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ECOLOGICAL RISKS: ASSESSMENT AND MANAGEMENT

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ABSTRACT

This article investigates the role of ecological risk management in the digital economy era. The purpose of this article is to identify the key patterns that determine the characteristics of risk assessment in business as a fundamental element contributing to the economic security of an organization, as well as to perform a comparative analysis of risk assessment and management methods in emergency situations. Various risk management methods are used in modern economic analysis. The most effective ways to reduce risk in the face of economic and political instability in Russia are the scenario method and the hierarchy analysis method, as well as diversification, i.e., the distribution of risks among multiple business participants. This article will mainly address hazards in the natural and man-made spheres.

Keywords: model, threat, risk management, ecology, safety.

INTRODUCTION

One of the main priorities in the effective development of society is ensuring the safety of human and environmental protection (Bezdudnaya et al., 2022; Tolkachev et al., 2023; Vakhitov, 2018). Measures to protect the environment and the people in it encompass a wide range of approaches and fundamental principles. These vary from those that respond to problems as they arise to those that attempt to anticipate problems (prevent rather than cure) (Kapustina & Goyushova, 2024); from those based only on the suspicion of causal relationships between activity or substance and effect to those striving for detailed scientific understanding of these relationships (Apergis et al., 2023); from those recognizing the potential for actions and substances to cause harm to those based on assessing these probabilities realized in the real world (Bezdudnaya et al., 2022).

Throughout recent history, there has been a shift from reactionary and suspicion-based approaches to more proactive measures and greater concern with risks and their cost relationships (Alekseev et al., 2022). However, different national approaches, social groups, interest groups, and even control tools within the same jurisdictions place varying emphasis on each of these principles (Gomola et al., 2019; Ostrovskaya et al., 2023; Sergeeva et al., 2023).

The relevance of the chosen topic is connected to the increasing number of global environmental problems: global warming, resource depletion, ozone layer destruction, air pollution, and the extinction of many flora and fauna species (Volkova et al., 2023). Consequently, the importance of how scientific and predictive methodologies are used to assess the risks associated with human activities and the objects and waste they generate for the environment and people in it is growing. It is also becoming increasingly important to consider how people process this risk information and take it into account when making decisions.

Concept of Ecologıcal Rısk

There are many definitions of the concept of Risk. In this context, risk refers to the possibility of negative actions. Risk is a quantitative assessment of a "bad" scenario resulting in losses (Chereshkin, 2014; Gubanov, 2014; Shapkin & Shapkin, 2013).

Decision support under uncertainty is the sole definition of risk assessment that describes its numerous applications (Elohin, 2014; Kiseleva et al., 2019; Vishnyakov & Radaev, 2007). The use of rational methods to cope with an uncertain future, rather than prophecies, traditions, omens, and premonitions, is a hallmark of modern culture. Risk assessment began with the need to calculate odds for gamblers and later, for instance, in 17th-century England and the Netherlands, the need to determine annuity premiums and the likelihood that a ship sent on a trading voyage would return successfully. Most risk assessment specialists still work in finance and insurance. Since then, risk assessment has spread to many areas of human activity, including engineering, wildfire management, medicine, and environmental regulation. The general definition indicates that all these enterprises share two common features: the need for decision-making and uncertainty regarding outcomes.

The commonly accepted objectivist definition of risk is the combination of the severity (nature and magnitude) and probability of consequences from the proposed action. Severity can be described in various ways depending on the situation, such as the number of deaths, reduction in population size, and reduction in the area of distribution. Probability can be derived from assessing the frequency of effect occurrence among individuals in the exposed population or the hypothetical frequency of effects if the same decisions were made multiple times. For example, risk could be the annual frequency of mass deaths among the exposed population equal to 0.3 or the likelihood that wastewater will reduce fish species numbers in a lake by up to 15%. Alternatively, risk can be defined subjectively as the mental state of a person making an uncertain decision or those subject to the consequences of a particular decision. This subjective risk is a significant issue when assessing risks for people prone to anxiety and fear, but it is less relevant for this book's topic. Note that subjective risk fundamentally differs from the Bayesian subjective interpretation of probability when assessing objective risk. Ecological risk is a quantitative or qualitative assessment of the ecological danger of adverse impacts on the environment (Bashkin, 2020; Serov, 2009). Depending on the nature of man-made impacts on the environment, risk can be:

- Regular or sharp
- Single due to an unforeseen event (accident).
- The technological ecological risk can be divided into two components:
- Risk accompanying daily activities, the level of which is recognized as acceptable
- Risk associated with exceeding established norms (or commonly accepted levels) of environmental impact (emergency impact).

It is probably not too broad a generalization to say that everything we do potentially poses a risk to human health and ecological systems (Akimov et al., 2001; Belyak et al., 2023; Shoigu et al., 1997). Some things are potentially more harmful than others, and standardized methods (test systems) are being developed to assess these potentialities and rank them. Describing this potential and conducting tests are called hazard identification and hazard assessment, respectively.

Thus, when considering the potential environmental harm from commercial chemicals, they are tested for effects on standard species considered ecologically significant in dose-response (concentration) tests that determine how much of a chemical is required to cause a specific harmful effect (often to kill 50% of the population). The lower the concentration that has an effect, the greater the likelihood of causing harm.

Some environmental protection legislation is based on these kinds of results, sometimes taking into account potential impact criteria, such as the likelihood of persistence in the environment and the likelihood of bioaccumulation (indicated by physicochemical properties or simple measurement results, such as the extent to which substances distribute between octanol and water under standard conditions) (Gosstandart of Russia, 1995). Considering the potential harm that may be caused by introduced organisms ("natural" or "engineered"), researchers may be interested in their potential to spread and reproduce.

However, even the most dangerous substances or organisms are unlikely to cause harm if they exist in small amounts and are stored under strict security. Therefore, the likelihood of realizing potential harm depends not only on this potential but also on the circumstances leading to a specific exposure scenario.

Stages of activity in assessing and Managing Ecological Risks

For solving the problem of the impacts of an organization's production activities on the environment, a series of approaches based on ecological risk assessment have been developed, applied in cases where it is impossible to give a definite answer about the impacts of pollution on human health and the environment's condition (Kiseleva et al., 2019; Tereshchenko, 2019). However, since harmful impacts almost always manifest and only the degree of damage varies, the required answer should include an assessment of the probability of ecological risk manifestation (Bezuglaya, 2010; Kiseleva & Simonovich, 2014).

The planning of activities for risk assessment and management consists of:

- Identifying risks
- Assessing the probability of adverse events (occurrence of violations)
- Determining possible consequences
- Determining the methodology for translating possible consequences (damages) into monetary terms
- Evaluating possible consequences in monetary terms and ranking them
- Identifying measures to reduce and prevent damage from identified risks
- Assessing the efficiency of necessary investments to reduce and prevent risks
- Deciding on the implementation of specific risk management measures
- For clarity, Figure 1 presents the general risk management process.

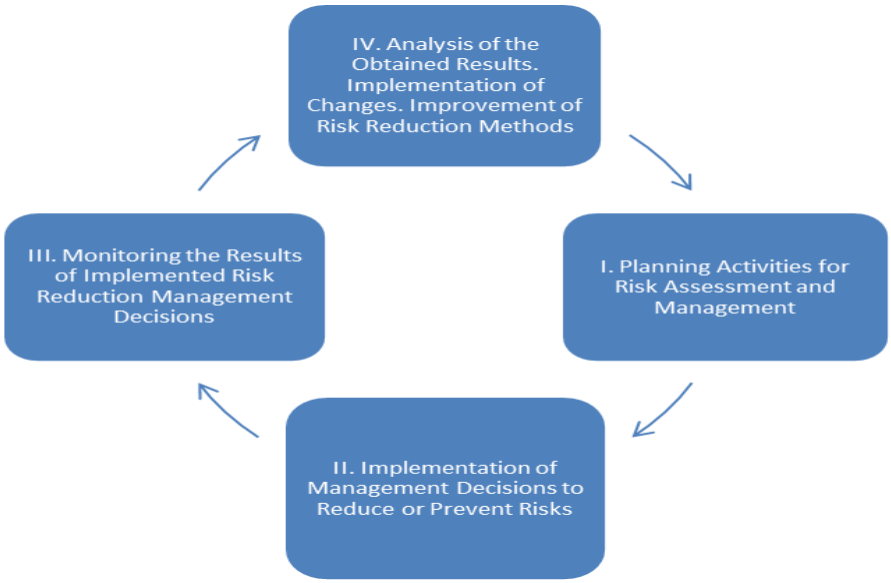

Figure 1. General risk management scheme.

The focus of an effective ecological risk management system is identifying risks and working with these risks. The task of ecological risk management is to ensure the maximum sustainability of all types of production activities (Foss, 2007; Makarenko, 2020; Morrow et al., 2007; PWC, 2021).

When conducting ecological risk assessments, the following rules of acceptable ecological risk are considered (Domashchenko & Finogenova, 2010; Kleiner, 2014):

- The volume of unavoidable losses in the natural environment;
- The volume of minimal losses in the natural environment;
- The possibility of actual restoration of losses inflicted on the environment;
- Absence of harm to human health;
- Proportionality of the economic effect of project implementation to environmental harm;

MATERIAL AND METHOD

Data collection

The data for this study were collected from a variety of scientific sources to ensure a comprehensive understanding of the topic. The sources were obtained from the Russian citation database RINTS, as well as the international databases Web of Science and Scopus. These databases were chosen for their extensive coverage and credibility in the field of scientific research.

Source selection

The selection of sources was guided by specific keywords that are directly relevant to the research goals. The search was conducted by using key words such as, "ecology", "ecological risks", "digital economy", "risk management", "economic development"

These keywords were chosen to capture a wide range of studies related to the intersection of ecological concerns and economic factors, particularly in the context of the digital economy and risk management.

Screening process

After the initial search, the articles were subjected to a two-stage screening process to ensure the relevance and quality of the data:

Initial Screening: The titles and abstracts of the articles were reviewed to identify those that met the inclusion criteria based on the relevance to the research keywords.

In-depth Screening: Articles that passed the initial screening were further evaluated through a thorough reading of the abstracts. This step ensured that the selected articles provided substantial and relevant insights into the research questions.

This methodology ensured that the final dataset comprised high-quality, relevant sources, providing a solid foundation for the analysis and conclusions drawn in this study.

Participants in the Ecological Risk Management Process

Assessors

Risk assessors are technical experts who conduct evaluations to support decision-making. Ecological risk assessors typically work in teams that may include health risk assessors, ecologists, toxicologists, chemists, hydrologists, statisticians, systems model developers, engineers, and other relevant technical experts. While most practitioners learn risk assessment concepts and methods on the job, universities increasingly offer risk assessment training. Assessors can be hired by regulatory bodies, applicants for permits, parties responsible for spills or waste sites, local citizen groups, or environmental protection organizations. In any case, they serve as technical consultants, transforming existing science and practice into useful information.

Risk managers

Risk managers are individuals or teams entrusted with the responsibility and authority to make risk-related decisions. In some cases, roles are clearly defined. For instance, in the restoration of contaminated sites, the project leader is typically an environmental protection officer responsible for deciding on the necessary restoration actions. Risk assessors are certainly responsible for providing technical support to this individual. However, in other cases, the role is less clear. For example, in Europe, risk assessments related to new chemicals follow a standard approach that leads to conclusions about the chemical's acceptability for intended use. As a result, although individual risk assessors do not have decision-making authority, their analysis leads to decision-making rather than just risk assessment. Nevertheless, authorized officials intervene when decisions are non-routine or when new methods are proposed.

The relationships between risk assessors and risk managers vary significantly depending on the country and regulatory conditions. One reason is the relative concern in various contexts about the relevance and independence from bias in risk assessment. It is evident that if risk assessments do not provide information needed by risk managers, the effort is largely wasted. Therefore, the risk manager must hold risk assessors accountable and be available to inform judgments that must be made based on policy rather than facts during the assessment.

On the other hand, risk managers have biases that lead them to prefer certain outcomes over risk assessments. Hence, if the risk manager is too involved in the technical analysis, the results will appear biased and may indeed be subjective. Therefore, it is emphasized that the risk manager, who bears political responsibility, should be isolated from technical experts who must ensure reliable and unbiased application of scientific data. The interaction also

depends on the routine nature of risk assessment. Assessments specific to a particular site, as well as unconventional or highly professional assessments, are more likely to attract the risk manager's attention.

Stakeholders

Stakeholders are individuals or organizations particularly interested in the outcomes of environmental management decisions. Examples include people living on or near a contaminated site, parties responsible for contamination, environmental advocates, fishermen, and other biotic resource harvesters, manufacturers of new chemicals, and recreational resource users. Although the general public is interested in environmental management decisions, stakeholders in decision-making form a much smaller group with specific interests. Involving stakeholders is crucial when rehabilitation is driven by fears rather than risks or observed effects.

Different levels of risk may be acceptable to different human communities due to variations in their risk tolerance. For example, stakeholders' preferences do not necessarily provide a basis for differentiated protection of birds or plants in different communities. Institutions must ensure compliance with environmental laws regardless of whether it concerns the local human community. For example, cranes are a national and world heritage object, but local river communities want to take water necessary for the cranes' habitat. These stakeholder preferences should not outweigh the legal protection or ethical obligations applied to these birds. However, if stakeholders are ignored or hindered, they will use legal or political processes to achieve their goals.

In many cases, ecological risk assessors have the opportunity to inform stakeholders about the properties of the environment at risk and their connection to human well-being. However, assessors should also be open to learning from stakeholders who may possess relevant knowledge or concerns related to the assessment.

Finally, stakeholders can be more than just sources of goals or concerns. In some cases, stakeholders will generate data and even conduct their own risk assessments. These risk assessments can be used as a basis for legally challenging the risk manager's decision or presented to the risk manager as an alternative to the assessment conducted by their own assessors.

CONCLUSION

- Damage to the natural environment from various anthropogenic and natural impacts is obviously inevitable, but it must be minimized and economically justified. Any economic or other decisions must be made in such a way as not to exceed the limits of harmful impact on the natural environment. Setting these limits is very difficult, as the impact thresholds of many anthropogenic and natural factors are unknown. Therefore, ecological risk calculations should be probabilistic and multifaceted, highlighting risks to human health and the natural environment.
- The primary goal of ecological risk assessment is to inform the decision-making process, but since decision-making is inevitably a socio-political process, risk assessment also serves socio-political purposes.
- Firstly, risk assessment provides a record of the technical basis for decision-making. Secondly, it provides information on the legitimacy of the interests of stakeholders and the public. Thirdly, it reduces contradictions by providing a technical forum for resolving contentious issues. And one of the most important aspects is that risk assessment allows for an early study of the current state of the issue and the development of a plan to minimize the probable consequences in case of risk occurrence.

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