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## MODELLING THE SPATIAL DEVELOPMENT OF THE RUSSIAN BARENTS-ARCTIC REGION

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### ABSTRACT

The paper presents a model of spatial development of the Russian Barents region based on institutional and functional approach. While constructing models of territorial development we describe the socio-economic area development from the point of view of institutional environment. Institutional environment in the model is characterized by the situation in social, economic, industrial and environmental spheres of human activity in the region. The model describes the quality of the institutional environment, including (1) the process of interaction between organizations and actors; (2) the process of interaction between organizations and environment; (3) the effectiveness of actors. Actors in the institutional and functional model of spatial development are companies-entities, reflecting the features of sectoral and industrial structure of the regional economy, as well as people living and working in the region. Organizations in the model are such legal entities that (1) regulate the actions of the participators of various socio-economic, industrial and environmental processes taking place in the socio-economic area of the territories; (2) regulate the actions of various parties involved and are immediately involved in these processes themselves. Institutional and functional development model is designed for territories of the Russian part of the Barents region.

**Keywords:** spatial development, Arctic, Barents-Euro region, modelling

### INTRODUCTION

Analyzing the works on the issue we can find some works related both to general problems of modeling and works, that use the principles of institutional analysis. Review of the territorial development modeling showed that the problems of development modeling of the Arctic territories from the environmental position were researched by Johannesen et al. [1], Antonovskaya [2], Rudenko and Skripnuk [3].

Forecasting of socio-economic processes in the Arctic regions was researched by Zimmerbauer [4], Bishop [5] and Didenko [6]. With researching of the impact of changing factors on development of territories of the Barents Euro-Arctic region there were engaged papers by Grigoriev and Korotaev [7], Ivanova and Sakulina [8], Feoktistov, [9] (studying of the geophysical aspects), Rudenko [10] (studying of the socio-economic aspects).

The research is built on the principles of the latest institutional analysis, developing the ideas that we find in traditional institutionalism. Traditional institutionalism as the doctrine originated in the late 19th century and was formed during a 20-30-ies of XX century. The authors applied the institutional and functional approach, which consists in the consideration of the object of study from a position of institutional environment. Modeling of territorial development of the Russian part of the Barents Euro-Arctic region is intended for analysis, forecasting and analyzing of the impact of changing factors on the specified indicators. We propose a model of institutional environment of the Russian part of the Barents Euro-Arctic region that characterizes the state of social, economic, industrial and environmental spheres of regional human activity, which increase the human development potential.

The Barents Euro-Arctic region includes the following administrative areas (Figure 1).



Fig. 1. Map of the administrative areas of the Barents Euro-Arctic region

Russia: Murmansk Oblast, Republic of Karelia, Arkhangelsk Oblast, Nenets Autonomous Okrug, Republic of Komi.

Norway: Finnmark, Troms, Nordland.

Sweden: Norrbotten, Västerbotten.

Finland: Lapland, Kajnuu, Oulu.

## METHODOLOGY

The methodology of the functional and institutional approach to modeling includes the following aggregated stages.

A. The object of analysis is selected according to its function. The object of analysis is the socio-economic area of the Russian part of the Barents Euro-Arctic region from the standpoint of condition of the institutional environment.

B. The institutional environment is determined. The institutional environment is characterized by the condition of social, economic, industrial and environmental spheres of human activity in the region, that increase the potential for human development.

C. The indicators evaluating the institutional environment are substantiated. The elements of the institutional environment are the passive ones – laws, regulations, traditions and the active ones – organizations, actors.

D. The object of the analysis is presented in terms of levels of the institutional environment.

E. The levels of the institutional environment are presented as a model.

The considered spheres of human activity are: social, economic, industrial and ecological. The social sphere of human activity is a set of industries, businesses, social processes and social relations, functionally connected to each other. It represents the social reproduction infrastructure. The social sphere is characterized by the purchasing power of the population, the share of the population with income below the subsistence level, unemployment, the level of average per capita income.

The economic sphere of human activity is characterized by a modern state of investment and innovative development in the region and its prospects, creation of innovation, the ability of the employed people to create innovations.

The industrial sphere is characterized by of industry and business development in the region. It includes the set of production branches creating wealth. It also includes services and a large part of the scientific activities directly associated with the production of these goods.

The ecological sphere acts as an essential condition of human life in the system of various relationships – public, social, economic, productive. It is valued by the influence of production on environment. Maintenance of the ecological balance and ecological safety stipulates sustainable socio-economic development.

Institutionalism enables selecting of the institutional environment of the territories of the Russian part of the Barents Euro-Arctic region. The institutional environment is a combination of active and passive elements interacting in social, economic, industrial and ecological spheres of human activity in the region. The active elements in the institutional environment are organizations, actors. The passive elements in the institutional environment are laws, norms and traditions.

The institutional constraints lead to formation of certain organizations, that provide a framework for the interactions in the society (regulatory entities, usually governmental, international (and social) organizations controlling and regulating the operations of the formal institutions (the informal institutions are controlled less). In turn the organizations also have an impact on the process of changing of the institutional constraints. The organizations are created for attaining of the specified purposes because of the existing set of institutional constraints creates the opportunities for the relevant activities.

## **MODEL**

The model of development of the Russian part of the Barents Euro-Arctic region on the basis of institutional and functional approach characterizes the condition of social, economic, industrial and environmental spheres of human activity in the region and describes the condition of the institutional environment. The model of territorial development of the Russian part of the Barents Euro-Arctic region includes four levels, each level has a system of 6 up to 8 equations. The model will be used (1) for the analysis and forecasting of the processes of human activity, (2) in the program-targeted management as an object of control.

In order to substantiate the variables and the axiomatics of the model the factors and conditions formation of the socio-economic space from the point of view of the condition of the institutional environment are analyzed. The institutional environment in

this model is a combination of active and passive elements interacting in social, economic, industrial and environmental spheres of human activity in the region, that increase the potential for human development.

As the factors one should consider innovative modernization of the economy, economic growth, national security in the water and on land of the region, the security and safety of the population, strengthening of the role of the Arctic in the economy of the Russian Federation.

The institutional environment of the region acts as the prerequisite for forming of an effective socio-economic space. The institutional environment provides for increasing of the potential for human development.

In order to create the axiomatics of the institutional and functional model of development of the territories of the Russian part of the Barents region the main conclusions and key findings of the analysis of the development of the Arctic regions represented in the works [6], [11], [12] are used, as well as the analysis of the implementation of the priority cooperation projects within the territories of the Barents Euro-Arctic region conducted in this article [13] and [14].

The model of the first level of the institutional environment – the industries and territories of the municipalities. It describes the process of interaction between the organizations and the actors.

(1) The result of interaction between organizations and actors is described an indicator of aggregate production volume  $Y_t^1$  by the leading industrial sectors of the region: the volume of production of mining industry –  $y_t^{11}$ , of pulp and paper and wood processing industry –  $y_t^{12}$ , of fisheries and aquaculture companies –  $y_t^{13}$ , of shipbuilding industry –  $y_t^{14}$ :

$$Y_t^1 = \left\{ \begin{array}{l} y_t^{11} = f(x_t^{111}, x_t^{112}, x_t^{113}, f(x_t^{114}), x_t^{115}, x_t^{116}) \\ y_t^{12} = f(x_t^{121}, x_t^{122}, x_t^{123}, f(x_t^{124}), x_t^{125}, x_t^{126}) \\ y_t^{13} = f(x_t^{131}, x_t^{132}, x_t^{133}, f(x_t^{134}), x_t^{135}, x_t^{136}) \\ y_t^{14} = f(x_t^{141}, x_t^{142}, x_t^{143}, f(x_t^{144}), x_t^{145}, x_t^{146}) \end{array} \right. \quad (1)$$

, where  $x^{111}, x^{121}, x^{131}, x^{141}$  - the number of companies in the corresponding industry,  $x^{112}$  - the share of population employed in the industry,  $x^{113}$  - the investments to the corresponding industry,  $f(x^{114})$  - the level of consumption,  $x^{115}$  - material intensity in the relevant industry,  $x^{116}$  - capital intensity in the relevant industry.

The model of the second level of the institutional environment – the areas of institutional environment (social, economic, industrial and ecological) and regions. It describes the process of interaction between the organizations and the environment.

(2) The result of interaction between the organizations and the environment is determined by the indicator of per capita GRP  $Y_t^2$ , that characterizes the condition of all the areas of human activity: the economic sphere –  $y_t^{21}$ , the condition of the

production sphere -  $y_i^{22}$ , the social sphere -  $y_i^{23}$ , the condition of the environmental sphere -  $y_i^{24}$ ;

$$Y_i^2 = \left\{ \begin{array}{l} y_i^{21} = f(x_i^{21}, x_i^{22}, x_i^{23}, x_i^{24}) \\ y_i^{22} = f(x_i^{22}, x_i^{25}, x_i^{26}, x_i^{27}) \\ y_i^{23} = f(x_i^{28}, x_i^{29}, f(x_i^{210}), f(x_i^{211})) \\ y_i^{24} = f(x_i^{212}, f(x_i^{213}), x_i^{214}, x_i^{215}) \end{array} \right\} \quad (2)$$

, where  $x_i^{21}$  – per capita income in the region,  $x_i^{22}$  – level of investments in the region,  $x_i^{23}$  – growth rate of labor productivity in the region,  $x_i^{24}$  – payments for the imported technologies,  $x_i^{25}$  – share of industrial production in the GRP,  $x_i^{26}$  – share of innovative products in the GRP,  $x_i^{27}$  – total volume of production shipped in the region,  $x_i^{28}$  – residential population of the region,  $x_i^{29}$  – HDI index,  $f(x_i^{210})$  – level of social security in the region,  $f(x_i^{211})$  – level of development of the infrastructural industries in the region,  $x_i^{212}$  – emissions of pollutants into the atmosphere from stationary sources,  $f(x_i^{213})$  – general ecological situation in the region,  $x_i^{214}$  – total sum of fines for polluting the environment,  $x_i^{215}$  – quantity of wastes of production and consumption.

The model of the third level of institutional environment - the development of the territory of the Russian regions of the Barents Euro-Arctic region. It describes the result of the interaction of the institutional environment and the actors, describing the effectiveness of the actors.

(3) The effectiveness of the actors is the result of interaction of the actors with the institutional environment and it can be described with an indicator  $Y_i^3$  – development of the Russian territories of the Barents Euro-Arctic region:  $Y_i^{31}$  – air emissions from stationary sources,  $Y_i^{32}$  – HDI index,  $Y_i^{33}$  – reduction of forested territories in the region:

$$Y_i^3 = \left\{ \begin{array}{l} y_i^{31} = f(x_i^{31}, x_i^{33}) \\ y_i^{32} = f(x_i^{32}, x_i^{34}, x_i^{35}) \\ y_i^{33} = f(x_i^{31}, x_i^{33}) \end{array} \right\} \quad (3)$$

, where  $x_i^{31}$  – is per capita total volume of production shipped in the region,  $x_i^{32}$  – total per capita GRP,  $x_i^{33}$  – total per capita export volume,  $x_i^{34}$  – total per capita export of high-tech products,  $x_i^{35}$  – number of doctors per 10000 inhabitants.

The model of the fourth level of institutional environment – the connection of the territory of the Russian regions of the Barents Euro-Arctic region with the national economy. It describes the condition of the institutional environment of the Russian part of the Barents region.

(4) The condition of the institutional environment of the Russian part of the Barents region can be described with an indicator  $Y_t^4$  – the connection of the territory with the national economy:  $Y_t^{41}$  – share of the regional GRP in the Russian GDP,  $Y_t^{42}$  – share of the region's exports in the total Russian exports,  $Y_t^{43}$  – share of high-tech products of the region in the total high-tech Russian output,  $Y_t^{44}$  – share of regional household consumption out of the total consumption of households in Russia:

$$Y_t^4 = \left\{ \begin{array}{l} y_t^{41} = f(x_t^{41}, x_t^{42}, x_t^{43}, x_t^{44}, x_t^{411}, x_t^{412}, x_t^{414}) \\ y_t^{42} = f(x_t^{42}, x_t^{43}, x_t^{44}, x_t^{46}, x_t^{414}) \\ y_t^{43} = f(x_t^{44}, x_t^{45}, x_t^{47}, x_t^{48}, x_t^{49}, x_t^{410}) \\ y_t^{44} = f(x_t^{411}, x_t^{412}, x_t^{413}, x_t^{414}) \end{array} \right\} \quad (4)$$

, where  $x_t^{41}$  – is the share of manufacturing in the GRP of the region,  $x_t^{42}$  – share of extractive industries the GRP of the region,  $x_t^{43}$  – share of fisheries in the GRP of the region,  $x_t^{44}$  – investments into the region,  $x_t^{45}$  – expenses on technological innovation,  $x_t^{46}$  – export quota of the region,  $x_t^{47}$  – payments for the imported technologies and services of a technical nature,  $x_t^{48}$  – share of the expenditure on innovations in % of the GRP,  $x_t^{49}$  – total personnel employed in research and development,  $x_t^{410}$  – share of organizations engaged in environmental innovation out of the total number of organizations that had innovations ready for implementation,  $x_t^{411}$  – share of transport and communications in the GRP of the region,  $x_t^{412}$  – share of the education in the regional GRP,  $x_t^{413}$  – per capita income of the population in the region,  $x_t^{414}$  – atmospheric emissions from stationary sources.

## CONCLUSION

In the paper we present the principles of modeling of development of the territories of the Russian part of the Barents Euro-Arctic region on the basis of institutional and functional approach. The model describes the condition of the social, economic, industrial and environmental spheres of human activity in the region, describes the state of the institutional environment. The model of development of the Russian part of the Barents Euro-Arctic region includes four levels, each level is presented by a system of 6 up to 8 equations. The model will be used for the analysis and forecasting of the processes of human activity, as well in the program-targeted management as object of control.

The model considers the problems of development of Russian regions of the Barents Euro-Arctic region. Such issues include: (1) the heterogeneity of territorial development (Arkhangelsk, Kotlas, Plesetsk, Murmansk, Vorkuta, Usinsk, Sosnogorsk, Pechora, Ukhta, Inta, Syktyvkar, Vuktyl); (2) a disproportionate structure of the population (social migrants, indigenous small peoples of the North); (3) a high level of man-caused influence; (4) the vulnerability of the ecosystems at high latitudes (fish processing



industry); (5) reduction of the intact forest landscapes (large areas of forest of at least 50 thousand hectares, which are not prone to significant man-caused impacts).

The creation of a model of sustainable development of the territories with a purpose of preserving the ecological and biological balance in the region is proposed as a strategic priority of cooperation of the territories of the Barents Euro-Arctic region. Sustainable development of the regional institutional environment (social, economic, industrial and environmental) is conceptually based on the principles of the program-targeted management of development with conservation of forest territories, which are not prone to significant man-caused impacts.

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