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MANAGAMENT OF NATURAL RISK PROCESSES

Abstract: Risk management is an activity that involves risk identification, risk analysis and risk assessment. The main goal of natural risk management is to reduce the manifestation of various natural risk processes, including all prevention and rehabilitation measures. The article describes the components of natural risk, suggests genetic classification, and various steps in the management process.

Keywords: risk managament, natural, classification.

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INTRODUCTION

Natural events with disastrous character often are the cause of deep socio-economic turmoil and increasingly they are seen as a serious destabilizing factor, which impeded the sustainable development of humankind. They are a cause for huge property damage, psychological trauma, injury and death of people.

Each year natural disasters reach more dramatic dimensions in terms of number and degree of manifestation. The destructive potential is constantly growing. Regardless of the scientific and technical progress and preventive measures to secure safety, people are becoming less protected from natural risk processes. The main reasons can be given ever-increasing human population as a result of which shall be inevitable settlement of vulnerable from natural hazards areas and poor knowledge of the mechanisms of development. Nowdays the global climate changes further aggravate the situation.

To avoid such prospects humanity must move towards a new strategy to ensure the safety of antroposphere based on the prediction and early prevention. Central place among these strategies take the natural risk classification, assessment, analysis and finally management.

COMPONENTS OF NATURAL RISK- BASIC TERMS AND DEFINITIONS.

Natural risk is any phenomenon or process of natural origin, which through its striking factor is able to alter negatively the set of human way of functioning of objects of social and technical spheres, causing death and injury to people, harm the natural environment. The natural risk is subject to the laws of nature and is often linked to negative human impact on the environment.

Natural risk processes often are product of such destabilizing changes displays planetary systems and subsystems of its state of unstable equilibrium, namely:

- sudden removal of the substance (earthquakes, landslides);
- release of the inner Earth's energy (volcanic activity, earthquakes, tsunamis);
- increase of the level of rivers, lakes, seas (floods, tsunamis);
- impact of unusually strong winds (hurricanes, tornadoes, cyclones);
- shock-blast impacts (meteorites, asteroids, comets);

- gravitational effects (when crossing the solar system around the galactic center or other large space objects);
- sharp fall in pressure, temperature or their sustainable extremely value; (after *Mazur, Ivanov*, 2004, with additions)

The risk of occurrence of a negative natural phenomenon can be defined as a function of hazard, vulnerability and the elements at risk (exposure):

$$R=HxVxE,$$

where *R* is risk, *H* is hazard, *V* is vulnerability, *E is exposure*.

According to this concept, known as the "Crichton risk triangle", the risk can be represented graphically as an equilateral triangle. If any of the sides of this triangle is reduced, then the risk will be reduced. (Fig.1)

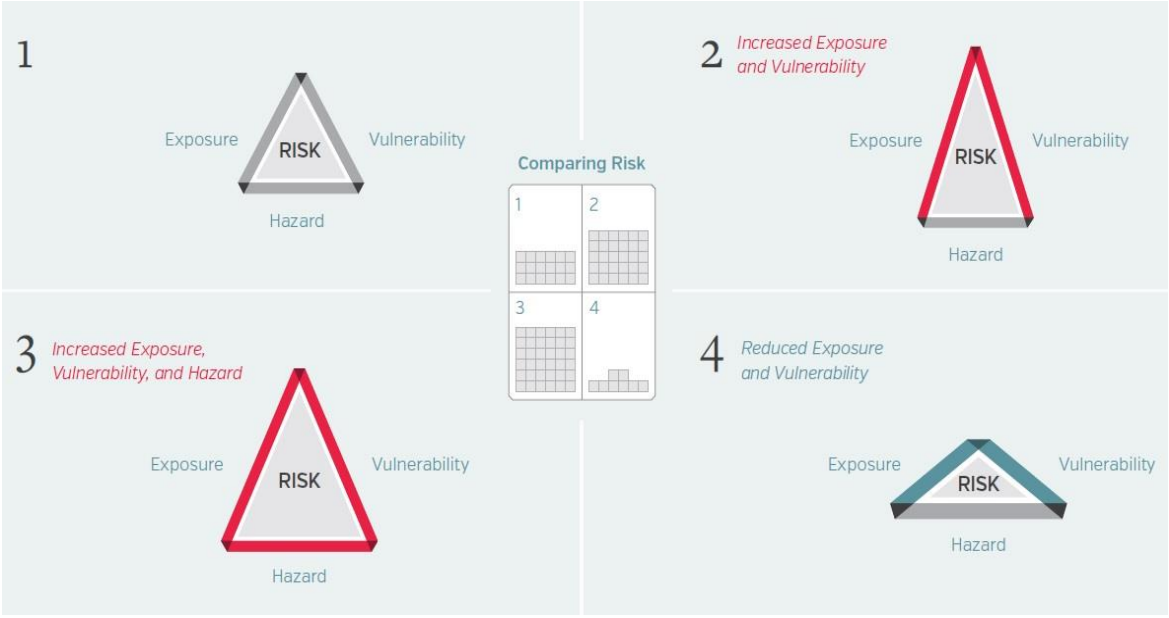

Fig.1 The risk presented as a function of hazard, vulnerability and exposure. Triangle 1 shows equal contributions to the risk equation. Triangle 2 shows a rapid increase in exposure and vulnerability, leading to increased risk. Triangle 3 shows increased hazard, exposure, and vulnerability,leading to increased risk. Triangle 4 shows controlled exposure and vulnerability leading to lower overall risk. (*GFDRR*, 2014)

The *hazard* is the event of natural or anthropogenic origin, the result of which is likely to be threatened the health and lives of people, be caused physical and economic losses. The hazard is characterized by probability and intensity. The threat of damage initiated by the realization of a natural disaster depends on the relative position of the source of the hazard and impact of its negative factors in space and time (for the stationary objects only in the space) (*Akimov* et. al., 2014).The hazard posed a threat only when it is able to cause damage, be it material or as victims and injured. The degree of threat to the proper functioning of antropospheric systems depends on the following factors:

- vulnerability of a given territory;
- location in space of the technosphere's objects;

This relationship may be expressed mathematically in the following way:

$$D=VxL,$$

where D- threat level, V- vulnerability level, L- locations of the technosphere's objects regarding the source of hazard.

Vulnerability is a concept directly related to the risk. Under vulnerability understand the nature of the objects of social and material sphere partially or completely lose their ability to perform their natural functions or set as a result of the effects of dangerous natural process or phenomenon. Vulnerability is the ability of individuals, natural and technogenic material objects to resist the dangerous natural phenomena. Vulnerability assessment is given in relative units or percentages (*Osipov*, 2002) According to the proposed systematization of the United Nations and the International

Strategy for Disaster Reduction, the elements of vulnerability can be separated into four groups: physical, economic, social and environmental.

In practice differ two main types of damage: direct and indirect. Direct damage depends on the amount of casualties and injured people, but also from the partial or total loss of the technosphere's objects. Indirect losses are determined mainly by malfunctioning of economic activities, such as interruption of power and water supply, transport performance, delivery of food and supplies, etc. It is customary to believe that the damage from dangerous natural phenomena in economically developed countries are expressed mainly in the form of money, ie financial losses, while lagging economically countries in the form of human life. Of course there are exceptions to the "rule" such as the earthquake in the Indian Ocean in 2004, according to data from USGS killed over 283,000 people and caused damage of more than $ 10 billion US dollars.

Under *exposure* means all people, property, systems, or other elements present in the danger zones, which are thus exposed to potential losses. The measurement of the exposure may include the number of people or type of public assets in the affected area. (*UNISDR*, 2009)

The level of knowledge of risk depends largely on the quality and quantity of information available and how different actors perceive the risk. People and society are more vulnerable when they do not realize the danger and do not perceive the existence of risk.

NATURAL RISK PROCESSES CLASSIFICATION

The interaction between different complex systems and subsystems is the primary cause of natural risk processes (*Ivanov, Vinnik*, 2010). The spectrum of interaction is sufficiently complex and varied, which in turn is a precondition for the emergence of different by genesis, duration and magnitude extreme natural phenomena. Understanding the mechanisms of emergence and development of natural hazards is the basis for effective forecasting and minimizing the consequences of their manifestation. An important step towards this kind of prevention is the systematization of these terrible natural phenomena.

In the foundation of the current natural hazards systematization stand point their origin or systematic affiliation (category), and most important signs and types of manifestation (types and subtypes). The greatest practical value has the natural risk processes (hazards) classification on the basis of basic phenomena and processes- so-called "genetic sign" (for example a phenomenon in the hydrosphere), types (for example a dangerous hydrological phenomenon in the seas and oceans) and subtype (for example tsunami). (Table 1)

Table 1 Natural risks classification by genetic sign

Category	Type	Subtype
1.Cosmogeneous phenomena	1.1 Thermonuclear and heliomagnetic phenomena	Solar storms, sunspots, cosmic rays, explosion of supernovae, quasars, etc.
	1.2 Impact events	Falling to the Earth's surface of large cosmic bodies - meteorites, comets, asteroids
	1.3Tidal-gravitational phenomena	Gravitational effects of various space objects on Earth - Sun, Moon, another planet of the solar system, galaxies, black holes, etc.
	1.4 Space biohazards	Falling to the Earth's surface of alien microorganisms, which would lead to mass death among the Earth's living creatures
2.Lithospheric phenomena	2.1 Tectonic [endogenous] phenomena	Earthquakes, volcanic eruptions
	2.2Geomorphological [exogenous] phenomena	mass movements [landslides, rockfalls, etc.]
	2.3Geoelectromagnetic phenomena	Geopathogenic zones, radiogenic zones, Earth's magnetic poles conversion, changing of the tilt of Earth's axis

	2.4 Geochemical phenomena	Deposits of harmful earth elements, releasing harmful gases into water, soil or atmosphere
3.Atmospheric phenomena	3.1 Meteorological and agro-meteorological dangerous phenomena	Wind storms [hurricanes, tornadoes, etc.], hail, lightning, torrential rain, blizzards, freezing rain, frost, droughts, extreme temperatures, etc.
	3.2Geoclimatological phenomena	Climatic cycles, fluctuations in the ocean's surface, El Niño event, La Niña event, global climate change, etc.
	3.3 Meteorological - biogenic phenomena	Wild fires
4.Hydrosphere phenomena	4.1 Dangerous hydrological phenomena in the seas and oceans	Tropical cyclones, tsunamis, high tides, strong fluctuation of sea level, icing on vessels and port facilities, etc.
	4.2 Dangerous hydrological phenomena on land	Floods, low water, wind surges, etc.
	4.3Dangerous hydrogeological phenomena	Low groundwater, high groundwater, subsidence of the Earth's surface as a result of karst processes, suffusion, etc.
5.Biosphere phenomena	5.1 Failures of technical facilities due to the activities of various organisms and microorganisms	Invasion of various macro- or micro-organisms causing damage to objects with technogenic character
	5.2 Infectious diseases in humans	Single cases of exotic and extremely dangerous infectious diseases, group cases of dangerous infectious diseases, epidemics, pandemics
	5.3 Infectious diseases in livestock	Single cases of exotic and extremely dangerous infectious diseases, epizootic, panzootic
	5.4 Defeats in agricultural plants from diseases and pests	Progressive epiphitotic, panphitotic, mass spread of plant pests

It is important to note that globally there are various classifications (*Smith* (1992); *Burton* et al. (1993); *Bruchev* et al. (1994); *Koch* (1995); *Kusky* (2003); *Bryant* (2005); *Foyo* et al. (2006); *Barinov* et al. (2009); *Below* et al. (2009); *Ivanov, Vinnik* (2010); etc.). Each one has its strengths and weaknesses. This feature is also inherent to the current classification. But this should not surprise us, simply because the object of study is extremely complex and has various qualities, in practice it covers the entire Earth. Various systems and sub-systems continuously interact with each other and for some processes and phenomena are virtually impossible to accurately be tied either to this or to that group. For example, the tsunamis are formed as a result of some earthquake, i.e. formed in the lithosphere, but in fact the disaster developed entirely in aqueous medium, i.e. in the hydrosphere. Constantly monitor the transition from one geosystem to another, which is something completely normal.

Other natural phenomena (such as collisions with black holes, supernova explosion, etc.) on the one hand are extremely rare and can not be seen in the context of human life and even within human civilization, but on the other hand can happen any time. Third phenomena such as invasion of alien disease-causing organisms are perhaps hypothetical, but the most recent scientific data gives us more arguments in this regard *(Wainwright* et al., 2013).

RISK MANAGEMENT STEPS

In order to avoid the negative consequences of the implementation of natural disasters in recent decades have passed to the implementation of new strategies for safety based on the prediction and prevention of realization of natural disasters. Significant place in these strategies takes the natural risks management. It includes organizational-management approaches and develop methods to minimize potential damages for socio-economic and natural systems.

Natural risk management includes development and systematic implementation of policies, procedures and practices for analysis, evaluation and risk prevention, rescue and rehabilitation activities. Risk management aims to reduce the vulnerability of socio-economic systems, reduce or prevent (where possible) dangerous consequences for the population in potentially endangered areas react to danger through early warning systems, conduct consistent use of environmental resources, supports ready specialized assistance units, conducts recreational activities after the disaster occurrence, etc.

There are various schemes of the process of risk management. Common is that they are associated with multistage process that aims to reduce or compensate the damage to the site in case of adverse events. Risk management includes several key steps:

- risk analysis;
- risk assessment;
- choice of modes to influence risk;

Under *risk analysis* we understand all research aimed at clarifying the nature and quantification of different types of risks with natural origin. This is a systematic approach to carrying out a comprehensive risk assessment aimed to bring understanding and clarity in our knowledge about a certain natural phenomenon. Thus facilitate the process of decision-making in risk management. Risk analysis usually starts with identification, ie assess the likelihood of realization of natural hazards and determine the level of its damage.

The *identification* is the most critical stage in the risk analysis process. The risk identification identify potential risks or hazards that may be expected for the society in the implementation of disaster. Key issues in the risk identification are:

- With what the specific natural phenomenon is risky?
- What will happen if continue the realization of the risky process?
- How can affect the risk, so it should be limited?

The risk analyses process includes the following main steps:

а) identify any risks that are inherent in the studied natural-territorial system;

б) quantitative and / or qualitative assessment of identified risks, ie their characteristics as well as the probability and extent of potential damage (loss). (*Bliznakov, Kostova*, 2013)

Risk assessment is expressed in its quantitative measurement, ie determining the possible consequences for the individual antropospheric layers at manifestation in space and time of various types of natural hazards. The main objective in risk assessment is the risk identification and decision-making aimed at minimizing the impact. When it evaluated the pros and cons in making the decision.

Risk assessment includes the following steps:

- assessment of the nature of the disaster (scope, frequency, intensity, magnitude, duration, scale, past and future events)
- assessment of the vulnerability of the elements at risk (people, infrastructure, social systems, natural resources)
- assessment of capacity to deal with natural disasters (skills, experience, equipment and infrastructure needed to minimize the level of risk or deal with the consequences of the implementation of disaster)

The concept of risk associated with the possibility of realization of relatively rare events. When this risk is often equated with the probability of such an event for a certain period of time, normally one year. The risk is also associated with the extent of damage from dangerous natural event or phenomenon (such as earthquake, flood, landslide, etc.), normally in the natural (including injuries and deaths, the size of the zone of the dangerous factor) or value aspect.

Therefore, the general indicator of risk applicable to any dangerous natural phenomenon has the following expression:

Indicator of risk (damage / time) = frequency (event / time) x average damage (damage / event).

Thus the independent variables in evaluating risk appearing time and the damage and to assess (forecast) risk is necessary to determine the frequency of realization of the dangerous phenomenon and injury. After identification of potential natural hazards is needed and evaluation of the degree of

impact, i.e., identify the risks and their destructive potential. Dangerous is announced every natural phenomenon, which is the catalyst for the emergence of such destabilizing processes that pose a threat to life and health of people on the set of human way of functioning of the society, the objects of technosphere and the natural environment. Dangerous natural phenomena pose a hazard to the society only when areas of occurrence and manifestation of such phenomena are populated by man.

In determining damages in social complexity represents a valuation of human life. For this purpose use such parameters as the economic situation of the country, average income per capita, life expectancy, employment, professional training.The risk as a material threat usually determined in the assessment of losses related to the technosphere and the natural environment. (*Osipov*, 2002)

For this purpose *Akimov* et. al. (2014) determines the following risk assessment methods:

- phenomenological
- deterministic
- probabilistic

Phenomenological method is based on the possibility of a risk processes, proceeding from the results of the analysis of the necessary conditions relating to the implementation of these or those natural laws. This method is the most convenient for the application, providing reliable results only if the working conditions and processes are such that with a great deal of accuracy can determine the condition of the components of the systems, but is unreliable abruptly change the status of the substance of the system.

Deterministic method focuses on the different stages of the risk process, starting from the initiating events, going through the sequence of the putative stages of deformation and destruction of components to establish the final state of the system.

Probabilistic method is based on the assessment of the probability of the risk process and the most likely direction of development of the process.

Based on probabilistic method can be built different methodologies for assessment of natural and technogenic risks for the population, which depending upon the output information can be divided into:

- *statistical,* wherein the probability is determined by the available statistics (in the cases that there are such);
- *theoretical-probability,* used to assess the risks of rare events, when statistics practically absent;
- *heuristic,* based on the use of subjective probabilities obtained by the expert assessment; used in assessing the complex risks when absent not only statistics but also mathematical models;

The stage *"choice of modes to influence the risk"* has the following strategic objectives:

- risk avoidance;
- risk reduce;
- risk transfer (sharing);
- quick recovery (rehabilitation) after implementation of risk process;

The process of impact on risk must be able to explain the following issues:

- Can the elements at risk to be protected?
- Can the consequences of natural hazards phenomenon be reduced?

Techniques for immediate impact on risk by their nature are economical and organizational-management. They include all activities, programs and measures which can be taken before the onset of the disaster (prevention and early warning), during the realization of the disaster (minimizing the impact assistance to victims) and after the occurrence of a natural disaster in order to prevent recurrence and to reduce its negative impact. (Table 2)

Table 2 Methods for the risk management

Economical	*Organizational- management*
• insurance • diversification • optimization • concentration	• developing evacuation plans • logistics equipment • creating early warning systems • educational activities among the population

• financing • immunization • construction of technical infrastructure	• mapping of vulnerable areas in the paper or GIS format • determining the areas safe for urbanization and development • acceptance of construction norms and rules, with a view to possible consequences of natural disasters and risk assessment for a given place • adoption of management decisions in order to predict and minimize the risk of national, regional and / or local level

A very important place in the system of activities have communication at all levels and proper management of available information. Integrated management of activities as diverse requires a multidisciplinary approach, ie multisectoral (administrative and legal sphere, socio-economic sphere, technological innovation) implementation of policies and measures to minimize the natural disaster risks. Obligatory is the participation of specialists from different fields of knowledge and institutional commitment. This implies the sharing of approaches, methods, data, using GIS and others. All this en masse should regulate processes resulting from global changes that lead to increased vulnerability of systems with anthropogenic or natural genesis and increase their resistance to potentially dangerous effects.

CONCLUSION

Main reason for the occurrence of natural risk processes is a complex interraction between the various systems and subsystems of planetary and universal level. Since the emergence of the planet Earth continuously occured conditions for the formation of dangerous natural processes. In fact these natural phenomena are „dangerous" mainly for the living beings, which can perceived and experience to back their impact, otherwise for the nature they are something completely matter-of-course.

During its entire history mankind has desperately sought to deal with the consequences of the implementation of catastrophic natural phenomena. In this regard, it has accumulated a huge amount of information database on the regularities of development and causation of these natural phenomena. However, the issue of early prediction and prevention of natural disasters remains one of the outstanding scientific and technical tasks of our time. At the present stage of technological development, it is considered unacceptable and in this connection it is necessary to focus on prevention, evaluation, and especially the implementation of strategies for managing natural disasters, whose main objective is the reduction of their adverse effects, respectively increase safety of the elements of social and technical sphere.

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