METHODOLOGICAL ASPECTS OF RISK MANAGEMENT DEVELOPMENT OF THE COASTAL AREAS

Evgeniy Istomin, ***Russian State Hydrometeorological University, Russia***
Alexandr Sokolov, ***Russian State Hydrometeorological University, Russia***
Valery Abramov, ***Russian State Hydrometeorological University, Russia***
Anna Fokicheva, ***Russian State Hydrometeorological University, Russia***
Ludmila Slesareva, ***Russian State Hydrometeorological University, Russia***
Nikolay Popov, ***Russian State Hydrometeorological University, Russia***

biom@bk.ru

Risk management of a development of systems and territories is one of the key problems of managerial decision-making. This is due to the impossibility of carrying out model experiments and the complexity of formalization of characteristics. The necessity of considering the peculiarities of the spatial distribution of subjects and objects of management allows to speak about relevance of geoinformation management.

Compared with other classes of potentially hazardous systems, spatially distributed systems and areas characterized by a significant level of inertia that contributes to sustainability in development, but hinders the development management and allows the dynamics to determine the influence of threat factors. The effects of hazards on the territory are systemic. The article describes:
- analysis of dynamics of control conditions for the development of spatially distributed objects and territories;
- classification of risks for coastal management;
- principles of risk management development of the coastal areas;
- the system model (conceptual model) of risk management in its spatial aspect, as well as private models for risk management under the influence of natural factors.

Key words: Territorial organizational-technical systems, risks management, development of systems and territories, risk management model

I. INTRODUCTION

Risk management for development of coastal systems and territories is essential problem of geo-information management (GM) [1-8]. Coastal systems and areas characterized by a significant level of inertia that contributes to sustainability in development, but hinders the development management and allows the dynamics to determine the influence of threat factors. The effects of hazards on the coastal territory are greatly important. In article we present:
- dynamic analysis for control conditions while the development of spatially distributed objects and territories;
- risk classification for GM of coastal systems and areas;
- principles of risk management while development of the coastal areas;

- the conceptual model of risk management with spatial aspects;
-private models for risk management under the influence of natural factors.

The use of risk management in GM involves the use of complex techniques of planning and control, which includes several stages [4]: conducting strategic analysis of potential development of the territory, including analysis of the current state of the territory and the main trends (opportunities, threats, etc.) development; identifying existing, emerging and potential clusters of signs on site [2]; assessing of competitive advantages of the territory and the rationale for management strategy development on the basis of cluster analysis [2], using of environmental monitoring systems [8-10] including sophisticated techniques [11-18].

II. METHODOLOGY

The GM phenomenon in modern conditions leads to the need to consider and implement a system of management of human activities as a multidimensional spatial phenomenon, comprising certain way distributed objective and subjective factors, and feasible in the geo-space. From the GM point of view, geo-space can be structured to allocate the interconnected components of the solution space [1]. To solve these problems, well-known methodological developments of strategic management can be used, including identifying current, emerging and potential clusters of signs on site [2].

III. RESULTS AND DISCUSSION

Territorial organizational-technical systems (TOTS) function in space and time, performing the appropriate function, focusing on the appropriate goals. The choice of targets for the development of such systems is based on the principles of sustainable development and security. Security of the population, enhance shareholder value and social facilities and natural environment elements of the territorial system, is a very complex task which is impossible without improving the methodological apparatus in the field of reliability research, forecasting, and security systems of different levels of complexity and goal of. Modern trends of security suggest a change from the concept "to respond to threats and fix" approach to a "predict and prevent is to give." The implementation of preventive security requires the identification of dangerous functions, threats to the development of TOTS, risk assessment of management decisions and the formation of the system of risk management system development.

Dangers of developing OTS arise as a consequence of the effects of certain negative external and internal factors. Manifestations of risk can be assessed as non-compliance of characteristics of the influencing factors characteristics of the OTS, which can cause unintended consequences directly or indirectly. Implementation of threat factors can be realized in the form of:

- direct or indirect damage to the territory, manifested in time, gradually or suddenly, and involve a critical decline in the level of safety for the population, environmental, natural and technological disaster as a result of failures and accidents of technical systems, destructions, deaths, etc.;

- reduction potential of the system properties object, which does not lead to a complete loss of ability to function, but its effectiveness;

- loss of control, loss of diversity, trauma, partial loss of functional activity, reduced competitiveness, pollution etc.

The development of territorial systems is potentially dangerous because of the hidden implicit nature of the manifestation of dangerous factors mediated in certain conditions, and in the long run (delayed symptoms). For a comparison, as compared to other classes of potentially hazardous systems, spatially distributed systems and areas are characterized by a significant level of inertia that, on the one hand contributes to the sustainability in development, and with another – complicates development management and allows the dynamics to determine the influence of threat factors, and to realize effective and adequate solutions to the adaptation of the system and minimizing negative governmental impact.

The danger is based on potential and the dynamic characteristics of the territorial systems. The latter are formed and rely on the property of openness of systems – flows of substance, energy and information that the system exchanges with the external it environment and which exist within its borders. Therefore, the risk can be characterized by:

- acceptable threshold levels of hazardous factors (potential characteristics);
- excess flows of substance, energy and information of acceptable levels characteristics of these threads (dynamic characteristics).

Sources of hazards the development of TOTS may be:

- technical factors such as defects, malfunctions, unsuccessful, merely leading characteristics, misuse, etc.;
-economic growth – costs of implemented solutions, reducing competitiveness, consumer dissatisfaction, etc.;
- social factors (the rise in crime, decline in fertility, political instability and large-scale, the weakness of the culture, etc.);
- information factors (information overload, the willingness of the individual and society to perceive information, the impact of information on the education of youth, etc.);
- environmental factors (harmful effects on humans and the natural environment, the degradation of the natural environment, reduction of resource potential, etc.).

The effects of hazards on TOTS are systemic: they are implemented in a spatial system "man – the individual – society – techno-sphere – geo-system".

The dangers are in space and in time, which involves the allocation of certain areas and intervals of exposure, frequency of manifestation of risk factors-in particular, frequency of exposure and other indicators of danger. Spatial aspects of risk include the region of occurrence of natural hazards, industrial specific zones and negative consequences of human activities (e.g., waste-baskets, war zones etc. the Classification (taxonomy) of hazards may be conducted according to certain criteria presented in table.

Table. Classification for hazards to development of territorial systems

Classification sign	Hazards
Source (nature) the occurrence of	Natural, technological, human, informational, economic, environmental, political and mixed
Symptoms	Physical, chemical, biological, physiological, organizational

Time of symptoms	transient or impulsive, long-term or cumulative, with the accumulation of consequences
Localization	Atmosphere, hydrosphere, lithosphere, space, society: staff, company, family
Area of activity	domestic, industrial, sports, military, road traffic, etc.
Kind of damage	social, technical, economic, environmental, etc.
Kind of the human exposure	active (having a direct impact on the basis of internal energy) passive-active (activated by the energy of the person) passive (indirect manifest)
Reason	voluntary - the person chooses a dangerous activity, the danger zone, etc. forced - finding near a source of danger as needed, meta residence, etc.
Structure	simple - factors, complex - multiple factors, derivatives - of the indirect factors
Concentration	concentrated in space, time, object impact, etc. scattered - distributed in space, time, objects of impact: local, domestic, local, regional, global etc.

The dangers present in the general case of multidimensional phenomena, which are manifestations or consequences of systemic or combined character. As a rule, the risk of single accidents, incidents, phenomena quite low, but the risk implications of the object - large. For group events (processes), the opposite pattern – the danger increases with the complexity and size of the object, but the risk is reduced due to the increase of stability and reliability of a complex object and, therefore, the growth of acceptable levels of risk (threshold of risk acceptable level of the object characteristics and impact).

The formalization of hazards involves the use of several types of features: energy, temporal and spatial. The energy of the hazard show the distribution of dangerous phenomena on the power of manifestation that is determined by the levels of physical quantities of the factors (amplitude, speed change, pressure, energy, etc.) and frequency of occurrence (impact on target), which allows to characterize the integral levels of influencing factors. The temporal characteristics of risk based on consideration of the hazards as flow of random events. The spatial characteristics of hazard it is convenient to depict on the map in form of isolines of the frequency of occurrence or strength. To characterize the degree of hazard areas, using the concept of injury rate dangerous phenomenon – the ratio of the area of the emergence or spread of a certain dangerous process to the total area of the territory. Area of negative factors, the affected area depends on the strength of the dangerous phenomenon, factor, durability of the object of exposure, and other factors. It is estimated according to statistical data or using theoretical models.

We call hazardous areas the region where the there are development of hazardous and harmful factors of the environment. They are characterized by an increased risk of the occurrence of the incident or accident. However, even if the person is in the danger zone, but properly organize their activities, to comply with the terms of the security, monitors the serviceability of technical systems, an accident occurs. Often accidents are the result of violations of security measures at the time of being in the danger zone.

The development of risk it is possible to present the relevant algorithms. The typical algorithm of impact on the object of threat of external factors: initiation, the accumulation of hazardous factors → the release and migration of hazardous factors on the object → the impact of hazardous factors on the object (interaction object) → object response to external stimuli → the violation of the processes of functioning of the object → the destruction of the object → internal threat factors → release of hazardous factors by the object itself → secondary effects of hazards, interaction, etc.

The typical algorithm of the impact of threat internal factors on the object: initiation, the accumulation of internal threat factors → the violation of the processes of functioning of object → object is destroyed → the release of hazardous factors by the object itself → secondary impact of hazardous factors on the object, interaction → transport of dangerous factors on other objects, etc.

Each such event can be put into correspondence with private indicator-probability event, which will formulate the logical-probabilistic model of the manifestation of risk – taking decisions in risk management for site development. For the realization of the danger, you need to meet several conditions:

- danger really exists, is present;
- the object is in a spatial or temporal region of existence for risk factor exposure conditions;
- the level of danger, exposure factor sufficient to disruption of the object, its destruction.

Measurement of hazards and the quantification is a quantitative expression of the relevant concepts via a scorecard. For the hazards the indicators are used:

- potential is evident in quantitative terms, using the maximum achievable value of the object characteristics, external and internal influences: noise, air dust level, the intensity of the electric current, needs, purchasing power, requirements for the level of personnel training, etc.;
- quality reflects the specific features of the object and impact the possibility of their interaction and adaptation: the physical composition of the inputs and outputs of the object, its purpose, accessibility to influence, etc.;
- damage is a quantitative measure of the impacts of danger. Can be measured quantitatively: the economic damage, the costs of elimination of consequences of realization of risk or qualitatively: implications for individual - psychological damage, social implications, changing socio – economic conditions of functioning of the object.

The dangers are unrealized potential, i.e. hidden, which suggests a solution to the problem of their identification - the detection and establishment of quantitative, temporal, spatial and other characteristics necessary and sufficient for the development of preventive and operational measures aimed at ensuring the normal functioning of the JTS of the quality of life of the population in the study area. To identify the range of hazards, the likelihood of their expression, spatial localization, coordinates, possible damage and other parameters required for solving specific tasks.

Danger threshold level is the one of external influence or change the internal factors for a system in which adverse reactions is not observed and the system stably operates within acceptable performance. The threshold levels depend on the stability margin of the system, its ability for resisting to external factors, workloads, level of available reserves and the ability of the system to their completion. The threshold levels can be characterized by the magnitude of this factor and the

exposure time, the system's ability to accumulate the negative effects of impacts and development of adaptive features of the system.

The flip side evaluation of the risk of developing TOTS is the estimation of the security level. The main indicators of safety TOTS is the system's ability to withstand the negative effects of external and internal factors can be divided into several groups.

Indicators of resistance include the critical loads or levels of negative factors which impact the object retain the ability to perform functions. The opposite characteristic is a conditional vulnerability. Rationing of indicators of resilience (vulnerability) takes into account the size of the prevented damage.

Security metrics characterize the possibility of harm to TOTS that can be prevented by conducting early protective measures. The modern concept of assessment - the so-called "barrier" concept based on the use to counter the negative factors, many barriers - layered protection. To quantify the degree of protection can be assessed using the coefficient of resistance, which generally represents the ratio of the forces influencing factor before and after the respective barrier, the protective echelon. Barriers have different meaning – the physical, organizational, financial, institutional, psychological, etc. the Efficiency of protection can be estimated by the decrease in the level of this factor to an acceptable level.

The overall objective of the potential development areas is to occur, the estimated liabilities exactly matches the existing potential. Knowing the potential areas for strategic period, it is possible to calculate obligations for this period.. Task of strategic management of the potential site is not only the preservation of the past but also providing capacity building in the implementation of any activities.

The presence of high potential areas is necessary but not sufficient condition for its implementation, which is associated with the existence of certain risks the occurrence of events with negative consequences. Risk assessment the management of territories should be focused on identifying key factors or issues about timeliness of management decision-making and increase predictive power. The system of factors allows to group model management on a specific basis and use appropriate methods and management tools, extending their capabilities based on spatial information. In this sense, the logic of geographic information management development of TOTS needs to take into account the characteristics of the territories, a system of internal and external objects and relationships between them. Control logic development based on the selected control factors suggests the possibility of decomposition of management practices across levels, content, the specifics of the management tools and functions. Using the terminology and the most common technology of geographic information systems we can talk about the formation of the corresponding slices or layers of analysis of the system and detail of objects of each slice in space and the object space for management decisions. The set of the slices or layers, of events and objects is based on multidimensional knowledge bases with respect to general components of the TOTS. In the context of several slices or layers of decisions aimed at the development of specific control object, component areas, involving the integration of management tools to achieve the common goal of developing the component TOTS for different levels of management in relation to significant events and dynamics attributes of the objects.

Within a single level of decision-making, the formation of several private sections in attribute space-oriented space of the respective characteristics or attributes, the TOTS needed for decision-making at the appropriate management level, and relevant events. Thus formed multi-level, at least three-dimensional spatially distributed system of decision making. Risk management in conceptual representation focuses on the main consequences of management decisions in appropriate situations.

Risk management of coastal areas have to be cost effective, use all possibilities of international cooperation and take into account best practice at global level [18,19]. Our experience let us to see the Technological platform "Green Technologies Platform" [20] as most convenient tool to take into account both international cooperation and national features including laws.

IV. Summary and conclusion

Risk management within GM at a conceptual level largely depends on the organization of relevant information. We propose meaningful ways of generating and presenting information to the decision-makers. GM for TOTS focuses on a multidimensional view of spatial information flows. The authorities may define additional components and additional requirements for the development plan of the state sector of the economy. They can develop a long-term target programs, subject to approval by relevant representative bodies. Well-designed concept of development greatly facilitates the development and adoption of specific target programs for the development of the region. The target program links resources, performers and terms of implementation the complex of scientific-research, experimental, production, socio-economic, organizationally-economic and other activities providing effective solution of tasks in the field of state, economic, social and cultural development .

IV. Acknowledgment

The platform https://www.researchgate.net/profile/Valery_Abramov2/?ev=hdr_xprf was used as a tool for scientific communication while research. The Ministry of education and science of Russia provides financial support for this research with the state task 1223.2014/166.

V. References

[1] Istomin E. P. et all. Geoinformation management as a modern approach to the management of spatially-distributed systems and territories, International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, Bulgaria, vol. 1, issue 2, pp 607-614, 2015.

[2] Istomin E. P. et all. CLUSTERS WITHIN GEOSPATIAL INFORMATION MANAGEMENT FOR DEVELOPMENT OF THE TERRITORY, International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, Bulgaria, vol. 1, book 2, pp 601-608, 2016.

[3] Sokolov A. G. decision Analysis in business management, St. Petersburg, Andrew's editing house, 2011, 189 p

[4] Karlin L.N., Abramov V.M. Environmental and ecological risks management, St.-Petersburg, RSHU, 2013, 332 p - DOI: 10.13140/2.1.1978.8482

[5] Istomin E. P. et all. Methods for external factors assessing within geoinformation management of territories, International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, Bulgaria, vol. 1, issue 2, pp 729-736, 2015

[6] Gogoberidze G.G. et all. Marine economic potential assessment for environmental management in the Russian Arctic and subarctic coastal regions, International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, Bulgaria, 2014.

[7] Gogoberidze, G. et all. Indicator method of estimation of human impact assessment for coastal local municipalities, Measuring and Modeling of Multi-Scale Interactions in the Marine Environment - IEEE/OES Baltic International Symposium, BALTIC 2014, Estonia, 2014.

[8] Lednova J. et all. Concept of environmental monitoring in the Russian arctic coastal regions, International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, Bulgaria, vol. 1, issue 5, pp 161-168, 2014

[9] Abramov V.M., Karlin L.N., Gogoberidze G.G., Golosovskaya V.A. On route to Integrated Water Resources Management for Russian arctic and subarctic rivers, International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, Bulgaria, vol. 1, issue 3, pp 495-501, 2014.

[10] Gogoberidze G. et all. Main results of summer oceanographic surveys in the eastern gulf of Finland in the framework of the Topcons project, International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, Bulgaria, vol. 3, issue 5, pp 253-260, 2014.

[11] Abramov V.M. et all. Water exchange between the Pacific and the Bering sea with impact on climate change in the Arctic and Subarctic, International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, Bulgaria, vol. 2, issue 3, pp. 701-708, 2014

[12] Abramov V.M. et all. On Atlantic water inflow to Arctic ocean: Unique Argo buoy trip across Atlantic and Barents sea, International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, Bulgaria, vol. 2, issue 3, pp. 661-668, 2014.

[13] Karlin L.N., Abramov V.M., Ovsyannikov A.A. THE TEMPORAL STRUCTURE OF THE ICEBERG HAZARD IN THE CENTRAL PART OF THE BARENTS SEA, Oceanology, 2009, vol. 49, No 3.

[14] Abramov V.M. et all. Clean technologies development strategy for the national black carbon controlling system in the Russian Arctic, International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, Bulgaria, vol. 2, issue 4, pp 313-320, 2014.

[15] Abramov V.M. et all. Method of assessment for black carbon random fields within Russia for climate management in the Arctic, International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, Bulgaria, vol. 1, issue 4, pp 953-960, 2015.

[16] Abramov V.M et all. Variability of particulate matter in Saint-petersburg megacity air within climatic time scale, International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, Bulgaria, vol. 2, issue 4, pp 599-606, 2014.

[17] Abramov V. M., Popov N.N., Bachiev R.I. DECADAL VARIABILITY OF PARTICULATE MATTER IN MOSCOW MEGACITY AIR, International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, Bulgaria, vol. 2, book 4, pp 323-330, 2016.

[18] Abramov V. M. et all. INNOVATIVE TECHNOLOGIES FOR DECISION SUPPORT

IN SOCIO-ECONOMIC DEVELOPMENT WITHIN COASTAL SYSTEMS OF RUSSIAN NORTHERN SEAS TAKING INTO ACCOUNT NATURAL RISKS AND ADAPTATION TO CLIMATE CHANGE Proc. of Int. Conference "Managing risks to coastal regions and communities in a changing world (EMECS'11 Sea Coast XXVI)", St.-Petersburg, 2016.

[19] Gogoberidze G. et all. THE PRINCIPLES AND ACTIVITIES OF THE NATIONAL SCIENTIFIC DEVELOPMENT STRATEGY IN THE ARCTIC ZONE OF THE RUSSIAN FEDERATION, Proc. of Int. Conference "Managing risks to coastal regions and communities in a changing world (EMECS'11 Sea Coast XXVI)", St.-Petersburg, 2016.

[20] Abramov V., Karlin L., Kasimov N. & Morgounov B. Technological platform "Green Technologies Platform" in the aspect of international cooperation in the modern stage of globalization changes, Digest of world politics of the XXI century: annual review. Volume 6, Chapter: Energy and ecology in regional dimension, Russia, pp.135-144, 2013. - DOI: 10.13140/2.1.3551.7123