ENVIRONMENTAL RISK MANAGEMENT IN THE STRUCTURE OF GLOBAL RISK ASSESSMENT

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Abstract

This article examines the role of environmental factors in contemporary global politics and economics. The authors analyze the main environmental hazards, including climate change, natural disasters, biodiversity loss, and natural resource depletion. Statistical data on the impact of these issues on various aspects of society are presented. Particular attention is paid to methods of assessing and managing environmental challenges, including the use of various indices and indicators. The article emphasizes the importance of an integrated interdisciplinary approach to hazard analysis and the need to consider socio-economic factors. The authors discuss risk management strategies, including preventive measures, adaptation, and mitigation. In conclusion, recommendations are offered for enhancing environmental policy, including strengthening the regulatory framework, developing infrastructure, and involving various stakeholders in the environmental risk management process.

Keywords: environmental risks, climate change, natural disasters, biodiversity, risk management

I. Introduction

Environmental factors play a significant role in modern global politics. Scientific and technological progress and increasing human impacts have led to adverse environmental changes, including resource depletion, decreased biodiversity and an increase in natural disasters. This forms new ideological patterns and behavioral strategies at the individual and institutional levels [1].

The modern natural environment is in a state of ecological crisis, characterized by long-term unfavorable changes in the biosphere. There is a steady trend towards deterioration of the environmental situation globally and locally. Some researchers believe that humanity exists in a period of permanent eco -catastrophes - critical states of ecosystems leading to their change or destruction [2][3].

The analysis shows a correlation between the environmental crisis and the aggravation of socio-economic and political risks. U. Beck [4] focused on the need for international cooperation in the field of environmental safety.

According to the Center for Research on the Epidemiology of Natural Disasters, in 2022 there were 387 natural disasters, causing 30,704 deaths and affecting 185 million people [5]. Economic damage is estimated at US$223.8 billion. A comparative analysis with 2021 (10,492 dead, 101.8 million injured) reveals a trend toward escalating risks.

- The most significant natural disasters of 2022:
- Heat wave in Europe: 16,305 deaths
- Drought in Uganda: 2465 deaths
- Floods in Pakistan and India: 1,739 and 2,035 deaths respectively
- Research indicates the uneven distribution of social costs of natural disasters [6][7] with the

predominant vulnerability of rural areas [8][9].

Analysis of social vulnerability to environmental disasters reveals a correlation with the economic development of territories. Research shows that low-income groups are at increased risk due to housing inequality and limited access to evacuation and recovery resources [10].

Statistics show that people in the poorest countries are 6 times more likely to suffer from emergencies [11].

The economic costs of environmental disasters in 2022 amounted to US$223.8 billion. During the period 1998-2017. financial losses from natural disasters increased by 151% [5].

According to the Allianz Global Corporate & Specialty (AGCS) study, based on assessments of 2,712 experts from 94 countries, climate change and natural disasters are among the top risks for government and business, along with cyber threats and macroeconomic factors [12].

- Climate change has a multifaceted impact on the global economy and social sphere, as evidenced by a number of studies and statistics.
- Food Security : According to Global Commission on Adaptation (2019), if the trend towards an increase in average temperatures of 1.5-3°C continues, a 30% reduction in crop yields is expected by 2050 [13]. This comes against the backdrop of a projected 50% increase in global food demand, which could lead to a significant increase in global hunger.
- Water resources: According to the UN World Water Development Report (2021), between 2 and 4 billion people suffer from water shortages on a permanent or seasonal basis [14]. It is predicted that by 2030, humanity will face a 40% water shortage if current rates of economic development continue. WHO Global Water, Sanitation and Hygiene Annual Report (2022) indicates that 1.4 million deaths each year are attributable to lack of consistent access to quality water and sanitation [14].
- Health: A study published in The Lancet Planetary Health (2022) shows that air pollution causes more than 6.5 million deaths each year, and water pollution causes 1.4 million [15]. The World Health Organization predicts that climate change will cause 250,000 additional deaths annually from 2030 to 2050 [16].
- Economic impact: The World Bank predicts that for the Middle East and North Africa, by 2050, the economic cost of water shortages caused by climate change could amount to 6-14% of the region's GDP.

A study presented at the World Economic Forum (2022) indicates that heat stress could reduce total hours worked by more than 2% globally by 2030, equivalent to a potential economic loss of US$2.4 trillion [17].

Agriculture: UN World Water Development Report (2023) notes that about 25% of the world's arable land experiences economic water stress, which is due less to hydrological constraints than to institutional and economic factors [18].

These data demonstrate the complex and interconnected nature of the impact of climate change on various aspects of the global economy and social development. They emphasize the need for an interdisciplinary approach to solving environmental problems and the development of adaptation strategies at the national and international levels.

The state of the environment and the general trends in the dynamics of its development largely determine the vector of development of the human community and states, which actualizes the need to develop a system of strategic political management for a timely response to changes in biogenic constants and leveling environmental risks. The multifaceted nature of environmental problems indicates that mechanisms that can counter socio-economic and political risks are also important for their solution.

Among the global environmental risks on a scale of the next 10 years, the following types are distinguished:

- Climate change:

An increase in temperature above the annual average from spring to autumn increases the

risk of droughts, which negatively affects the moisture content of agricultural land and crop yields [19].

Accelerated melting of glaciers poses a serious threat to coastal areas [20].

The rate of sea level rise has doubled over the past 30 years, and this trend is likely to continue.

- Natural disasters:

According to the UN, over the past 50 years the number of natural disasters has increased 5 times [21].

In the Russian Federation, according to the Ministry of Emergency Situations, from 2016 to 2022 the number of natural emergencies increased from 42 to 78 cases [22].

In 2022 in Russia, the greatest threat was posed by hydrological (floods, floods) and meteorological (storms, hurricane winds) phenomena.

The problem of forest fires, threatening more than 40% of the territory of the Russian Federation, is getting worse [23].

- Biodiversity change:

About 1 million species of plants and animals are on the verge of extinction in the coming decades [24].

The World Meteorological Organization predicts that at 2°C warming, the number of species at risk of extinction will be 30% higher than at 1.5°C warming [24].

Warming of 1.5°C could destroy up to 90% of coral reefs, and warming of 2°C could destroy up to 99% [1].

The loss of species disrupts the balance of local ecosystems, affecting agriculture, livestock farming and fishing.

- Natural resource crisis:

The world's population reached 8 billion in October 2022, increasing the demand for resources [25].

At the current level of consumption, proven gas reserves will last for 52 years, oil – for 47 years, coal – for 130 years [25].

The transition to green energy carries risks of depleting rare metals and elements needed to produce solar panels, wind turbines and electric vehicles.

The uneven geographic distribution of these resources could hamper the global transition to low-carbon technologies.

- Anthropogenic influence:

The CO2 content in the atmosphere is 150%, CH4 (methane) – 264%, N2O (nitrogen oxide) – 124% of pre-industrial levels [25].

The influence of CO2 on climate lasts for centuries, in contrast to CH4, which exists in the atmosphere for 9-10 years [26].

High concentrations of greenhouse gases are accelerating climate change, which could lead to faster melting of polar ice caps, rising sea levels and an increase in the frequency of extreme natural events [27].

These data highlight the interconnectedness and complexity of environmental problems that require the development and implementation of effective strategies at the global and local levels to minimize negative impacts and adapt to changing conditions.

It is also important to note that the problem is the nonlinear nature of the development of environmental risks, which implies more difficult to predict dynamics of environmental changes under the influence of various factors, as well as the emergence of the issue of accumulation of risk potential over time [28].

The risk of ineffective human action to solve the problem of climate change in recent times is also quite high. A confirming circumstance is the fact that despite the actions taken by the international community, keeping the level of climate change at the level of 1.5 ° C set by the Paris

Agreement seems practically unattainable, which increases the risk of negative consequences for the planet [29]. Despite some signs of environmental progress, at current dynamics and full implementation of national climate commitments until 2030, temperature changes will at best be kept to 2.4-2.8°C by the end of the century, demonstrating the need significant revision of the measures taken due to their lack of effectiveness [30].

II. Methods

To predict the development of environmental risks, analyze the overall effectiveness of actions taken, as well as their long-term planning, various indicators and indices that make up risk assessment systems are important.

Environmental Risk Assessment – Environmental Risk Assessment – aims to identify and analyze potential environmental risks arising from human activities that may cause harm to people and/or ecological systems [31].

The Global Climate Risk Index analyzes and ranks the extent to which countries and regions are exposed to climate-related extreme weather events (storms, floods, heat waves, etc.) [32].

Environmental Performance Index , which analyzes the overall performance of states' environmental policies in the context of three main categories: environmental protection, ecosystem viability and climate change [33]. This rating also ranks the states in question according to the degree of their environmental efficiency: for example, in the 2022 report, Russia ranks 112th in the overall rating of 180 countries [33].

The Green Growth Index assesses countries' progress towards achieving sustainable development goals across four dimensions: resource management, natural capital protection, green economic opportunities and social inclusion [34].

The Global Green Economy Index measures the performance of the green economy across four key dimensions: climate change, industrial decarbonization, ESG investing and environmental stewardship [34].

The World Risk Index analyzes the risk of natural disasters resulting from extreme natural events, taking into account a country's exposure and vulnerability to risk [35]. The above indices make it possible to evaluate certain components of the general environmental state of countries and regions of the world.

A more comprehensive approach is featured in the Sustainable Development Goals Index compiled by SDSN and Bertelsmann Stiftung [36]. It is based on the 17 socio-ecological development goals outlined in the 2030 Agenda adopted in 2015 by the UN General Assembly [37]. The most difficult to achieve are the following environmental sustainable development goals (SDGs): SDG 12 – transition to sustainable consumption and production patterns, SDG 13 – combating climate change, SDG 14 – conservation of oceans and seas, sustainable use of marine resources, SDG 15 – protection terrestrial ecosystems and biodiversity [37]. All of these goals relate to the environmental sphere, which demonstrates the high complexity of the practical implementation of environmental actions by states around the world. This problem is exacerbated in low-income countries due to the lack of infrastructure and mechanisms to deal with environmental problems, which demonstrates the greater environmental vulnerability of less developed countries.

III. Results

A comprehensive multidisciplinary risk analysis should include not only an assessment of the influence of a certain factor, but a set of various risk determinants and their influence on each other [39]. Thus, the factor of climate disasters in 2020 was significantly aggravated by the development of the Covid -19 pandemic, which caused a high burden on healthcare systems, energy supplies, and the work of emergency services in many countries [38].

It is also worth noting that when assessing overall environmental risk, it is important to consider responses, as they play a key role in achieving potential outcomes and are also determined by political and economic components [39]. This approach provides a holistic perception of real or predicted risk, since it explains why, in some cases, decision makers do not take action to reduce risk: the reason may be possible reputational risks, insufficient funding, untested technological solutions, etc. [40].

Decision-making, in turn, can be accompanied not only by positive consequences and risk mitigation, but also by aggravation of current problems, including through numerous compromises and associated benefits for the actors, which can change the overall nature of the risk and its complexity. Thus, taking into account socio-economic, political factors, regional characteristics, and the interaction of management systems at different levels makes it possible to more accurately assess environmental risks and conceptualize strategies to mitigate potential negative effects.

Environmental risk management consists of several stages of risk management:

1. primary analysis and identification of risks;
2. determination of the main directions for their leveling;
3. assessment of probability, influencing factors, probable damage;
4. development and planning of risk reduction measures [41].

Natural disaster risk management must be based on a structural understanding of the formation and evolution of natural disasters, disaster mitigation and subsequent recovery. Taking into account the factors mentioned above, as well as the use of developed geotechnical and environmental engineering systems, should help improve the assessment and identification of natural risks and reduce disaster risk in general [42]. It is also important to analyze the social context, structural forces and conjunctural factors that make up the contextual framework of the problem under study.

A separate factor that can also potentially have a significant impact on managing environmental risks and reducing the negative consequences of climate change is the use of information systems and artificial intelligence. In the context of digitalization, the competent use of modern technologies can help solve existing problems and achieve sustainable development, but this strategy also has potential adverse consequences in case of irresponsible use of information systems [43][44].

In general, risk management methods are divided into 4 categories [45]:

1. risk avoidance methods;
2. methods of risk localization;
3. risk dispersal methods;
4. risk compensation methods.

In relation to environmental issues, it is worth noting that the option of evading an unfavorable natural phenomenon is not always possible, therefore it seems important to pay attention to procedures for minimizing negative effects. At the same time, some environmental risks can be mitigated by localization if they are clearly identified, the source is determined, and ways to influence the process are established. Risk reduction also occurs through the dissipation method when distributing areas of responsibility between various actors and structures, including political organizations, business structures, non-profit associations and individual local communities. Methods for compensating for environmental risk involve the development of strategic planning to predict scenarios for the development of natural and man-made disasters and the development of tools for their prevention.

An environmental risk management strategy typically reflects one of several principles [4]:

1. the zero-risk principle, based on the premise that there is no harm to the environment and there is no need to do anything;

2. the principle of minimal risk, which implies the development of options for minimal impact on the biosphere;

3. the principle of balanced risk, which takes into account the anthropogenic factor and implies the implementation of measures to reduce negative effects on the natural environment and potential dangers to the population;

4. the principle of acceptable risk, which is based on an assessment of the costs and benefits of certain business strategies; this principle often leads to a conflict of economic and environmental interests.

In this case, the most effective is the balanced risk approach, which allows one to assess the degree of negative impact on the environmental situation at the national, regional or local level and develop a set of measures to prevent and minimize possible negative effects, as well as reduce the impact of adverse anthropogenic factors.

Environmental risk management includes both a preliminary risk assessment and forecasting of possible scenarios for its implementation, as well as the use of preventive measures to counter the risk, as well as measures to mitigate the consequences. In this case, when forming a strategy for dealing with the risks of natural disasters, three stages of the life cycle of a natural disaster will be taken into account:

1. pre-event stage: assessment of potential impact and development of preventive measures;
2. post-disaster response: a phase that facilitates the strategic mobilization of resources and technical support regarding previously identified critical aspects;
3. post-event stage: assessment of the damage caused by the disaster, measures to prevent its socio-territorial consolidation and accelerate recovery processes.

Depending on the phase of the natural disaster cycle, the following options for management activities in relation to natural disasters can be distinguished:

- prevention and minimization: a type of preventive measures aimed at significantly transforming or eliminating certain areas of risk in order to prevent the occurrence and development of adverse consequences;
- recovery: in the event of a disaster that has already occurred, measures are taken to restore infrastructure and repair damaged material objects;
- compensation: measures aimed solely at redressing damages through payments to injured people.

For accurate results of forecasting environmental risks, it is important to assess in advance the degree of vulnerability to extreme events. One of the factors that increases the vulnerability of an area and the uneven distribution of disaster risk is socio-economic inequality. Poor and marginalized populations often live in areas more prone to natural disasters and therefore face greater risks to life, health and finances; Education and age factors greatly influence the level of awareness of what needs to be done in the event of a disaster, and also affects the ability to access warnings, understand them and respond correctly - for example, older people often need additional support in emergency situations Social vulnerability affects not only behavioral responses to natural disasters, but also the ability to recover after it. Therefore, taking into account heterogeneity in society is important for correct analysis of the distribution of potential environmental risk and recovery trajectories.

Also an important part of the work on environmental risk management is the implementation of adaptation policies to prepare for the inevitable consequences. For its implementation, it seems important to develop strategic management at the state and regional levels, taking into account an understanding of the geographical, climatic, socio-economic and other characteristics of the territory. Increasing resilience, a developed system for preventing and responding to the most common natural disasters in the region, and an active information and communication policy aimed at increasing public awareness of behavior in the event of an emergency will reduce socio-economic risks in the event of environmental disasters.

To summarize, it can be argued that today environmental problems are associated with significant social, economic and political risks. Climate change and the increase in natural disasters - floods, droughts, hurricane winds and record temperatures - threaten the food security

of individual states and world regions, for example, East Africa. The problem of ensuring access to water in the countries of the Middle East and North Africa also remains. The lack of constant access to water and necessary sanitation conditions increases the risk of epidemic outbreaks of various diseases. Also, in conditions of insufficient resources, geopolitical tension arises between states, which reduces the level of security in the region. Macropolitical and economic factors such as geo-economic confrontation and military conflicts are additional catalysts for environmental problems.

Integrated environmental risk management involves primary analysis and identification of risk, taking into account the influence of a combination of various factors on it, identifying directions for their leveling, designing possible risk scenarios and assessing the likelihood of their occurrence, as well as the likely consequences, taking measures to counter risks and minimize them consequences. An important role is played by forecasting and the scenario method, which allows one to calculate the possible effects of a potential environmental disaster or catastrophe, as well as determine their impact on the aggravation of other current or upcoming crises. The implementation of predictive models, scenario analysis and integrated data collection mechanisms into environmental risk management will improve the ability to effectively prevent and mitigate emerging environmental risks. In recent years, the role of modern technologies and machine learning in risk management has also increased.

IV. Conclusion

An important area within which it is worth developing a risk management system at various levels is adaptation to the consequences of the crisis and mitigation of the consequences. Since not all environmental risks can be prevented, strategic planning should include development in conditions of environmental crisis with minimal damage. Measures to create and regularly modernize infrastructure that is somewhat resilient to climate change and to introduce renewable energy sources seem to be effective.

Improving the regulatory framework is also a significant stage in the development of the state's environmental policy. Regulations and strategic planning documents with mandatory, clearly defined standards and environmental performance indicators, as well as strict liability measures, are designed to ensure effective environmental protection. Increasing the effectiveness of measures taken is possible through the development of environmentally oriented interaction between authorities at various levels, business structures, non-profit organizations and associations, individual local communities and groups and civil society.

In conditions of geopolitical uncertainty and rapidly changing environmental conditions, as well as high socio-economic costs of unfavorable environmental conditions, priority should be given to the use of methods to anticipate and counter possible risks and minimize future negative effects. Environmental problems belong to the category of long-term risks, which complicates their management due to the difficulty of reaching a compromise in making political decisions, the consequences of which will manifest themselves after a certain time and at the moment may not seem to be of sufficient priority to the political and economic elite. More active involvement of the scientific community and practitioners of strategic risk management in the decision-making process is potentially intended to help find a compromise and limit the negative anthropogenic impact on the environment.

Successful Russian practices that demonstrate a new level of risk management deserve special attention in the context of environmental risk management. One of the significant steps towards managing climate change is the new Russian Climate Doctrine adopted in October 2023, according to which Russia must achieve carbon neutrality by 2060. It is important to note the features that form the basis of the new doctrine: special attention to NPOs, public organizations and business. The need to involve different structures and communities in addition to the state itself is emphasized, since the problem of climate change cannot be solved solely by one actor. For future

changes, it is clear that the new doctrine means the prolongation of existing federal projects in the field of nature protection and climate change. And non-profit and public organizations will have to replicate the successful practices of climate policy programs. For example, the reforestation campaigns “Garden of Memory” and “Save the Forest,” which have planted more than 220 million trees throughout Russia since 2019, will likely develop and transfer the experience gained internationally.

Based on the practices listed above, a number of common themes should be identified for animation in other industries, both within the state and for the world as a whole.

1. Involving all key actors in network interaction in environmental risk management: government, business and the non-profit sector;

2. Non-triviality and creativity in environmental issues allows us to most successfully involve people in the agenda, which is necessary for successful risk management in the field of ecology;

3. The integration of innovative computer technologies and artificial intelligence allows for the implementation of higher quality and more effective projects and programs for assessing and managing environmental risks.

Thus, it should be noted that at the present stage, the risk potential of environmental problems is regularly increasing, which determines the actualization of the development of strategic risk management to manage environmental risks both at the global level and at the level of individual states and regions. As it was established, to counter them, it is necessary to implement a set of political, legal, economic and social measures to develop the state’s environmental policy. In conditions of high socio-economic costs of unfavorable environmental conditions, an important role in environmental risk management is given to the use of methods to proactively, minimize relevant risks and level out possible negative effects.

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