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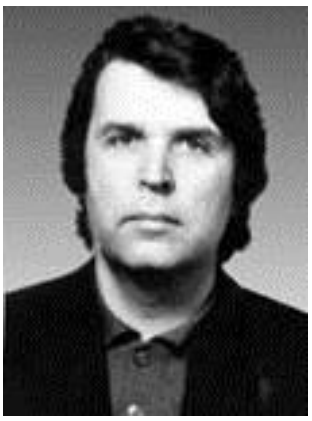
Trends and risks of economical activity in Arctic in long-term Climatic changes



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Abstract

Climate changes get last 30 years more and more distinct character and in the foreseeable period can already make serious impact on social and economic processes. However in various regions they have different degree of intensity and even a various orientation. In the Arctic zone of Russia signs of the active warming which consequences are inconsistent enough are shown. So, in the Arctic water areas decrease ice can improve considerably economic parameters of navigation, and on a land thawing of a long-term frozen ground, on the contrary, will raise costs of operation of the majority of capital constructions. The separate question of geopolitical character is represented by jurisdiction of the Russian Federation concerning Northern sea way. Attempt to consider the basic tendencies and risks of economic activities in these conditions is undertaken in offered article.

Key words: *Arctic regions, the North, economic activities, economy, risks, climatic changes, tendencies, consequences, mechanisms.*

Russian and foreign researchers recently showed that the predicted warming will be felt in the Polar Regions to a greater extent than in many other parts of the world. Where temperatures are close to the average freezing point, global warming leads to melting ice on land and at sea, and as a result of sea level rise. However, in the inner parts of the ice caps rise in temperature is unlikely to be sufficient to cause melting of ice and snow, and, obviously, lead to increased accumulation of snow [1].

Because of the warming, in the Arctic ice cover is likely to become smaller and thinner. Navigation in the coastal zone and rivers will increase, and new opportunities for water transport. Predicted changes in Arctic sea ice cover will have major strategic implications for trade, especially between Asia and Europe.

In the past century the average annual temperature on Earth has increased by approximately 0.6 degrees. But the area of permafrost warmed much more: seats up to 5 degrees. At the same time and are warming the upper layers of permafrost. Since the 1960s in Central Yakutia, soil temperature increased by one-half degrees, and in Western Siberia - one degree. Even with such a small warming changes the physical and mechanical properties of the soil, thereby decreasing the ability of non-sheer foundations. As a result, the buildings, bridges, transmission towers and other structures built on permafrost; subsidence occurs foundation, deformation and destruction of the pillars of the roadway.

In Yakutsk, due to subsidence of frozen ground over the past 30 years have severely damaged more than 300 buildings. Over a decade - from 1990 to 1999 - the number of buildings were damaged due to uneven subsidence of foundations has increased over the previous decade in Norilsk - by 42% in Yakutsk - by 61% in Amderma - 90% [2].

Global climatic changes will appear in the Arctic zone of the Russian Federation is uneven. Most of the settlements within the Arctic zone of Russia located on permafrost soils. Their total number exceeds 300 n.p.with a predominance of rural settlements with a population less than 3,000.

One of the main parameters that determine the bearing capacity of permafrost soils as bases of engineering structures is their temperature, which depends on the temperature of air at the surface of rocks. Fluctuations cause changes in the last bearing capacity of foundations of engineering structures, which must be considered in the design.

Otherwise, the positive development of the currently existing scenarios of climate warming occurs a sharp deterioration in the bearing capacity of permafrost as a base of engineering structures. This could eventually lead to damage or even destruction of existing and under construction at the moment of engineering structures in permafrost regions. For areas of Vorkuta, Tiksi, Yakutsk and in case of global air temperature increase by 2030 to 4-5 ° C longevity base buildings constructed on the principle I can go down 15-25 times, and built on the principle II - in the 5-15 time [3].

Development of a new type of foundation is based on combining the functions of cooling load and the soil structure, which is carried out through slept on the frozen grounds of the intermediate layer - a layer of intermediate spatial foundation that runs from specific material greatly reduces the intensity of cryogenic processes in the thermal and mechanical interaction with the frozen ground buildings , the foundation is being built without violating the frozen-ground conditions on construction sites, which allows time to eliminate the technology gap, which is required when constructing pile foundations for their freezing the surrounding frozen ground.

This helps to reduce or eliminate the seasonal melting of underlying permafrost foundation during construction of the first principle, that is maintaining the frozen land; to create an artificial basis set with the strength of the lower deformative properties; redistribute stress, the maximum is localized within a firm (for compared with the underlying natural ground), an

artificially created middleware, using well-known in soil mechanics the effect of reducing the depth of the stress of the extra pressure of the transmitted basis.

In the energetic it should be developed and implement a system of measures to increase energy independence and autonomy of the power system of the Arctic areas of Russia, including the development of remote monitoring, assessment of risks of accidents and disasters and the need for actions to protect power lines, pipelines and other utilities in the Arctic.

It would take a very serious effort, the huge financial and human resources to eliminate the results of such changes. The preliminary expert estimates indicate that operating costs could increase in 2-4 times depending on the location of the object that is likely to withdraw most of them over the brink of economic profitability.

The only positive result of the climatic changes for municipal infrastructure of Arctic communities should recognize the reduction in heating due to periods of increasing of average temperatures. This will lead to significant savings in fuel consumed for heating, and consequently to reduce the total cost of operation of the communal structure of the region.

The most authoritative international organization dedicated to the value of climate changes is the Intergovernmental Panel on Climatic Changes (IPCC / IPCC), established in 1988 jointly by the World Meteorological Organization and the UN Environment circling. Every 3-4 years the IPCC publishes Assessment Report (EA), compiled by leading climate scientists of the world that reflect the changing global and regional climate in the past, present, and future impacts of climate change and possible adaptation, as well as opportunities to reduce human impact. The IPCC estimated, since the second half of the XIX century to the present, in the global climatic system, there were big changes in air temperature at the surface, accompanied by changes in other climatic characteristics. The annual average global air temperature according to the third ML (2001) for the entire XX century has increased by 0.6 ± 0.2 ° C, the sea level rose by 18-20 cm [4].

In 2007, the Fourth Assessment Report was prepared, from which it follows that the temperature rise is already 0,74 ° C, and rising sea level - 30 cm MGIEK has also developed a package of climate change scenarios based on scenarios of greenhouse gas emissions, population growth, the use of more efficient technologies and economic growth. Scenario-based (hard, soft and moderate human impact) were made by several model calculations of changes in global mean temperature for the period up to 2100 According to various forecasts of average surface temperature will increase from 1.4 to 5,8 ° by the end of this century [5].

Together with the global warming, there are big changes in climate of high latitudes, especially in the Northern Hemisphere. In the Arctic, recorded a high warming, which intensified in recent decades and is accompanied by a reduction in area and thickness of sea ice in the Arctic Ocean. According to leading domestic and foreign researchers, climate scientists, the Arctic region in general and the Western Arctic, in particular, are the areas of the most sensitive to global climate changes, as well as reliable indicators of these processes. In this regard, the Ministerial Meeting of the Arctic Council, held in October 2000 in Barrow (Alaska), was

developed and adopted a program of the ACIA (Arctic Climate Impact Assessment / ACIA), according to which experts have analyzed the fifteen countries climate change and its consequences in the Arctic. The results of these studies are presented in the November 2004 report "Evaluation of the effects of climate change in the Arctic." In recent decades, much of the Arctic temperatures have risen, especially in the winter season. Winter warming in Alaska and western Canada was 3-4 º C over the past 50 years. Over the past 30 years the average annual area of sea ice has decreased by about 8%, in addition, the ice has become thinner in the middle of the Arctic by 10-15%, and in some areas between the 1960s and late 1990s, there was a reduction of its thickness by 40 % [6].

A bright appearance of the extreme conditions in the Western Arctic winter is allocated for 2002-2003, when the ice edge in the Barents Sea in April, down to latitude 72 º N on the meridian 40 º E (A very rare occurrence with the frequency 1 time in 50 years). Extreme southern position in the sea ice of the Kara took two years of origin. In the northeastern part of the sea (74 º 40's. Sh., 43 º E), i.e. 100 km from the Stockman gas condensate field, was recorded two years of ice thickness up to 2.7 m. In the Stockman gas condensate field, it was noted a large number of icebergs and their fragments (about 110 units), with maximum dimensions 190h430 m and weight 3.67 million tons. Such a rare phenomenon was caused by 3-4-year-olds of positive air temperature anomalies, the state of ice cover (in August and September of 2000 and 2001 the sea was free of ice, in August-September 2002, the area of ice was only 5%) and anomalously high heat flow of Atlantic water. Melting glaciers of Franz Josef Land and Novaya Zemlya dumping has caused them and the formation of icebergs. Under the action of wind currents and surface currents from the north and north-eastern part of the icebergs reached such a southern location and the end of April were recorded in the Shtokman structure. Simultaneously, in the southeastern part of the Sea in March-April 2003, the winds of the north and north-western areas have led to compaction of the ice, it is 4-5 (height of the hummocks was 4-5 m, the drift velocity of 170 m / s, the keels of ice ridges to a depth of 18 meters), there was a lot of grounded hummocks (separate blocks of ice, standing on the rocks). In this shipping season of ice-class tanker "Volgograd" deadweight of 20 thousand tons, loaded with oil from the terminal "Varandey" could not get out of a bag of ice measuring about 200 km, even with the diesel-powered icebreaker "Capitan Nikolayev." Season of 2002/2003 is included in the 10 most severe ice conditions in years from 1928 to 2005. [7].

It should be noted that the beginning of the development of Shtokman (exploratory drilling, stock assessment, the creation of Russian and international consortia for its development) coincided with the period of 1988-1996, when the appearance of icebergs in the central part of the Barents Sea was estimated as a rare event.The maximum mass of the iceberg, implicit in the design documents, resulting from the expert estimates based on few observations, was 1.45 million tons, however, surveys of recent years did not change the estimates of the probability of finding an iceberg and its rapprochement with the platform in the Shtokman gas condensate field. During the decision-making to develop the Shtokman gas condensate field probability (> 95%) of the iceberg collision with the platform was once in 295 years, and with the 2003 data, the probability exceeds 95% only once in 35 years [8].

Reduced of ice cover of the Arctic seas, the increase in the frequency and magnitude of storm winds and wave heights, together with rising sea levels could lead to the destruction of coasts composed of permafrost. In the East Siberian Sea coastal abrasion today amounts to tens of meters per year. Therefore, construction of coastal infrastructure (gas and oil tanks, pipelines, ports, terminals) may be subject to significant risks.

In the table № 1, the authors attempt to combine the expected socio-economic impacts and risks from those projected in the beginning of the XXI century climate change in the Arctic region. If there are some positive trends, it seems that the problems to be already integrated solutions will become more significant. Foremost among them are:

- Complex of negative effects associated with the thawing of permafrost and subsidence (the destruction of roads, foundations of buildings, power transmission towers, bridges, etc.);
- The deterioration of transport accessibility (time of delivery of goods) in areas associated with the activity of transport by winter roads and ice of the rivers;
- Increase the frequency of ice storms, the increase in the intensity of the destruction of the coast, increasing the risk of icebergs in the locations of future hydrocarbon deposits.

With high probability we can say that in the next 10-15 years, the ice conditions in general will become easier. However, more than 6 months of the year the Arctic ice will be closed, from the Kara Strait and further to the east. Despite the more favorable conditions for navigation on the average, if warming continues, in some areas will remain the risk of a severe ice conditions due to ice movements arrays. Need to reassess the previously obtained extreme wave heights, masses and sizes of icebergs, provide for the establishment of special monitoring services of iceberg and ice hazards and construction of icebreakers.

Table 1

Expected changes of the climate in the XXI century in the Arctic region and his natural and social – economic results.

Characteristics of climatic changes	**Implications**	
	conditionally positive	**Conditionally negative**

Characteristics of climatic changes	Implications	
	conditionally positive	Conditionally negative
The growth of the temperature	The reduction of the heating period, the improvement of thermal conditions of buildings. Reducing the thickness of sea ice and ice cover the sea: facilitation of access by sea to the oil, gas, mineral resources of the Arctic Ocean; lengthening the period of the navigation of sea and river navigation; adverse implications for ice-dependent marine mammals. Extending the range of the boreal forest, tundra reduction: the empowerment of Forestry; shift of the boundaries of habitat for birds, animals, some species of fish. Increase opportunities for commercial cultivation of crops: forage (alfalfa), some cereals (barley), and vegetables (potatoes). Expansion of distribution ranges of some species of insects, pests, weeds.	Reduction of soil freezing season: reducing the time to access resources on the mainland. Thawing permafrost: subsidence, landslides, solifluction (soil within the slope), thermokarst: the destruction of roads, airports, oilfield and other industrial plants, the deformation and rupture of pipelines, water supply and sewage systems; deformation of building foundations, transmission towers, bridges; threat of destruction of radioactive waste; difficulties in the delivery due to shortening of winter roads. An increase in wind load due to reduction in size of the ice, the formation of ice ridges, sea spray: more frequent ice storms increase the intensity of the destruction of coasts composed of permafrost, ice ships, limiting the work in the oil and gas platforms in the open sea, limiting fishing and maritime transport messages. Increase the probability of occurrence of the iceberg: difficulty of navigation and operation of the Stockman field. Later freezing and earlier ice autopsy on rivers and lakes: reduction in the delivery of goods by land in remote areas of the frozen channels; change in the evaporation rate of flow, level of dissolved oxygen and effects of UV radiation on freshwater organisms; modify flooding. Damage to forests due to increased frequency of fire risk and pest invasions of wood (fir bark beetle, spruce Tortrix-pochkoed). Desertification of some areas (along with temperature increase evaporation and outflow of water from the soil thawed frozen), replacement of coniferous forests in aspen. Growth of some infectious diseases: an increase in cases of tick-borne encephalitis, an increase in the number of intestinal infections due to violations of the water and sewer facilities, etc. Threat to traditional way of indigenous
The growth of the rainfall, increasing of heavy rainfall		Soil erosion, improve water table, flooding vast areas. Floods, rock slides and avalanches: the destruction of infrastructure
The growth of the water temperature	Productivity growth of certain types of commercial ocean fish (cod, herring, flounder) invertebrates, lower stocks of capelin (a threat to most commercial fish stocks, whales and sea birds), a more southern species of fish (mackerel), radical changes in species composition in some areas .	The changing direction to the north of aquaculture (fish disease growth, bloom of toxic algae), the increase in costs. Reduction of habitats of some arctic freshwater species (whitefish, arctic char, arctic omylya) due to suboptimal thermal conditions and competition with the species, moving from the south
The growth of the sea level		Flooding of low-lying coastal areas increased coastal erosion, flooding in the coastal zone: the destruction of coastal infrastructure (pipelines, storage facilities, terminals, ports and human settlements). Reducing tundra: the shrinking of reindeer pastures
Changes in the atmospheric circulation, increasing of the wind speed	The development of wind energy	Increased frequency of storms and the drift velocity of the ice fields: the difficulty of many species of marine operations. Increasing the number of accidents on the power line. Rise in price of construction works in the open air.
Large interannual variability of meteorological parameters (ice cover, wind speed, wave height)		Difficulties in planning and development of maritime transport offshore. In some years the duration of the heating period, this exceeds the average rate. In some years very difficult ice conditions in the Northern Sea Route, which limits the period of navigation without ice
Sharp daily fluctuations of		The high degree of variability of the ice and

Characteristics of climatic changes	Implications	
	conditionally positive	Conditionally negative
meteorological parameters (air temperature, barometric pressure), increase the probability of the duration of extreme events with the critical values of meteorological parameters, changes in seasonal weather singularities		weather conditions would complicate naval operations. Deterioration in the terms of buildings, reducing their longevity. Deterioration of health and public health: improving morbidity and mortality from coronary heart disease, stroke, respiratory diseases, nervous system

The foreign organizations and firms regard the revival of the transit through the NSR is quite real, especially in anticipation of further climate change. Canadian firm Broe / Omni TRAX announced in 2007 its intention to implement jointly with Russian companies, the international project "Arctic Bridge" for large-scale transport of goods in transit on the highway in the direction of East - West. A similar scheme proposed Merchant Marine Academy United States: transport-technological system between the ports of New York - Reykjavik - SMP - Petropavlovsk-Kamchatsky - Brementon (West Coast USA) using an atomic container capacity of 8,000 TEU. Sailing ship in the Arctic will be year-round without icebreaker assistance. The Finnish shipbuilding company Aker Arctic Technology with the Institute of North (Alaska) carried out in 2006 model studies of Arctic container vessel operating capacity of 5,000 TEU on the direction of the Aleutian Islands - SMP - Iceland. The simulation results showed the possibility of a container for NSR to 6 months. a year without icebreaker assistance. Assessment of the cost of transporting container is $ 526 / TEU, which is significantly below the cost of shipping containers south through [9].

So, a sudden increase in traffic on the NSR is very likely within the next 5 years, and the Russian transport system should be ready to not give a strategic advantage and financial flows relevant to other hands.

We should understand that the Article 234 of UNCLOS provides for-Arctic states in ice-covered most of the year's 200-mile area the exceptional economic zone of the right to pass laws aimed at protecting the marine environment, the rules adopted by Russia, may contain more stringent measures in the construction and equipment of ships and crew training than at the international level. It allows Russia to establish a special regime of navigation on the Northern Sea Route and the West makes the thesis of the need to maximize the internationalization of the Northern Sea Route groundless.

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