Integrated ecosystems management of the coastal zones in the Artic zone of the Russian Federation: problems and solutions

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Abstract. The article is devoted to development, implementation and information support of integrated approach to ecosystem management in the Arctic zone of the Russian Federation in the context of global climate change. According to the adopted strategic planning documents for the development of the Arctic zone of the Russian Federation, integrated ecosystems management of the coastal zones is an issue that must be dealt with expeditiously. Solution of this problem is an urgent task in the state policy of the Russian Federation. The article presents the methodology for development, implementation and information support of integrated approach to ecosystem management in the Arctic zone of the Russian Federation as well.

1 Introduction

1.1 Specifics of coastal zones in the Arctic zone of the Russian Federation

The importance of Arctic spaces and resources in the life of mankind and the formation of the global gross product has increased dramatically. It is predicted that as a result of global climate change the dominant position in the structure of world trade can reach the commodity flows passing through the high-latitude transport and communication highways of the Arctic region. Despite all the technical difficulties of sailing in the High North geographically the North Sea Route (NSR) is the shortest route connecting Europe with the Far East, Asia and the Western part of North America (Figure 1). The use of the NSR can reduce the length of the reference route between Hamburg and Yokohama 2.3 times when sailing around Africa and 1.4 times in comparison with the passage through the Suez Canal.

For example, we developed two scenarios for cargo transportation volume along the NSR: baseline and target. The baseline scenario extrapolates the available data. The second scenario takes into account the possible global climate change influence. According to these scenarios, the expected cargo transportation volume along the NSR is about from 76.5 million tons (baseline scenario) up to 109.7 million tons (target scenario) (Figure 2).

The full-scale development of mineral and energy resources of the richest Arctic continental shelf directly affects the structure of the world's energy supply. The usage of renewable energy sources in the Arctic region including wind, geothermal, circulating ocean, wave, planetary gravity (tides) energy generates a wide and huge range of technological innovations used in various spheres of life. According to the Food and Agriculture Organization scenario forecasts, there will be a significant growth of marine industrial fisheries in the nearest future. The Arctic region plays an important role in this sphere. The global climate-forming function of the Arctic Ocean catalyzes the intensification of fundamental marine studies. All these trends led to the necessity of systemic evaluation of the impact of maritime activities on the environment, as well as its control and transition from sectorial to integrated management [1].

As a result of the intensification of maritime activity the competition and conflicts for the same areas as well as resources of the Arctic Ocean occur often between branches of marine complex. The occurring competition demand accommodation of conflicting interests by means of integrated coastal zone management (ICZM) and marine spatial planning (MSP). Goals of such planning are based on provision of a balance between economic activity, implementation of social policy priorities and environment-oriented tasks. The MSP instruments (including functional zoning of marine areas according to biological productivity and biodiversity; evaluation of their integral vulnerability to anthropogenic impacts; use of geographic information systems and technologies; determination of high conflict zones and their identification according to the compatibility/incompatibility of types of marine activities; establishment of “green” corridors for migration of biological resources; efficient supra-departmental control of implementation of the MSP programs and their regulatory support, etc.) allow to increase significantly the level of protection of marine ecosystems from degradation, reduce conflicts between branches of marine complex.

The Strategy for the Maritime Activities Development of the Russian Federation until 2030 was approved by the Government of the Russian Federation in 2010 [2]. According to the Strategy one of the strategic tasks is devoted to elaboration and implementation of the

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programs for coastal territories and marine areas integrated development as a component of strategies and programs for social and economic development of coastal regions of the Russian Federation. The Strategy for the development of the Arctic zone of the Russian Federation, approved by the President of the Russian Federation [3], among the priorities and main activities put an increased focus on elaboration and approbation of the integrated coastal zone management models in the Arctic zone of the Russian Federation (AZRF). Paragraph 31 of the Action Plan for implementation of the Strategy on social and economic development of the Ural Federal District for the period until 2020 adopted by the Government of the Russian Federation in 2012 [4] sets a task to elaborate the program for Yamal-Nenets autonomous district's coastal territories and marine areas integrated development. Solution of this task should be closely related to the issues of MSP as a tool for spatial reflection of the strategic decisions approved in programs for integrated coastal zone management / coastal territories and marine areas integrated development (ICZM/CTMAID).

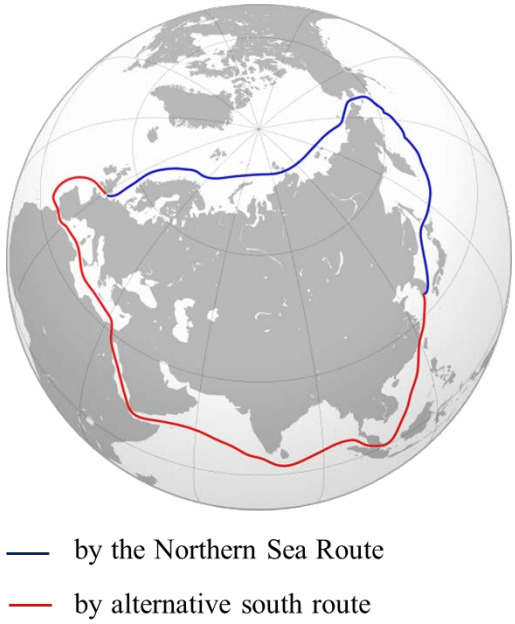

Fig. 1. "Asia-Europe" passage

The strategic planning documents emphasize that economic development in the AZRF are closely related to the Arctic Ocean, maritime transportation via the NSR. Most of the settlements here are located on the coast of the Arctic Ocean [5]. Global climate change, a shift in economic activity in the shelf zone of the Arctic seas leads to an increasing role of the marine factor in the economic and social development of the AZRF [6]. The coastal location of the macroregion differentiate it from the "continental" parts of the North of Russia and determines the uniqueness of the regional economic complexes formed here [7].

In comparison with other Arctic States, it is in the AZRF that the most powerful industrial layer has been created. Here the part of value added of extractive industries is about 60%, while in Alaska and Arctic Canada it does not exceed 30%, and in the countries of Fenno-Scandia (including the Northern regions of Norway, Sweden, Finland, as well as Greenland and Iceland) it reaches only 15%. At the same time, the fragility and vulnerability of the Arctic environment demand the development of the environmentally friendly technologies that do not cause irreversible environmental damage during the exploitation of the rich resources of the AZRF.

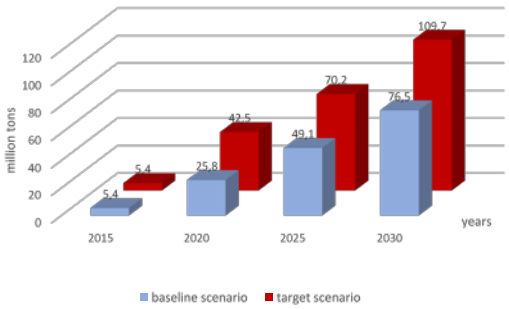

Fig 2. Forecast of cargo transportation volume along the NSR

The Arctic region is undergoing pronounced climatic changes, which affect all components of the environment, including aquatic ecosystems, the water balance of river basins, cryogenic processes, etc. [8]. The state and development of various types of infrastructure in the Arctic are subject to natural risks associated with adverse hydrological processes: floods, congestion, and blockages, ice formation, etc. One of the main factors affecting the processes of flow formation is permafrost [9]. During the recession of permafrost, water exchange increases between surface and groundwater, groundwater flow, including the movement of water in soils, supra-permafrost, and sub-permafrost. Direct and indirect evidence of such changes is observed in various cold regions of the world [10, 11]. Different types of models are applied to the modeling of the influence of hydrometeorological, hydrological, cryolithological, ecological and other parameters on certain types of infrastructure in the Arctic [12-16].

1.2 International practices of integrated approach implementation to regulation of maritime activities

International practices of integrated approach implementation to regulation of maritime activities show, that various countries have started to use MSP to achieve sustainable use, including the goal of developing a "Blue Economy". About 70 countries now have MSP initiatives.

For example, in 2005 in the Netherlands there was a methodology on MSP of Dutch sector of North Sea developed, which was determined by economic growth and advance in business activity (wind power engineering development, extraction of commercial minerals, mariculture, tourists flow increase, necessity for organizing new specially protected natural areas). Principles and mechanisms for the implementation of

MSP are fixed in Integrated Management Plan for the North Sea. The main aims include creation of environmentally safe and stable marine environment, attraction of additional investments and execution of maricultural business-projects, formation of efficient spatial management tool, which will allow to specify zones with a definite kind of use, etc. Among the general tasks are: 1) use of cartographic documents to define aquatorium sections, where activities are already being carried out, and to find out prospective zones to become utilized in future; 2) environmental monitoring; 3) integral assessment for the purpose of issuance of licenses, permits; 4) integrated scientific researches of marine environment; 5) jurisdictional disputes resolution in cases when one aquatorium user's activities do harm to another one; 6) launching the different economic operators' initiative to share aquatorium. In 2015 the Netherlands have published North Sea 2050 Spatial Agenda as a legal platform for using MSP.

Belgium was one of the first European countries to elaborate and implement MSP documents in a very short time. The main cause for the country to get into forming MSP system was development of wind power engineering in offshore water and international commitments on protection of bioresources and ecosystems. MSP in Belgium pursues economic and ecological aims – development of wind power engineering on the open sea, demarcation of specially protected areas, implementation of plan of sand and gravel extraction, conservation of maritime biodiversity, management of different kinds of economic activity, influencing on maritime ecosystems. Belgian MSP scheme was worked out in 2003. It is estimated that in prospect MSP documents will preserve their multipurpose nature and will include additional zones of nautical archaeology objects protection, zones for studying alternative methods of fishing, etc. As part of the Plan of North Sea aquatorium development, they developed the method of integrated use of offshore zone, with special emphasis on alternative use scenario. Scenarios represent "views on projects which are supposed to be implemented in the nearest future in North Sea areas". A revised Marine Spatial Plan (2020-2026) has been drafted in 2017.

MSP in Germany rests upon the Federal Law on Land Use Planning, application of which was extended over water areas, and is based on the principles of economic empowerment via orderly spatial development and optimization of maritime spaces management, protection of maritime ecosystem against pollution. In 2007 Federal Sea and Hydrographic Agency of Germany prepared the project of MSP of the country's exclusive economic zone in the North Sea and the Baltic Sea. Federal marine spatial plans approved for Baltic and North Seas exclusive economic zone (EEZ) in 2009.

In April 2006 the Government of Norway started development of overall plan on managing Norwegian part of Barents Sea, which secures management of all economic activities with a view to ensuring safety of ecosystems' quality and functions. Plan implementation involves achievement of a number of aims:

resolution of conflicts between economic activity and environment protection;

continuation of development of existing managerial measures, regulating different kinds of activities;

prioritized solution of environmental problems;

expansion of international cooperation.

Ecosystem-based MSP plan for Barents Sea was updated in 2011 and 2015, covers Barents Sea part of Norwegian EEZ. Analogous management plans are developed for Norwegian Sea and Norwegian part of North Sea. Ecosystem-based MSP plan for Norwegian Sea was approved in 2009 and updated in 2017, ecosystem-based MSP plan for North Sea was approved in 2013.

Since the beginning of 2000 Australia started development of conception "maritime bioregionalization" as the basis for development of MSP. Bioregionalization is directed towards depiction of spatial structures of ecosystems at scales of corresponding MSP schemes. In 2005 the Government of Australia adopted a program of regional maritime spatial planning, developed on basis of the law on environmental protection and conservation of biodiversity. According to this legislative act, the main principle of MSP documents is protection of maritime spaces.

In 1997, according to national policy of China Government, which was based on "steadfast implementation of laws, regulating management and protection of land, water, forest, fossil resources and seas", State Administration of Oceans suggested to develop the law of controlling maritime areas, which came into effect on the 1 of January 2002. The law warrants that any use of maritime spaces should correspond to the scheme of maritime zoning, approved by the state. After the extensive data gathering, active researches and numerous consultations, the scheme of national maritime zoning was presented to the State council of PRC and approved on 22 August 2002. Its implementation is the basis for creation of regional planning systems and schemes of overall development and preservation of maritime spaces of China. Marine Functional Zoning Plan for EEZ approved in 2012.

One of the well-known example of MSP as the mean of natural ecosystems preservation is national marine preserve Florida Keys in south-east part of the USA. The aims of MSP in Florida Keys imclude protection and preservation of valuable components of the ecosystem, for the region of high conservation value to be able to run its natural course with minimal human impact. There were a number of zones kinds with different protection statuses marked in the preserve: Special Protected Natural Areas; ecological reservations; regions of natural resources use.

There are several international organizations playing integrating role in development and implementation of MSP in Europe:

HELCOM (The Baltic Marine Environment Protection Commission);

VASAB (Vision and Strategies around the Baltic Sea – Russia presides over VASAB in 2012);

ICES (International Council for the Exploration of the Sea);

OSPAR (Convention for the Protection of the Marine Environment of the North-East Atlantic).

Today, geo-information systems (GIS) provide significant assistance for decision-making. For example, the Ministry of the Interior of Japan uses big data analytics to provide timely information on evacuation during disasters. Such a system more effectively notifies residents of evacuation plans during environmental disasters, such as floods and landslides. The system collects statistics on various PALs, as well as user data from social networks. This data allows for providing more accurate and personalized information based on the location of users and the level of danger. During major disasters such as tsunamis and earthquakes, rescuers use geolocation information from smartphones and other mobile devices during the evacuation. The information is disseminated both through traditional notification channels (radio and television), and through the Internet, mobile networks.

According to the adopted strategic planning documents for the development of the Arctic zone of the Russian Federation, integrated ecosystems management of the coastal zones is an issue that must be dealt with expeditiously. Solution of this problem is an urgent task in the state policy of the Russian Federation. It is necessary to development, implementation and information support of integrated approach to ecosystem management in the Arctic zone of the Russian Federation in the context of global climate change as soon as possible.

2 Methodology For Development, Implementation And Information Support Of Integrated Approach To Ecosystem Management In The Arctic Zone Of The Russian Federation In The Context Of Global Climate Change

Technologies for integrated ecosystem management in the AZRF and the creation hardware-software system for monitoring of their implementation in the strategic planning in harsh climate should solve such issues as:

development of technologies for integrated coastal zone management and marine spatial planning in the AZRF, as well as a set of scientific and technical solutions for their implementation in the strategic planning for social and economic development of the macroregion;

database population and updating for the development and implementation of programs for integrated coastal zone management / coastal territories and marine areas integrated development and schemes of maritime spatial planning in the Arctic region;

creation of an information system for monitoring of ecosystem management technologies implementation in the system of strategic planning for long-term infrastructure development in harsh climate;

balancing of spatial development of the Arctic zone of the Russian Federation in the context of global climate change;

comprehensive and advanced development of infrastructure in the Arctic zone of the Russian Federation on the principles of public-private partnership;

technological, organizational and institutional innovation in the economy and social sphere of the Arctic zone of the Russian Federation, development of knowledge intensive services and elements of the service economy of navigation on the Northern sea route;

ecological safety ensuring in the Arctic zone of the Russian Federation, improvement of the quality of life of the population living and working in the macroregion.

Methodologically ICZM/CTMAID program components depicted in the MSP schemes include some parts. Among them:

1) development and implementation of programs for integrated coastal zone management / coastal territories and marine areas integrated development in the Arctic zone of the Russian Federation;

2) priority development of transport, industrial, energy, information and telecommunication [17], service and social infrastructure in the interests of sustainable social and economic growth of the macroregion;

3) development of knowledge intensive services and elements of the service economy of navigation (logistics, hydrometeorology, navigation and hydrographic support, etc.);

4) development of programs to ecological safety ensuring of coastal territories and marine areas in the Arctic zone of the Russian Federation;

5) social and sociocultural design, including projects in education, medicine, culture (by using of remote technologies in education, culture, development of telemedicine), preservation of ethnoforming activities and traditional crafts of indigenous peoples of the North, Siberia and the Far East of the Russian Federation living in the Arctic zone of the Russian Federation;

6) development of strategies and programs for adaptation of regional marine complexes to global climate change;

7) creation of an information system for long-term forecasting of infrastructure development taking into account the impact of natural and climatic factors, including global climate change;

8) formation of regional transport subsystems using high-speed amphibious equipment: hovercrafts, floating amphibians with wheeled or tracked chassis, air cushion platforms, seaplanes, amphibious aircraft with air cushion chassis, etc.;

9) projects of deep and non-waste processing of aquatic bioresources, renewal of ocean fishing, development of mariculture and fishing of non-traditional and underutilized species of hydrobionts, creation of technoparks of marine genetic and biotechnology, enterprises for the production of innovative bioproducts;

10) the use of renewable energy sources of marine origin (tidal power plants, wind farms, spar buoys, wave power plants, floating hydrothermal power plants, osmotic power plants, technologies for the production of biofuels from sea weed, etc.);

11) new technologies (nanotechnology, biotechnology, information, cognitive technology, cryotechnology, CALS-technology, etc.) and materials implementation;

12) development of tourist and recreational complex (cruise, ecological, cultural and educational, pilgrimage, scientific and scientific-expedition, adventure, extreme, business, Congress and intensive tourism (conferences and seminars), sports, medical and General health tourism, diving, etc.);

13) clusterization of spatial development and creation of a network of specialized clusters;

14) preservation of cultural, natural and spiritual heritage;

15) comprehensive studies of the nature of the Arctic ocean;

16) spatial development planning.

These tasks will be focused on supporting decision-making in the interests of the effective infrastructure development of the Arctic zone of the Russian Federation - the country's key macro-region, which plays a significant role in the socio-economic development of Russia.

According to our estimation, development and implementation of integrated approach to ecosystem management in the Arctic zone of the Russian Federation will lead to such social and economic effects, as shown in Figure 3-4.

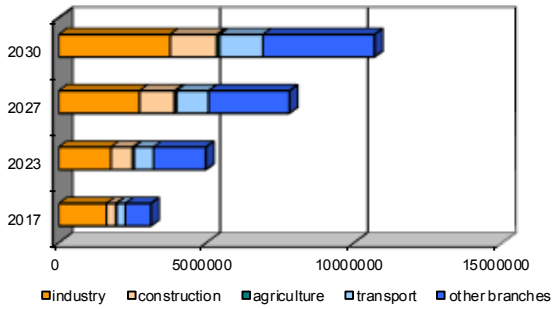

Fig. 3. Effects in economic sphere: volume and structure of the gross regional product (mln. RUB)

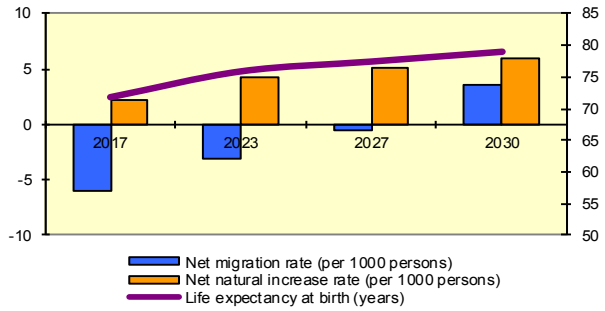

Fig. 4. Effects in social sphere: key demographic indicators

3 Conclusion

1. MSP in Russia could be implemented in the framework of coastal territories and marine areas integrated development program; so, both these elements (CTMAID and MSP) may be an integral part of the Russian state strategic planning system.

2. Guidelines for the elaboration and implementation of the CTMAID programs and MSP, as well as their legislative formalization, should be approved as soon as possible.

3. First of all “coastal territories and marine areas" are the objects of the state regulation, management and control, so when determining its borders, it is desirable not to use only geographical criteria, but the principle connected with the impartibility of the administrative and territorial structure of the Russian Federation.

4. Priority in the CTMAID programs and MSP should be given to social and economic development to meet the “green economy” principles, taking into consideration the valuation of ecosystem services.

5. The length of the Russian coastline leads to localization of maritime industries in poles of growth on perimeter of the maritime borders of the Russian Federation; that’s why on first stage CTMAID and MSP should be focused on areas with intense maritime activities and with stakeholders’ conflict interests, as well as on special tasks, for example, connected with traditional activities of indigenous peoples of the North, Siberia and Far East of the Russian Federation.

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