources, including "technogenic deposits" (assessed by structure, reserves and growth opportunities, volumes and conditions of extraction);

– health and recreational resources (carried out by determining their suitability for treatment and recreation (climatic conditions, aesthetic value of landscapes, availability of balneological properties, etc;);

– the state of the environment (characterized by levels of pollution of water and air basins, soils, volumes of accumulation of all types of waste and their species structure, acoustic discomfort, electric and magnetic fields, radiation and exposure, capacity, structure and prospects for increasing the elements of the ecological network (reserves, national nature parks, biosphere and nature reserves, nature reserves, ecological corridors, etc;);

– level of natural and technological safety (characterized by the list, structure, location of potentially hazardous facilities and other sources of emergencies, their distribution by risk groups, parameters of the affected areas (territory, number of settlements and population) and the consequences of emergencies, the state of the facilities, the cost and sources of funding for measures).

As we can see, regional intelligent information systems, in addition to performing current tasks of information support for environmental management, are becoming the information basis for regional strategies for development and harmonization of coexistence between humans and nature.

In the postwar period, specialized information systems will also need to be developed: information systems for protected areas, depressed areas, potentially hazardous facilities, basin information systems, etc. Operating within regions, sometimes at the interregional and interstate levels, these systems will require proper structural and organizational design. The issue of their interaction with regional information systems will require appropriate legislative resolution. In addition, it will be advisable to address the exchange of information related to interregional problems (including interstate problems), such as transboundary pollution, natural and man-made emergencies.

In general, in Ukraine, solving the problem of forming regional intelligent information systems for environmental monitoring will require a serious systematic approach to a set of methodological, organizational, legal and financial issues in the field of environmental management information systems.

It should be noted that the extreme uniqueness and complexity of environmental management require

– application of special information methodologies: natural cadastral, ecological and economic balances of territories, environmental monitoring, environmental mapping, geographic information systems (GIS methodologies), regional information systems;

– integration of systematic information system databases and information methodologies into environmental legislation;

– reduction of intersectoral and international information gaps and expansion of the volume of available information and access to it through existing international requirements for information as a decision-making tool;

– ensuring the accounting data provided by the state and regional information systems, state cadastres (land, water, forest, subsoil, fauna, flora, natural areas of resorts, greenhouse gases, climate, territories and objects of the nature reserve fund);

– environmental mapping, which provides for the inclusion of component, indicator, assessment, forecast and other maps on electronic media, cloud storage or online format to accumulate spatial information on changes in natural territorial and landscape systems under anthropogenic impact;

– strengthening of informative influence through ecological and economic balances of territories in determining the economic (carrying) capacity of natural objects and territories to achieve ecological and economic balance for the purpose of strategizing sustainable development and harmonization of society's life in the natural environment;

– ensuring access to monitoring information for all segments of the population, as the database of the environmental information system is updated and replenished through environmental monitoring of the objects under management by means of observing their condition, displaying the dynamics of changes that occur with them, and forecasting the development of situations;

– effective cooperation between international organizations, governments and public organizations

– environmental monitoring.

Environmental monitoring in the management of environmental situations provides an opportunity for systematic feedback. The state environmental monitoring system serves both the state and other (corporate, public, local) environmental management systems. The spatial nature of most environmental aspects of natural and anthropogenic systems, their multifactorial nature and significant volumes of processed data have necessitated the automation of environmental and geographic mapping using the latest computer technologies. GIS technologies are effective and promising for use in many spheres of society, in particular in the context of enriching the arsenal of management decision-making tools. In environmental management systems, GIS technologies have found the following practical applications: territorial (regional) and basin management, natural resource cadastres, monitoring GIS, etc.

The foregoing proves that the use of regional level information systems allows to increase the efficiency of actions in making management decisions in the field of environmental protection, to

ensure the unification of software and hardware used in the information process, and also increases the content and accessibility of natural resource and environmental databases.

Conclusions and prospects for further research. As a result of the full-scale war, the environmental problems that existed in Ukraine before it began have become much more complicated. During the war, there was a need to assess environmental damage and the costs of its restoration. The scale of the environmental crimes committed by the Russian occupiers is impressive. Some ecosystems and unique natural sites are no longer restorable. While the environmental damage is obvious, its assessment requires new approaches, as the full extent of environmental damage and losses remains unknown due to the disruption or destruction of the monitoring system, restrictions or lack of access to forests and other natural areas. The consequences of the armed invasion will undoubtedly have a lasting negative impact on the ability of the national economy to prevent and adapt to climate change.

In the context of the European Green Deal, effective cooperation of all stakeholders (international organizations; government; NGOs) and the introduction of intelligent monitoring information systems are important for environmental recovery after the war. They are able to ensure systematic and effective environmental monitoring (through the use of advanced technologies for collecting, analyzing and visualizing data on pollution, resource use, climate change and other aspects affecting the environment), prompt response to the problem (through timely detection of problems in real time and speed of response to them, which allows to avoid the spread of pollution, eliminate accidents and minimize environmental damage), forecasting capabilities (through data analysis), and other aspects of environmental monitoring. The study of intelligent information systems for environmental monitoring will be deepened in the direction of mechanisms of their effective functioning and relevant supporting subsystems.

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