# THE APPROACHES TO THE SOLVING ENVIRONMENTAL AND ECONOMIC PROBLEMS OF SUSTAINABLE DEVELOPMENT ON THE SHELF OF THE ARCTIC SEAS OF THE RUSSIAN FEDERATION

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**Russian Arctic shelf - rich larder of the hydrocarbons, at the same time Northern Sea Route (NSR) - a strategically important route for transporting them.**
**The extraction and the transportation of the hydrocarbons along the NSR requires the solution of a number of ecological and economic problems in the first place to ensure environmental and technogenic safety.**
**For the solving of these problems on the continental shelf it is required a system of comprehensive measures:**

- ✓ **the development of the regulatory framework for environmental support oil and gas projects;**
- ✓ **the introduction and use of integrated methods for monitoring environmental conditions at the sites of technogenic loads on the shelf of the Arctic seas, including the use of drones;**
- ✓ **creating different models for assessing the marginal stability of ecosystems to technogenic loads during production and transportation of hydrocarbons on the continental shelf based on systems of dynamic simulations;**
- ✓ **the development and use of sensitivity maps of coastal areas of the Arctic seas during oil spill response;**
- ✓ **accounting of the results of the analysis of the total environmental benefit in the development of oil spill response plans;**
- ✓ **application of the principle of "zero" resetting, due to the high fishery valuation in Barents and Kara seas and the conservation of marine biological resources.**

*Key words: Arctic, ecosystems, hydrocarbons, shelf*

## I. INTRODUCTION

Russian shelf totals the area of more than 6 million sq km, with 4.2 sq km promising for oil and gas. According to estimates, initial recoverable energy resources on the shelf total approximately 100 billion ton of oil equivalent (of which 80% is concentrated in the Arctic).

Most scientists believe, that summer due to global warming, the Arctic drifting ice may completely disappear. Three Arctic routes (Fig. 1):

1. Northern Sea Route;
2. Northwest Passage;
3. The route through the central zone of the Arctic Ocean.

The first and second routes lie in the coastal areas of the Arctic states. The most studied and attractive is the Northern Sea Route, which lies primarily in the coastal zone of the Russian Federation. The legislation of Russia define it as the historically formed, unified national transport communication of Russia in the Arctic. Northwest Passage less studied and little used because of very difficult ice condition between the arrays of the islands, as well as due to the fact that the

circumpolar countries through which territories is crossed route, has for its disposal a small numerically fleet of icebreakers . The Participation by other countries in transiting of goods on a shorter route through the center of the central Arctic Ocean appears in the case of it exemption of pack ice.

Currently, Northern Sea Route is the most realistic route wiring cargo in the Arctic seas. Facilities atomic icebreaker fleet and prospects for economic development (production of hydrocarbons on the shelf of the Arctic seas) allow Russia to occupy the leading position in the Arctic region.

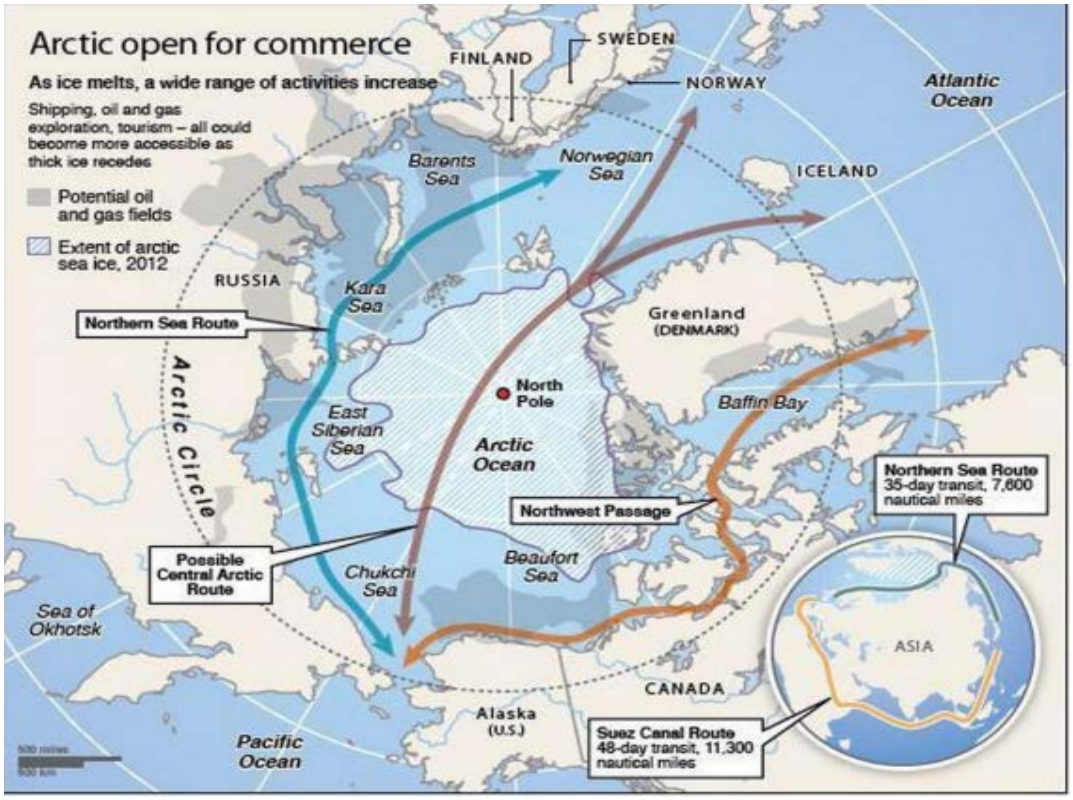


*Fig. 1 Sea transportation routes in the Arctic region (Existing and alleged) [1]*

Northern Sea Route (NSR) is the promising way to transport hydrocarbon resources from Europe to Asia. At the same time, there is a danger of oil spill in the oil fields and along the transportation lines in the NSR. That is why we should take measures to minimize anthropogenic influence ecosystems on the Russian arctic shelf.

## II. THE LEGAL FRAMEWORK WHICH REGULATES ACTIVITIES ON THE CONTINENTAL SHELF OF THE ARCTIC REGION OF RUSSIA

The legal framework about the continental shelf of the Arctic region of Russia consist from the decrees of the President of Russian Federation, from the decrees of the Russian Government, the sets of laws, the regulatory legal acts and the acts of technical regulatory activities on the continental shelf in the Arctic zone of the Russian Federation.

A special Polar Code have already in the process of implementing to solve the problems of navigation in the sea, it was adopted in late 2014, by the International Maritime Organization (IMO). The Code establishes international standards in the Arctic considering the allowable level of environmental pollution, the training and the certification of personnel, the standards for equipment on the ships and also, for the protection of life and health of crew members. The requirements prescribed in the Code in particular are for the marking plates on the ships from different countries, also for the ships, which depend from the class of ice, which they need to

overcome on the way. The regulations are binding on all courts, who are planning to navigate above 72 degrees north latitude, therefore, a special place in the Polar Code requirements is allocated to the construction and equipment of vessels used for navigation in ice, the quality of communication and navigation, as well as environmental standards. The Polar Code expected will come into force, in January 2017.

The main international legal acts in which is involved Russia in terms of pollution of the marine environment, relates:

- The international Convention on Civil Liability for Oil Pollution Damage (CLC). Edition: 1969; Being replaced by the protocol 1992 with amended by IMO Resolution of 18.10.2000;
- The international Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (FUND) 1971 (Amendment to the International Convention on Civil Liability for Oil Pollution Damage 1969) in the version of Protocol 1992 (with the IMO amendments);
- The International Convention on Civil Liability for Bunker Oil Pollution 2008;
- The international Convention for the Prevention of Pollution from Ships, 1973, MARPOL 73/78 (Russia joined the wording introduced by the Protocol of 1997);
- The international Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC) 1990;
- The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, 1989.

To date, the regulatory and legislative framework of the Russian Federation, that regulates the marine insurance, is still in the process of the harmonization with the international conventions in which our state is member. According Russia, the main documents are:

- The Federal Law of the Russian Federation about the continental shelf of the Russian Federation from November 30, 1995 of No. 187-FZ (as amended on 02.05.2015).
- The Federal Law of 21 February 1992 № 2395-1 «On Subsoil" (as amended on 01.01.2016).
- The Federal Law of 10 January 2002 №7-FZ "On Environmental Protection"(as amended on 12.29.2015);
- The Federal Law of 27 July 2010 № 225 "On compulsory insurance of civil liability of the owner of a hazardous facility for injury in an accident at the hazardous facility" (as amended on 04.11.2014);
- The Federal Law of 21.07.1997 №116-FZ "On industrial safety of hazardous production facilities" (as amended on 13.07.2015);
- The federal law from 17.12.1998 N 191-FZ "On the exclusive economic zone of the Russian Federation" (as amended on 14.10.2014);
- The Decree of the President of the Russian Federation of January 17, 1997, №11 approving Federal Target program "The global ocean" , that includes the subprogram "Development and use of the Arctic";
- The draft Order of the Ministry of Natural Resources of Russia "On approval of the list of species of flora and fauna that are indicators of a steady state of marine ecosystems of the Arctic zone of Russian Federation" (as of 20/04/2015) (prepared by the Russian Ministry of Natural Resources) (Order signed 22.09.2015 N 25-p).
- The Government Resolution of Russian Federation of September 11, 2012 N 916 "On Amendments to the Resolution of the Russian Government dated June 9, 2010. N 417" On approval of rules for issuing permits for the laying of submarine cables of pipelines on the continental shelf of the Russian Federation and the Rules of issuing permits to conduct drilling for the purposes not connected with the regional geological researches, the exploration and production of mineral resources of the continental shelf of the Russian Federation.

The following documents define the basis of the state strategy for the development of the Arctic region of Russia:

- Basics of the state policy of the Russian Federation in the Arctic for the period till 2020 and for a further perspective.
- The development strategy of the Arctic zone, and national security until 2020.
- The strategy of exploration and development of oil and gas potential of the continental shelf until 2020.

The new edition of Maritime Doctrine of the Russian Federation until 2030 approved, in Russia, 26 July 2016. [2]

The doctrine defines core regional tasks in the Arctic region:

1. Formation of the industrial and technological base;
2. The development of coastal areas.

According to the above regulatory documents of the Russian Arctic can be determined that a key objective of legal regulation in the sphere of the Arctic right, is to ensure the balance between the active economic activities and the preservation of the unique environment of the Arctic.

## III. APPLYING THE PRINCIPLE OF THE "ZERO DISCHARGE"

The following legislation introduced for mining companies to work on the continental shelf of the Arctic region of Russia:

1) Can work only Russian companies, which received a license for the production of hydrocarbons and the controlling stake of which is in the possession of the state;

2) The experience on the shelf must be at least five years.

(These criteria satisfy, only two companies - Gazprom and Rosneft.)

In the complex of the necessary technological measures, which should aimed at reducing anthropogenic impact on marine ecosystems of the continental shelf of can be identified two principles:

1) The principle of "soft start";

2) The principle of "zero discharge".

The use of the first principle (gradual increase in the acoustic signal strength) allows to the mammals and to the fishes escape from seismic survey area otherwise if a mammal is approaching closer than 500 m to the work area, all the work will suspended.


*Fig. 2 The transit zones of Russia: areas of seismic survey [3]*

The seismic survey in the Kara Sea,is expected, will be spent according to principle of "soft start". The offshore facilities must correspond the requirements of the safe operation, in accordance with the requirements of international regulations and Russian laws, oil and gas companies: Gazprom, Rosneft and Lukoil, which has the Varandey oil export terminal on the

continental shelf of the Russian Arctic, carried out activities aimed for the assessment timely of the impact of objects of oil and gas complex the environmental impact of the continental shelf. For localization and liquidation of oil spills in the area of offshore constant vigil organized specialized vessels.

The oil Platform Prirazlomnaja operates under the principle of "zero discharge". The used drilling mud, sludge and other waste pumped into a special reinjection well, while the refined oil and oily water, a polluted rainwater and snow collected by the drainage systems - and re-injected back into the reservoir.

These activities provide almost absolute protection of the natural environment. For example, the work of the Varandey terminal goes on the principle of "zero discharge", which provides that all industrial and domestic waste is collected in special containers and transported to shore for disposal.

## IV. THE COMPLEX METHODS OF ENVIRONMENTAL MONITORING IN THE FIELD OF TECHNOGENIC LOADS ON THE CONTINENTAL SHELF OF THE ARCTIC REGION OF RUSSIA

It is important to include activities that can ensure the safe operation of offshore facilities, monitoring of the continental shelf ecosystems. The continental shelf is relatively shallow, the submarine extension of continental plates with a specific biological productivity value per unit of surface area which several times greater than that of the open sea. According to the ecosystem classification proposed by the American ecologist Eugene Odum, the waters of the continental shelf belong to the marine ecosystems. Moreover, most of the Arctic ice formed in the region of the shelf of the Russian Arctic zone, and the ice algae are an important component of the marine ecosystems of the Arctic. The contribution of cryoflora to the annual total primary production of the Arctic seas is an average of 26%. [4]

It is necessary to organize a system of ecological monitoring of the continental shelf ecosystems per time of the exploration and development of mineral resources on the continental shelf of Russia. The environmental monitoring system of the continental shelf should include the following activities:

- Monitoring the sources of technogenic impact in the areas of exploration and development of mineral resources in the waters of the Arctic seas and transportation of extracted resources for SMEs;
- Monitoring the state of the marine ecosystems in the areas of exploration and development of mineral resources in the waters of the Arctic seas;
- identifying factors of anthropogenic impact and assessment of the actual state of marine ecosystems;
- forecasting changes in the state of marine ecosystems under the influence of factors of anthropogenic impact and assessment of the projected state.

The marine mammals and the seabirds that breed on land, while the food is obtain on the continental shelf may be included in the marine ecosystems of the continental shelf and thus are part of the marine food chain.

In addition to visual observation of the sources of technogenic impact with the help of unmanned aerial vehicles and autonomous underwater vehicles, it is necessary to monitor the marine ecosystems on the continental shelf.

It can based on the list of biological indicators, proposed by experts of the Botanical Institute. V.L. Komarova, the national Research Institute of Environmental Protection, by the Botanical Garden of the Faculty of Biology, Lomonosov Moscow State University, by the World Wildlife Fund. It is necessary to assess the state of sustainable marine ecosystems of the Arctic.

In accordance with the Russian Natural Resources Ministry order dated 22.9.2015 number 25-p "On approval of the list of species of flora and fauna that are indicators of a steady state of marine ecosystems of the Arctic zone of Russian Federation" the marine bio-indicators are

composed of 111 species of algae, higher plants, invertebrates, fish, birds and marine mammals, 79 species of flora and 32 - fauna. These biological indicators, in particular, are include the Arctic cisco, the sea gull, and the ringed seal living in the seas of the Arctic Ocean basin, the beluga whale, the walrus and the polar bear.

It is expected that the monitoring behind the bio-indicators will allow adjusting the technogenic loads during the production and transportation of oil and gas, as well as determine the parameters of stability of biological resources and preserve biodiversity on the continental shelf.

With the increase in oil production on the continental shelf and the growth of its volume for transportation by tankers through the NSR at times increase the risk of oil spills, which threaten the Arctic areas and the coastal zones by the fast dissemination of pollution.

In addition, in the presence of ice on the sea surface practically reduced to zero the possibility of localization of oil spill using floating booms and repeatedly decreases the ability to collect surface oil using skimmers, and in case of leaving the oil under the ice is much more complicated task of determining the location of the Oil Spill. Accidental oil spills in ice conditions can cause catastrophic damage to Arctic ecosystems, as well as accelerate the melting of sea ice, by reducing their reflectivity.

For the rapid detection of oil pollution is carried out satellite monitoring of the continental shelf surface, which can be amplified by means of the monitoring of unmanned aerial vehicles.

The advantage of using these monitoring devices in the Arctic area are: the speed of application, regardless of the time of day; the ability to monitor below the cloud cover ; longer duration of the flight; high detail of the images; low cost flight hour. The need to use drones on the shelf of the Arctic seas for monitoring oil spills during exploration, the NSR production and transportation is determined by climatic conditions that are extremal: low temperatures, strong winds, high waves and the possibility of earthquake, the impact of the ice fields, the corrosion-mechanical and erosive effects of sea water and ice at offshore facilities, the impact loads, including the vibration caused by the operation of oil drilling equipment and the platforms adjacent conduits.

## V. CREATING THE ASSESSMENT MODEL LIMIT STABILITY OF ECOSYSTEM TO TECHNOGENIC LOADS

Assessing the changing status of pollution and health of an entire LME is scientifically challenging. Ecosystem health is a concept of wide interest for which a single precise scientific definition is difficult. The health paradigm is based on multiple-state comparisons of ecosystem resilience and stability, and is an evolving concept. To be healthy and sustainable, an ecosystem must maintain its metabolic activity level and its internal structure and organization, and must resist external stress over time and space scales relevant to the ecosystem [5].

The simulation has now become one of the main methods of studying complex dynamic systems. When building simulation models of specific ecosystems are used almost all the available information about the structure and behaviour of these objects. The developers of the simulation model consciously try to avoid any kind whatsoever serious simplifications. Methodology of the simulation model of the continental shelf marine ecosystems based on the possibility to taking in account of the larger number of elements in the system and the connections between them. The explanation and interpretation of a wide range of marine ecosystem change is a problematic because difficult to formalize the patterns of their behaviour. Indeed, any dynamic changes that occur in marine ecosystems on the continental shelf of the Arctic seas depend of their resistance to limit state. For example, in the Marine Ecosystem very important role played by the temperature. It is challenged the fact, recently, that the speed of biological processes in the cold waters are slow down compared to the such in the waters of the temperate and warmer latitudes . The number of authors showed that heterotrophic plankton and microbenthos Arctic seas is hydrolyzed and oxidized organic matter at speeds that are comparable to those in temperate waters and warm latitudes. [6] To protect the marine ecosystems on the continental shelf of the Russian Arctic, the

current focus is to create a model of assessment of limit stability of the ecosystem to technogenic loads on the basis of tools multimethod simulation, for example - Anylogic.

## VI. THE DEVELOPMENT AND USE OF SENSITIVITY MAPS OF COASTAL AREAS OF THE ARCTIC SEAS

The transportation of oil and oil production from offshore platforms is potentially dangerous for coastal marine area. It is therefore necessary have timely information to respond quickly and eliminate spills and the oil ejection on the coast. Currently, there is an active development of the maps of sensitivity for oil pollution of marine and coastal. The maps are formed based on data obtained by monitoring these zones. The cartographic material contains a map of the distribution and vulnerability to human impacts of major groups of biota (from the bacterial plankton and phytoplankton to the birds and marine mammals). The comprehensive map of vulnerability of marine ecosystems can made, based on the main expected anthropogenic impacts .In addition, the areas of coastal resources and the environmentally sensitive of areas can designated and marked on these maps. At the same time, Russia does not have a regulatory document that prescribes how to produce maps of vulnerability, what they should contain and how to use them during the operations of oil spill liquidation.

## VII. THE ACCOUNTING OF THE OVERALL ENVIRONMENTAL BENEFITS IN THE DEVELOPMENT OF OIL SPILL RESPONSE PLANS

It is necessary to conducting analyze of aggregate environmental benefits (AAEB), which allows you to make informed decisions on the choice of method of responding to an oil spill, taking into account the possible environmental impacts and includes four stages:

- Data analysis to identify potential spill scenarios and the formation on its basis options of potential effects;
- Construction of forecasted evaluation of the results for specific scenarios and identifying the most effective tools and methods;
- Search for a compromise by comparing the environmental advantages and disadvantages in every possible embodiment;
- Selection of the best options for a particular script, which combines the tools and techniques allowing minimize oil spill.

## VIII. CONCLUSIONS.

Must move to the "green" (sustainable) model of subsoil use on the continental shelf of the Russian Arctic, to improve the stability of the Russian Arctic shelf of marine ecosystems. To do this, you must perform the following activities:

1) Develop and adopt legal acts of the Russian Federation on the procedure for reimbursement of compensatory damages to biological resources in favor of the subjects of the Russian Federation.

2) Implement and use complex methods for environmental monitoring in the field of technogenic loads on the shelf of the Arctic seas, including the use of unmanned aerial vehicles.

3) Create the models of assessing the marginal resilience of ecosystems to technogenic loads in the extraction and transportation of hydrocarbons on the continental shelf, based on multimethod simulation of dynamic systems with using tools like - Anylogic.

4) Develop and use of sensitivity maps of coastal areas of the Arctic seas for efficient oil spill response.

5) Take account the results of the analysis of the overall environmental benefit in development of oil spill response plans.

6) Applying the principle of "zero" discharge in the extraction of hydrocarbons in the aquatories of seas with intensive fishing (Barents and Kara Seas) for the conservation of biological resources.

The emergence of the global market of significant volumes of additional hydrocarbons has a restraining influence on the prices of oil and gas, which significantly reduces the profitability of Russian offshore projects.

Known that on the shelf of Greenland and Iceland the work almost does not carried out. Canada collapses their projects in the Beaufort Sea, the US production in Alaska cannot be embedded, and large companies - Shell, BP, Exxon are leaving from the Arctic seas.

At the same time, the adopted scheme of distribution of licenses on the shelf between state-owned companies "Rosneft" and "Gazprom" can lead to excessive exploration of potentially unclaimed hydrocarbon reserves, but the introduced sanctions may much slow down the pace of exploration and development of the Russian shelf. It is required a review of licensing policy on the shelf of the Arctic seas.

The territory of Russian Arctic should become a territory of the partnership in the sphere of high technology, where they could perform tasks such as adaptation to Arctic conditions and a development of new basic technologies for improving the efficiency of economic activities, growth of competitiveness of production, reducing energy and resource consumption, as well as risks technogenic disasters, etc.

Required a more complete elaboration of the programs of conservation of biological diversity and uniqueness nature of the Arctic, by the mining companies on the Arctic shelf, the establishment of resource-saving, innovative industries in the Arctic zone of the Russian Federation.

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