Quantitative Assessment of Arctic Geoeconomic Space Development

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Abstract. The article presents a method for quantifying the development of the Arctic geoeconomic space by different countries. The Arctic reserves are estimated at 10-15% of the world’s reserves as two main studies – USGS (2008) and Wood Mackenzie and Fug Robertson (2006) – show. The resources are mainly concentrated on the shelf (about 85%), with 80% of the resources being gas resources. Of the five states bordering the Arctic, Russia has more than half of all undiscovered reserves. The observed melting of ice due to warming makes real plans for their development, which turns the Arctic zone into a leading strategic resource base. In the conducted research, the Arctic space is divided into the following areas: demographic; innovation and technology; environmental; production and markets; social; manufacturing. The indicators that evaluate these areas are presented. For each of the eight Arctic countries, baseline data on indicators for the period of 2006-2018 were collected. The indices for each country for each year indicator in every area were calculated on the basis of the initial statistical data. The indices are calculated as the arithmetic average of the partial indicators for each year indicator that characterizes each of the listed areas. The areas under consideration are ranked by significance and each sphere is assigned weight coefficients. The proposed formula for the integral index has the form:

\[ I_I = 0.125* I_1 + 0.25* I_2 + 0.25* I_3 + 0.125* I_4 + 0.125* I_5 + 0.125* I_6. \]

The results of the analysis by all areas are presented.

1. Introduction

In the 21st century the importance of the natural resources, transport and economic potential of the Arctic has increased. This was facilitated by the publications of scientific research on the confirmed and forecast hydrocarbon resources in the Arctic, as well as statements by scientists, fueled by the media, about global warming and the possible availability of all the riches of the Arctic in the nearest future [1], [2].

The presence of potentially significant natural resources, climatic change (global warming and the melting of the Arctic ice), enabling operation of the transport systems (increasing the possibility of using the Northern sea route for the international traffic between countries of Europe, Asia and America), has a significant impact on the geopolitical situation, the development strategy of the Arctic leading players.

Secondly, the presence of unresolved issues within the framework of the current international law can be cited as the next reason that strengthens the Arctic contradictions. Today, the main problem is the uncertainty of the status of the Arctic Ocean waters. There is still no recognized and legally defined demarcation of the sea and continental shelf in the Arctic [3].

The Arctic is estimated at 10-15% of the world’s reserves, as shown by two main studies: USGS (2008) and Wood Mackenzie and Fug Robertson (2006). Mostly resources are concentrated on the shelf...
(about 85%), while 80% of resources are gas. Of the five states bordering the Arctic, Russia has more than half of all undiscovered reserves. Of particular interest are the Lomonosov and Mendeleev underwater ridges, where, according to the recent research, about 12% of the world’s oil reserves may be contained. Within the Arctic mainland, there are unique reserves and forecast resources of copper-nickel ores, tin, platinoids, agrochemical ores, rare metals and rare earth elements, large reserves of gold, diamonds, tungsten, mercury, ferrous metals, optical raw materials and ornamental stones.

Directions of scientific research on the problems of the Arctic integrated development are the following [1]:
- The first group is related to geological and geographical research and is aimed at studying the continental shelf and clarifying maritime boundaries.
- The second group is the analysis of the further possible climate change (warming) and the analysis of problems related to the economic activity in the new conditions, with an emphasis on the negative consequences of the economic activity on the environment.
- The third group is research related to the study of the development of the Arctic that are demographic, social, innovation and technology, economic development at the level of regions and municipalities.
- The fourth group is the study of problems of ensuring the safety of life in the Arctic, including the study of problems of solving defense issues, prevention and elimination of man-made disasters, emergencies and natural disasters.
- The fifth group is aimed at solving the problems of managing the development of the Arctic, organizing monitoring of the implementation and systemic impact of specific projects of integrated development of the Arctic zone.

The purpose of the article is to analyze the development of space in each country and to compare the Arctic countries by the level of their development.

2. Research methodology
The research methodology includes the following stages [4, 5]:
- (a) decomposition of the Arctic space into areas;
- (b) selection of indicators that assess each area;
- (c) ranking the areas under consideration by significance and calculating an integral index for each year for each country as a whole for all areas;
- (d) construction and analysis of trends in the dynamics of the Arctic zone development index for each country;
- (e) forecasting the value of the Arctic development index by circumpolar countries for each of the areas.

3. Results
The Arctic space is divided into the following areas: socio-demographic; innovation and technology; environmental; production and markets; social; manufacturing [6].

The socio-demographic area is assessed by the following indicators: birth rate, life expectancy, income of the population, the population not falling below the poverty line, the employment level [7].

The innovation and technology area is assessed by the following indicators: the number of Universities in the Arctic region; the number of University students; electricity consumption; exports of the high-tech products; the number of patents, phones, Internet users per 1000 people, R&D costs.

The environmental area is estimated by the volumes of natural resources extraction in the Arctic regions of different countries; the volumes of natural resources processing in the Arctic regions of different countries, investments into environmental activities [8].

The area of production and markets is estimated by the growth rate of the total volume of products shipped, the acreage of all agricultural crops, the number of cattle, meat production, and milk production [9].
The social area is assessed by the following indicators: the number of secondary schools for 1000 people; availability of libraries per 1000 people; availability of doctors of all specialties per 1000 people; availability of retail trade enterprises per 1000 people; the number of students in secondary schools [10].

Manufacturing area is estimated by such indicators as the length of roads, the number of ports, and the number of airports [11].

For the jth indicator of the country of each sphere for the ith year, the index was calculated using the formula:

\[ X'_{ij} = \frac{X_{ij} - \min (X_{ij})}{\max (X_{ij}) - \min (X_{ij})} \]  

where \( X_{ij} \) – value of the jth sphere indicator for the ith year; \( X_{ij} \) – value of the jth indicator of sphere development for the ith year; \( \max (X_{ij}) \) - maximum value of the jth indicator for the ith year; \( \min (X_{ij}) \) - minimum value of the jth indicator for the ith year.

The index for the sphere of each country for each year was defined as the arithmetic average of the indices of indicators according to the formula:

\[ I_{i} = \frac{\sum_{j}^{m} X'_{ij}}{m} \]  

where \( I_{i} \) - index of the country development of the sphere in the ith year; \( m \) – the number of indicators that assess the degree of development of a particular area of the country.

Ranking of the considered areas by their significance was performed by assigning weight coefficients (\( \alpha_i \)) to each area in descending order in accordance with the significance of the area and calculating the integral index for each year for each country as a whole using the formula:

\[ I_{i} = \alpha_1 * I_{1i} + \alpha_2 * I_{2i} + \alpha_3 * I_{3i} + \alpha_4 * I_{4i} + \alpha_5 * I_{5i} + \alpha_6 * I_{6i} \]  

The forecast of the value of Arctic space development indices by circumpolar countries for each of the areas was carried out using the autoregressive distributed lags model [12].

The distributed lag autoregression model is a time series model in which the current values of a series depend on both the past values of this series and the current and past values of other time series. The ADL (\( p,q \)) model with a single endogenous variable has the form shown in the formula (4):

\[ y_t = a_0 + \sum_{i=1}^{p} a_i y_{t-i} + \sum_{j=0}^{q} b_j x_{t-j} + \epsilon_t \]  

When selecting the exogenous variables of the equation, finding the coefficients of the regression equation, standard regression analysis procedures were used: the significance of the equation was checked using Fisher’s F-test, the significance of the coefficients of the equation using Student’s t-test.

The ARCH-model was used to improve the accuracy of calculations [13]

\[ U_t^2 = c_0 + c_1 * U_{t-1}^2 + ... + c_n * U_{t-n} \]  

where

- \( U_t^2 \) - the remainder (error) squared at the time t;
- t – the moment of time that takes values from 1 to 22;
- \( c_0, c_1, ..., c_n \) – the equation coefficients;
- n – the number of lags.

In our case, three lags were taken, so the ARCH-model will look like this (6):
4. Conclusion

The study of the dynamics of the Arctic space development index of the demographic area shows that in Russia this area was not being developed and has not become significant at the moment [14], [15], [16]. At the same time, in Norway and Iceland, this area is a priority throughout the whole period. The index of development of the Arctic regions in the area of innovation and technology develops approximately similarly for each country during the analyzed period. The highest rate is observed in Russia and the United States, and the lowest – in Canada. The highest development index for the environmental area is observed in the United States, and the lowest in Iceland. In other Arctic countries, including Russia, it is in the average value. The dynamics of the development index for the area of production and markets significantly changes for each analyzed year in each country. The index of the Arctic regions development for social infrastructure, no matter what, almost always remains at the same level. In Russia, this index has no development. The index for the manufacturing infrastructure significantly affects the development of the Arctic regions in the United States, while in other countries it is not very important, especially in Iceland, Denmark, Finland and Sweden. According to the results of the analysis, of the selected indicators that influence the demographic area in Russia, two factors were identified as the most significant: life expectancy and average annual income. It can be stated that if the life expectancy changes by one year, the index will grow by 0.077 units, if the average annual income of the population per 1 USD changes, the index will grow by 0.0001 units. Almost all indicators have an impact on the area of innovation and technology in Russia, except for the number of University students, telephony and the Internet development. With the increase in exports of high-tech products and R&D costs per 1,000,000 USD, the index will grow by 0.000047 units, and with the increase in the number of patents, the index will decrease by 0.002 units. As it follows from the analysis of the environmental area, by increasing the volume of natural resources extraction by one unit the index for this sector decreases by 0.004 units, while increasing the volume of natural resources processing, the area index will increase by 0.024 units. Of all the indicators of production and markets, the growth rate of the total volume of products shipped and the number of cattle have the greatest impact. Thus, with the increase in the growth rate of the total volume of shipped products by 1% and the number of cattle per 1,000 heads, the index increases by 0.291 units and 0.00005401 units respectively. Based on the analysis, the social infrastructure index changes significantly, as the number of libraries, doctors, and retail businesses increases. It increases by 0.002 units with the increase in the number of libraries by 0.006 units, the increase in the number of doctors by 0.004 units and the increase in the number of retail businesses per 1,000 people per 1 point. The following indicators were selected for the industrial infrastructure index: the length of roads, the number of ports and airports. The results of the analysis show that all of these indicators significantly affect the variability of this index. Thus, with the increase in 1,000 km of roads, the index will increase by 0.0000734 units, and if there is one port and one airport built, the index will increase by 0.003 and 0.0001 units respectively.

The forecast of the Arctic regions development index, as based on the trends, was made for all countries and it turned out that in comparison with 2015, in 2016-2018, there was a slight decrease in the index in the United States and a slight increase in Russia, while in other countries the index remains approximately at the level of 2015.

The general conclusion of this study is that the degree of the Arctic regions development by the Russian Federation is at the average level. To increase the development, it is necessary to develop mining, manufacturing and industrial production; to form favorable investment activities; to develop the innovative and technological potential of the Arctic regions; to attract people to the regions.

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