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ON THE QUESTION OF METHODOLOGICAL FEATURES OF ENVIRONMENTAL FORECASTING UNDER THE CONDITIONS OF THE STATE OF WAR

In the conditions of martial law, risk assessment of the implementation of geological and mining projects and the environmental justification of the innovative possibilities of acceptable technological solutions, acquires particular importance. Defining risk responses is currently the weakest point in the risk management process.

To build a universal methodology for the complex analysis of dangerous man-made risks, the problem of the "critical limit" is sometimes singled out, that is, a set of critical limitations, and the basic principle of risk assessment is called the "critical limit principle". Thus, it is possible to estimate the value of risk as the ratio of expected values to the critical value (for all components of the environment, both at the global and regional levels).

The risk of the impact of man-made activity on the environment is the probability of the occurrence of an event that has adverse consequences for the environment and is caused by the negative impact of economic or other activities, emergency situations species of man-made [1]. Such a negative feature as the absence of certain conditions and technologies for the use of material resources in a closed cycle determines the modern "Production-Consumption" system, which leads to the formation of a huge amount of industrial and household waste. At the same time, as a rule, their processing is either technically impossible, or economically impractical, or both. As a result, irreversible losses of renewable and non-renewable natural resources and dangerous pollution of the environment are have observed, that are repeatedly intensified by military actions.

The technologies for extraction and processing of mineral raw materials cause especially unjustified consumption of natural resources and the accumulation of large volumes of waste. The actual solution to these problems is determination the risks of the operation of mining enterprises and hydro-technical structures, including. In the conditions of martial law, the definition and assessment of environmental risks creates the necessary basis for the application of legal norms of the European direction and state mechanisms of administrative and economic influence in order to achieve an acceptable level of risk and safe landmarks.

At the ecosystem level, the indicators of zones of ecological losses determined by spatial characteristics (by indicators of relative and absolute area and ratios of their areas). Under conditions of the same stage of disruption of geoecosystems, a higher level of danger have will be observed where there is an increase in the relative disturbed area. As a result, the spatial criterion of zones of geoecological losses is the heterogeneity of destabilizations, for example, the relative area of the land (in %) removed from the land use: under normal conditions − less than five, in the ecological risk zones − 5-20, of crisis − 20-50, of disaster − more 50.

For an objective assessment, criteria for identifying environmental damage based on the rate of increase in adverse changes in the environment are required. The probability of realization of forecasts of natural and man-made hazards is determined by the area affected or the recurrence of the event.

Material damage $D_m(H)$, presented in the form of area affected by a single manifestation of danger *H*, can defined as:

$$D_m(H) = V_m(H) \cdot S_0 = S_H \cdot S_0 \cdot S_t^{-1} , \qquad (1)$$

Where $V_m(H)$ – the degree of damage to the territory under the impact of a certain danger,

S_H – the area affected by a single manifestation of danger *H*,

S_0 – the area of the hazard object of the developed part of the territory,

S_t – the total area of the territory.

From this, the risk of damage (destruction) of a unit of area within the developed part of the territory S_0 in time and space by danger *H* and the full integral risk of losses in this event are calculate, according to the formulas:

$$R_{sm}(H) = P^*(H) \cdot V_m(H) \ , \tag{2}$$

$$R_m(H) = P^*(H) \cdot D_m(H) = R_{sm}(H) \cdot S_0 \, , \tag{3}$$

Where $P^*(H)$ – the recurrence of the danger (H), which is numerically equal to its statistical probability.

Formula (2) characterizes the material risk of specific losses from a unit area of both the object and the entire assessed territory per unit of time, which can be expressed through the dimension ha/ha/year; km^2/km^2/year. This risk is usually called the "specific risk of damage to the territory", specifying in each case the specific nature of the consequences of the damage. The material risk of damage to the territory is the basis for determining other types of risks and losses from extraordinary and catastrophic events, in particular, the risk of land destruction because of hostilities.

Specific damage risk can have used for mapping and comparative assessment of the risk of dangerous phenomena, especially in the absence of reliable information about the location and cost of individual objects, as well as for determining indicators of the stability of territories in conditions of military operations. The full value of the damage risk obtained by formula (3) determines the conditional rate of land loss within the developed part of the territory. Values of the damage and risk for the entire territory (if it is accepted as an object of danger) can have obtained by formulas (1, 2), considering the $S_0 = S_t$.

Since tailings dumps are an integral part of the process of the beneficiation of poor iron ores, practically all the mining and processing enterprises are carry out monitoring the state of tailings dumps and auxiliary structures, develop projects to increase the capacity of their existing tailings dumps. Today about 2 billion m^3 of beneficiation waste accumulated in Kryvbas, and up to 10,000 hectares of agricultural land occupied by the tailings dumps [2]. During the period from 1961 to the present day, the five active mining and processing enterprises of Kryvbas was stored iron quartzite beneficiation waste in six tailings dumps. The waste from the mining and processing enterprises of Kryvbas contains up to 25% of total iron and about 12-13% of magnetic iron. The reserves of iron ore tailings in these storages are estimated at more than 8 billion tons, the content of magnetic iron in which varies from 3,0% to 7,17%, and of total iron − from 15,7% to 18,6% [3, 4]. Tailings dumps of beneficiation waste of the mining and processing enterprises of Kryvbas are of interest, both promising man-made deposits and sources of ecological danger.

The construction of a predictive assessment for any natural and man-made negative phenomenon should begin with the definition of such categories as “Essence / State / Relationship / Predictive assessment” according to a simplified scheme. These categories should be determined for all indicators that are have represented the characteristics of ecological, social and economic consequences in a certain sequence of four stages, the content of which proposed in the Table 1.

Table 1. Structured form of four consecutive stages of predictive assessment of dangerous natural and man-made phenomena considering the risks

Sequence of categories	*Four stages and essence of assessment*			
	I	II	III	IV
Logical sequence	The essence of a negative phenomenon	State of danger	Relationships (interactions and connections)	Development of forecast assessment
Process sequence	Process analysis of activation mechanisms	System analysis of geotechnical system monitoring data	Correlation analysis of basic factors	Determination of negative consequences
The resulting sequence	Construction of the system of direct and indirect factors of negative impact	Justification of the system of basic factors	Determination of indicators for the geotechnical system	Assessment of risks of various degrees of danger (including military actions)

Innovative solutions for the introduction of unmanned aerial vehicles as a component of aerospace systems are needed in the management of monitoring the quality of the environment and the operational determination of the risks of man-made impact. At the same time, the degree of operational awareness of relevant state and municipal institutions and relevant specialized emergency and rescue formations, which allows online monitoring of the situation [5], increases. Today in Ukraine, the problem of the effectiveness of management of environmental monitoring for the operative identification of risks of man-made impact is relevant. In countries such as the United States of America, Canada, Germany, France, and Great Britain, this problem are successfully solving with the help of technologies of geo-intelligent decision-making systems, the core of which is satellite systems of remote sensing of the Earth [6].

Risk assessment of the operation of existing storage facilities and mineral processing products at mining enterprises caused by man-made and environmental factors is an important step in ensuring safety and optimizing production. This process should be include the following steps:

1 – Risk identification: assessment of potential hazards associated with the processes of raw material storage and processing. These can be landslides, soil and water pollution, man-made accidents and others.

2 – Analysis of compliance with safety standards: assessment of the extent to which storage facilities and processing processes comply with international and national safety standards.

3 - Classification of storages and processing products: distribution of storages and products by risk level, for example, high risk, medium risk and low risk, which helps to prioritize the implementation of measures.

4 – Development of risk minimization strategies: development and implementation of risk reduction plans in storages and processing processes, and improvements technologies, implementation of monitoring systems and other measures on security issues.

5 – Security audit: regular analysis of the security of the processes of storage and processing to identify new risks and tracking the effectiveness of implemented risks minimization measures.

6 – Documentation and reporting: maintaining relevant documentation on risk assessment, and measures taken and reporting support to relevant regulators.

7 – Implementation of the innovative available technologies to minimize or eliminate risks.

The classification of risks and safety in the mining industry is a complex and multifaceted process that requires the integration of specialized expertise in geology, engineering, ecology, mining technologies and industrial production safety.

For the increase the level of man-made and ecological safety of potentially dangerous productions and reduce the level of risk of emergency and catastrophic situations, it is necessary to create a complete interdepartmental system of integral monitoring and forecasting of emergency situations.

In the future, it is necessary to study the dynamics of deflation and migration processes, which are associated with functioning tailings dumps and lead to changes in the components of the environment - soils, surface and underground waters, bottom sediments, and landscapes and local geoecosystems.

The main direction of further research is the determination of environmental risks of the operation of tailings dumpi of mining enterprises and innovative possibilities of eliminating the shortcomings of existing technologies of iron ore extraction and beneficiation. For to determining potential risks, and to reveal the potential of an accessible comprehensive assessment (with comparing the expected risks/losses) of mining and processing enterprises, innovative support of environmental monitoring is needed.

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