Information support for sustainable development of coastal areas of the Far East

P P Lepekhin¹, V M Stolyarov¹, N A Ivanova¹ and S V Savinova¹
State University of Land Use Planning, Kazakova str., 15, 105064, Moscow, Russia
E-mail: shampol amo@gmail.com

Abstract. The article considers problems and prospects of reducing the risks of occurrence of emergency situations of natural and technogenic character in the coastal river areas, as well as the usage for operational informing of the population of a comprehensive system that includes Federal, regional and local information centres. It is shown that the solution of the problem is based on the formation of information about emergency situations, their consequences, the state of radiation, chemical, medical, biological, explosive, fire and environmental safety in these areas, taking into account the coastal and transboundary situation to ensure their sustainable development. The authors defined the indicators and presented a strategy for collecting information and proposed a comprehensive system of support for management decisions aimed at preventing natural and man-made emergencies for the river coastal territory (RCT) of the Far East regions.

1. Introduction
In the era of globalization, everyone relies on information on the basis of global networks such as the Internet, the global information space. These trends are fundamentally changing the way in which information is provided to all governing bodies.

The authors believe that the implementation of the concept of sustainable development of coastal areas of the Far East, which required a change of the natural paradigm and reorientation to rapidly renewable resources, should be based on the use of new information technologies in order to develop and make management decisions, providing stakeholders with relevant information in the requested form on-line.

Evaluation of the intensity of the development of the coastal zone of China is given, for example, in the article Wei Xu, Yue-e Dong and others [1]. Problems and prospects for the development of the Far East are presented and analyzed in the article by Michael J. Bradshaw and Nicholas J. Lynn [2]. We rely on these and other sources when conducting our own research.

2. Materials and methods
As the object of the study, the regions of the Far East, the situations that require an urgent solution to the problem of Informatization and updating of information flows for all stakeholders are considered. The solution of the problem is based on the use of highly scientific information technologies and expert systems with artificial intelligence to account for and preserve biodiversity and bioresources. The authors give proposals for solving the problems of sustainable nature management in coastal areas on the basis of the coastal-border-basin-territorial principle of information analysis and the creation of various predictive models of management solvers. They believe that the implementation of the concept...
of sustainable development of coastal areas of the Far East, which requires a change of the natural management paradigm and reorientation to rapidly renewable resources, should be based on the use of new information technologies to develop and make management decisions, provision of relevant information to interested parties in the requested form on-line.

3. **Structure of information support of sustainable development of coastal areas taking into account their transboundary character**

Information is essential for the optimal management of coastal areas. It is a limited and expensive resource of executive authorities, management bodies of various industrial structures, individuals and legal entities that are somehow connected with the nature of their activities with the territories located in the coastal, transboundary and border areas of water bodies.

Table 1 shows the relationship of information with the objectives and decisions based on the information support for the object of study.

| Information Status | Complete | Incomplete |
|--------------------|----------|------------|
| Decision           | With certainty | With risk | With uncertainty |
| Objective expectations | Unequivocal | Quasi-Unequivocal | Ambiguous |
| Subjective sensations | Confidence | | Uncertainty |

The use of the basin organization (in contrast to the administrative-territorial principle of information analysis) in information technology is the most promising, however, statistical information (data on physical-geographical, ecological-economic, natural-resource, labor, etc. components), as a rule, is given in administrative districts, which, on the one hand, greatly simplifies the calculations, but, on the other hand, becomes unacceptable for the river-border-transboundary territories.

Increasing demands for information efficiency in the management of coastal areas as economic and natural objects necessitates the creation of network technologies that are developed in accordance with the requirements of modern conditions for the functioning of management bodies. Management of natural processes should be based on reliable information about the past, present and future states of natural and anthropogenic subsystems, such systems are monitoring systems.

Information systems, as well as monitoring information systems, are an integral part of the management system, human interaction with the environment (environmental management system), since information on the current state of the environment and trends in its change should be the basis for the development of measures for the protection of nature and taken into account in planning the development of coastal areas. The results of the assessment of the existing and projected state of the coastal area, in turn, provide an opportunity to clarify the requirements for the subsystem of observations [3].

The problem of pollution of the Amur river appeared in the middle of the twentieth century. The accident at the chemical plant and the emissions of benzene in 2005 in the Songhua river (China) showed the absence of the modern and effective mechanism to address transboundary problems in the basin. It was the basis for the development of cooperation between the two countries in the field of environmental protection with the creation of joint mechanisms for the protection and use of natural resources in the coastal areas and river basin of the Amur river, the largest in the Far East.

The order of the Ministry of natural resources and ecology of the Russian Federation of October 8, 2014 adopted "Guidelines for the implementation of state monitoring of water bodies in terms of observations of the state of the bottom, banks, the state and mode of use of water protection zones and changes in the morphometric characteristics of water bodies or parts thereof". This order provides the composition of observed and measured parameters, frequency of observations and surveys, forms and methods of processing observations, which should be linked to the scale of the water body and the intensity of natural and anthropogenic rearrangements of riverbeds. For individual water bodies, the
water situation on which has specific features, combinations of different methods are used in different sequences. The main results of remote sensing are space and aerial photographs of water protection zones, shoreline and water areas of water bodies, as well as materials of remote sensing data processing: transformed images, photographic plans and photographs with special thematic content and other materials.

| Type of observation | Observation parameters | Frequency of observations |
|---------------------|------------------------|--------------------------|
| River bottom, banks, morphometry | The condition of the bottom of the water body | 1. Characteristic channel forms | Once a year during the summer-autumn low flow period |
|                     |                        | 2. Change of bottom relief, ΔZ, m |                    |
|                     |                        | 3. Foreign objects at the bottom, location: a) type of object; b) size; c) potential danger; |                    |
|                     |                        | 4. Sediment (degree of sedimentation) |                    |
|                     | 4 Shoreline position  | 5 Shoreline change over the observation period, ΔX, m | 1 time in 5 years during the summer low water period |
|                     | 6 The area of flooded areas ΔS, m² | 7 Area of wetlands S, m² |                    |
|                     |                        | 8 and its change ΔS, m² |                    |
| Sections of rivers where a narrowing of the river bed is observed due to Hydro Technical Facilities, bridge structures | Threat of flooding | 1. Foreign objects at the bottom, location: a) type of object; b) size; c) potential danger. | Once a year during the fall low water period |
|                     | The condition of the bottom and banks of the water body | 2. The presence of islands; 3. The area of plots under shrub and woody vegetation. |                    |
| Water protection zone, river coastal territory (authors’ proposals) | State of the river coastal area | a) civil engineering objects | Once a year during the summer-autumn low flow period |
|                     |                        | b) engineering infrastructure objects |                    |
|                     |                        | c) objects of cultural heritage |                    |
|                     |                        | d) protected areas |                    |
Information is collected for: changes in the position of the shoreline; dynamics, causes of changes in the shoreline; consequences and potential danger of changes in the shoreline; the presence of foreign objects in the riverbed. The list of necessary parameters and frequency of their determination established by Methodical instructions are given in table 2.

Information gathering must be performed for the coastal basin of the transboundary territories. To do this, it is necessary to develop a strategy for collecting information corresponding to statistical data and innovative technologies, local capabilities, the required accuracy, and the result using the above guidelines.

The authors believe that the method of collecting information, its analysis and processing for the completeness of obtaining reliable and relevant information about the state of the object of study, should include the following actions:

1) analysis of initial (stock) materials on the state and use of land in riverside coastal-transboundary territories;
2) selection of the most informative indicators for monitoring river coastal border-transboundary territories based on a geo-ecological assessment of the territory and danger of natural and man-made regional risks;
3) determining methods for selecting monitoring indicators, developing approaches to collecting information in accordance with local conditions, using Earth remote sensing data (aerospace surveys, data obtained from unmanned aerial vehicles);
4) collecting information on additional indicators using modern innovative technologies for obtaining and processing information on the state of land and water resources; verification and analysis of all selected indicators for coastal area (CA) objects;
5) creation of a database of completed studies by combining and unifying all the materials received so that the results can be obtained promptly at the request of the portal user;
6) creation of a server for the primary processing of information on the basis of incoming requests from ordinary users of the portal, the creation of a CA geoportal and metadata portal, including modules for monitoring transboundary territories, coastal areas, shores, waters, engineering structures, bioresources, etc.

Based on the considered actions, the author proposes a comprehensive system of support for management decisions aimed at preventing natural and man-made emergencies for the river coastal territory (CA) of the Far East regions.

The main methods of CA data collection include: expert opinion, remote data collection, statistical data study, in-situ measurements, sampling of water levels in the rivers of the basin (on the basis of in-situ criteria, expert opinion of nature users and land users), processing, forecasting and modeling.

The development of river coastal areas depends on many factors, among which we can note such as: 1) currently, there is no developed program for the development of river coastal territory; 2) there is great competition between the various owners of natural resources located in this territory; 3) there is ambiguity in the formalization of the definition of the boundaries of the river coastal territory; 4) the discrepancy between the boundaries of administrative territories and natural landscapes, etc.

Based on this, there arises the need to develop, first of all, an information system allowing one to design the use of these natural and man-made coastal territories, taking into account natural and man-made regional risks in the system of sustainable development.

According to the authors, the creation of the coastal territory information system (CA IS) will allow one to ensure, in the necessary volume, all interested users with information on the status and use of these territories, represented by thematic cartographic materials, diagrams, graphs. This will allow information exchange with the Unified State Register of Real Estate, cadastres and registers of natural resources and information systems of other business entities [4].

Thus, CA IS is an integrated information system based on a set of reliable information about the state and dynamics of the use of the coastal area. In this connection, the precise selection and mapping of floodplain areas, the assessment of the main floodplain arrays, the study of the scale and degree of their possible degradation are of particular importance. On the basis of satellite images and topographic maps, Egidarev EG studies of the effects of hydroelectric power stations on the adjacent territories in the Amur
River basin were conducted, and a high flood plain of the Amur and its major tributaries, which have a catchment area of over 10 thousand km\textsuperscript{2}, was identified. The total area of the floodplain-channel complex in the valleys of large watercourses of the Amur basin is 80 341 km\textsuperscript{2} [5]. Taking into account the location of existing hydraulic facilities in the basin, it was found that in 2013 the transformation of natural flow to varying degrees occurred in the watercourses, forming half of all floodplain areas with a total area of 42 752 km\textsuperscript{2} [6]. Modern methods of obtaining spatial information allow a high degree of accuracy and in a short time to conduct research and perform mapping and modeling on any territory of interest.

The formation of the information base of CA IS is based on materials monitoring the environment and the state of the land; on USRN data; cadastres and registers of natural resources; statistical data. Information exchange of relevant information between the copyright holders of such information on the state of the coastal territory should be carried out through the Unified Information Center, taking into account information on the status of transboundary territories. Therefore, it is necessary to obtain the necessary information to fully assess the condition of the coastal territory and predict its condition. Information in CA IS is formed on thematic blocks: legal, cartographic, economic, environmental, economic use; recreation; special use areas.

The source data in the CA IS are based on basic cartographic material, data on land users, users of natural resources, data on water, land, forest, mineral resources, biological resources, wildlife, engineering structures, specially protected areas, restrictions on use. Each database block (DB) consists of a coordinate grid description, including a complete set of information units. There are 11 such blocks in the IS, among the generally accepted blocks, special attention should be paid to the blocks "CA risks" and "Transboundary territories", which include data on regional natural and technological risks and data on international transboundary territories, playing a special role in the collection, systematization, data processing, assessment and forecasting of the state of man-made objects and natural coastal areas.

The block of risk description of the coastal territory includes data on the boundaries of the CA, taking into account areas with a special mode of land use, as reflected in the Unified State Register of Real Estate. The table "land resources" contains a comprehensive description of the soil cover of the CA in accordance with the accepted classification.

The cartographic basis of CA IS can be represented as a digital spatial model using 3D technologies. As sources of information for creating a digital terrain model, you should use topographic maps, materials of aerospace and photographic surveys, materials of topographic and geodetic works, data from river and sea bottom surveys, remote sensing materials, including those obtained from unmanned aerial vehicles (UAVs), presented in a single coordinate system.

4. Conclusion
The introduction of elements of CA IS at the present stage can be provided under the current state program of the Russian Federation "Information Society (2011 - 2020), approved by the decree of the Government of the Russian Federation of October 20, 2010 N 1815-p", which defines the main priorities of strategic development in the field of information and communication technologies.

CA IS will allow coordinating and directing the efforts of state authorities, regions of the Far East, local governments, economic entities and citizens to improve the informatization of coastal area management taking into account regional natural and man-made risks and the international transboundary characteristics of the Far East regions.

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