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Assessment of Effectiveness of New Economic Growth Centers in the Arctic

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Abstract. In the current conditions of economic instability, the problem of regional space development in the Arctic zone, Eastern Siberia and the Far East, the regions where the main hydrocarbon and other mineral reserves are concentrated, is becoming more and more relevant. The main reserves of hydrocarbons and other minerals are concentrated in these regions. The integrated development of the mineral resource base on the principles of rational nature management, including the stages of exploration, production, processing, transportation, is the driver of the Russian regional economy development. The organization of raw materials centers (RMC) with regard to the development of energy resources and regional transport infrastructure, determines the effective development of the spatial economy. The aim of the study is to develop an integrated approach to the spatial development of the region by forming an RMC for achieving the national priority of efficient use of natural and economic resources. The achievement of the goal requires the solution of interrelated tasks, namely, the study of domestic experience in the spatial organization of regional economy; the analysis of the regulatory framework governing the functioning of specific industries in the Arctic zone, Eastern Siberia and the Far East in order to further socio-economic development of undeveloped regions, as well as the analysis of data on the current state of energy reserves in the Arctic. As a result, the study of the RMC organization indicates that their effectiveness is associated with the interaction of national and corporate interests and the development of a communication system. The interrelation of all components allows us to assess the multiplicative effect of the RMC organization on the economy of the region and the country as a whole, which determines the novelty of the work.
Keywords: *raw materials center, Arctic Zone, socio-economic development, multiplicative effect*

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Introduction

The choice of effective directions and mechanisms for stimulating the development of Russian regions is one of the most controversial issues in the scientific and professional communities. Recently, the spatial organization of underdeveloped regions of the Arctic zone, Eastern Siberia and the Far East has become increasingly important in order to achieve and improve their socio-economic level of development; this fact, combined with the presence of a large-scale resource base, is an essential prerequisite for organization of new mineral resource centers (MRCs) there.

Currently, a number of legal documents have been adopted at the state level, regulating operation of certain industries in the Arctic zone of Russia, Eastern Siberia and the Far East for the purpose of further socio-economic advancement of undeveloped regions. Thus, the Strategy for spatial development of the Russian Federation up to 2025 outlines the main goals and objectives aimed at the spatial development of Russian regions. The fundamental task is to reduce the level of inter-regional differentiation in the socio-economic development of the constituent entities of the Russian Federation, as well as to reduce intra-regional socio-economic differences. The solution to this problem lies in the introduction of new forms of organization of the regional economy into the conceptual apparatus. These forms include mineral resource and agro-industrial centers, identified in the Strategy as promising centers of economic growth.

The Energy Strategy of the Russian Federation up to 2035 also defines MRC along with oil-gas-chemical complexes, aimed at optimizing the spatial distribution of energy infrastructure in certain regions. The term MRC was first introduced in 2010 in the Strategy for the development of the geological industry for the period up to 2030. It was interpreted as a set of fields and promising areas being developed and planned for development, connected by a common existing and planned infrastructure and having a single point of shipment of the extracted raw materials or products of their enrichment into the federal or regional transport system. The isolation of the MRC is considered in terms of the object of joint management both at the regional and federal levels, which in turn allows combining national and regional tasks aimed at the socio-economic development of the regions, taking into account the infrastructure component.

This approach to state management of exploration and exploitation of hydrocarbon resources, taking into account the supporting infrastructure, has been developed in other documents of federal and regional significance: Program for the socio-economic development of the Arctic zone of the Russian Federation, Strategy for the development of the mineral resource base of the Russian Federation up to 2035, Fundamentals of the state policy of the Russian Federation in the Arctic up to 2035, Strategy for the development of the Arctic zone of the Russian Federation and ensuring national security for the period up to 2035, Resolution of the Government of the Russian Federation on the creation of the territory of advanced socio-economic development “The Capital of the Arctic”, Strategies for socio-economic development of the Northwestern Federal District, etc.

According to the Transport strategy of the Russian Federation up to 2030 with a forecast for the period up to 2035, the so-called "Unified backbone network" is proposed, which combines the most important transport infrastructure facilities and ensures the functional unity of the transport system and the spatial development of MRCs and industrial zones, which are factors affecting the distribution of demand for transportation and its redistribution by modes of transport. The same document considers MRCs as types of macro-regional production clusters that include "points of cargo flows origin", i.e. current and future freight demand generation centres.

In order to implement the development task "Preservation of the population, health and well-being of people", according to the Unified Plan for achieving the national development goals of the Russian Federation for the period up to 2024 and for the planned period up to 2030, it is supposed to develop the social infrastructure of settlements, in which bodies, performing functions in the sphere of national security and functions of a base for MRC development, implementation of economic and infrastructure projects in the Arctic, are located.

Thus, the review of legal documents allows us to conclude that there is a fundamental need for the development of resource regions through the further growth of hydrocarbon reserves, rational subsoil use, and formation of new transport communications for the supply of raw materials to premium markets. In this regard, it is necessary to develop an integrated approach to the spatial development of the region through the formation of the MRC, taking into account the possible multiplier effect, and the combination of national and corporate interests is an urgent task.

Literature review

The topic of organization and development of new MRCs is relevant not only in state strategies and programs, but also in the works of modern scientists — economists and geographers, who study problem areas of this direction. The spatial organization consists in considering the country's economy in terms of multi-regional unity, which implies the interaction of social and political components and the spread of this connection at the regional and international levels. Granberg A.G. [1, p. 58], Artobolevskiy S.S. [2, p. 102], Minakir P.A. [3, pp. 7–10], Tatarkin A.I. [4, pp. 10–15] made a special contribution to the development of this idea.

The mineral resource center is an example of the spatial organization of the economy of the Arctic region, when the formation process is based on a regional communications system, strengthening the geographical and economic connection of the Arctic space and sea communications, in particular the Northern Sea Route [5, p. 96].

It should be noted that the experience of the spatial organization of the MRCs of the Arctic and sub-Arctic countries is identical, especially in terms of limiting factors, namely:

- severe natural and climatic conditions;
- availability of the infrastructure necessary for all stages of development and production of raw materials.

Foreign researchers [6; 7] mention promising deposits in Norway in the Barents Sea and the need to create and develop infrastructure [8], for example, a railway in Finland for transportation of minerals, fish products, timber, and natural resources of the Barents Sea.

In Sweden, as experts note [9], there is not only a desire to ensure the exploration and extraction of resources in the region, but also to create conditions for innovative developments and their further commercialization; this would enable high value-added products to be produced.

Extreme natural conditions prevent successful exploration in Greenland (Denmark), despite the region's large resource potential [10].

Most foreign researchers believe that MRCs are directly related to the global resource market conditions, hydrocarbon prices, which is why there is an uneven development of the region [11; 6].

Domestic researchers [12, p. 24] consider MRC as a certain territorial entity that has the prerequisites for the formation of "cargo flows of products of the mineral raw material profile". "The main prerequisites for the MRC formation are in the "technological production centers", which include a complex, uniting a number of mineral deposits, infrastructure for the shipment of marketable products and hydrocarbon development facilities that have a common technological component" [13, pp. 30–31]. Thus, such production centers are a constituent element of the MRC.

Directions for the MRC development and the emerging effects of national importance, which manifest themselves in the implementation of such projects, are presented in [14, p. 30]. Questions of the expediency and problems of including the MRC of Russia in the system of territorial planning and management are considered in [15, p. 389]. Serious attention is paid to the role of mineral resource centers in ensuring environmental safety [16, p. 276].

Domestic research compares the definitions of "mineral resource center" and "industrial clusters with territorial-production complexes". However, the concept of the complex refers to the Soviet period, and this form of territorial organization of economic activity was most widespread in the post-war period. Territorial-production complexes were mainly used to describe the schemes of location and methods of organization of productions in the regions of new economic development. In the early 1970s, the new territorial production complexes included the national economic complex of the North of Western Siberia and the system of the Angaro-Yenisei complexes, the Timan-Pechora and South Yakutsk complexes, as well as industrial units and some agro-industrial complexes [2].

Since the transition to a market economy in Russia, new areas of regional policy have begun to appear. They identified and formed so-called regional clusters, including those regions where program-targeted territorial-production complexes, industrial and transport hubs were created in the USSR. Thus, territorial-production complexes, regional clusters and new MRCs contain features of different technological stages in the development of the Russian economy [2; 1]. As a result, the following forms of organization of economic activity have been formed in modern Russia (Table 1)

Table 1

Forms of territorial organization of economic activity[1]

Form of organization	Definition	Form examples
Industrial hub	Combination of industrial enterprises, one or more settlements, together with common industrial and social infrastructure facilities, located in a compact area.	Angarskiy, Nizhnekamskiy, Nazarovskiy, Saratovskiy, etc.
Territorial-production complex	Combination of various technologically related industries with common production and social infrastructure facilities.	Bratsko-Ust'-Ilimskiy, Zapadno-Sibirskiy, Kansko-Achinskiy, Orenburgskiy, Timano-Pechorskiy, Yuzhno-Tadzhikskiy, etc.
Cluster	Geographically concentrated groups of interrelated objects of subsoil use (enterprises) integrated with the activities of related industries (most often transport, manufacturing, scientific and educational). Evolutionary stage of organization of socio-economic space with allocation of a new object of management and concentration of state support.	West Siberian Oil Technology Cluster, Petrochemical Cluster of the Tomsk Oblast, Petrochemical Territorial Cluster of the Republic of Bashkortostan, Oil Refining and Petrochemistry Cluster of the Omsk Oblast, etc.
Agglomeration	Territorial formation integrating industrial and transport hubs, communication systems, cities and towns.	Moscow, St. Petersburg, Samara-Togliatti, Yekaterinburg, Rostov, etc.
Geostrategic territory	Territory within the boundaries of one or more constituent entities of the Russian Federation, which is essential for ensuring sustainable socio-economic development, territorial integrity and security of the Russian Federation, characterized by specific living and economic conditions.	Republic of Crimea, Sevastopol, Kaliningrad Oblast, Karachay-Cherkess Republic, Kabardino-Balkar Republic, Republic of Dagestan, Republic of Ingushetia, Republic of North Ossetia - Alania, Chechen Republic, Stavropol Krai, Republic of Buryatia, Republic (Sakha) Yakutia, Zabaikalskiy Krai, Kamchatka Krai, Primorskiy Krai, Khabarovsk Krai, Amur Oblast, Jewish Autonomous Oblast, Magadan Oblast, Sakhalin Oblast, Subjects and parts of subjects of the Russian Federation included in the Arctic zone
Mineral resource center	Territory and (or) water area of one or more municipalities, containing a set of developed and planned for development deposits and promising areas, connected by a common existing and planned infrastructure and having a single point of shipment of extracted raw materials or products of its enrichment into the federal or	Karelo-Kolskiy, Arkhangelskiy, Vorkutinskiy, Norilsko-Turukhanskiy, Taymyrskiy, Tomtor-Ebelyakhskiy, Tsentralno-Chukotskiy, Bilibinskiy, Baimskiy, Kupolnyy, Valunistyy, Beringovskiy

[1] Source: compiled by the authors.

	regional transport system.	
Support zones	Parts of the Arctic territory with interrelated projects, aimed at the integrated development of the macro-region.	Kola, Arkhangelsk, Nenets, Vorkuta, Yamal-Nenets, Taimyr-Turukhansk, North Yakutsk, Chukotka

Since MRCs are associated with the oil and gas industry, this definition can be considered as a planning target for exploration and further development of the communications system on its basis. In the future, this can lead to the socio-economic development of the region as a whole. It is necessary to consider in detail the term MRC and its meaning in the spatial economy.

If we talk about the Arctic zone of Russia, then, according to the program for the socio-economic development of the Arctic zone of the Russian Federation for the period up to 2025, complex projects for the development of the Arctic regions are being formed, including 8 support zones, each of which is a regional project and includes a set of industries. Such concepts as supporting zones and MRCs should be considered in a complex, since they contain characteristics of similar objects, but are at different stages of study [17]. The organization of the MRC in the Arctic zone of Russia in the future may be a prerequisite for the formation of designated support zones due to the same territorial affiliation and infrastructural connectivity.

Research materials and methods

Theoretical constructions are based on a general scientific approach, reflecting the results of an expert assessment of domestic and foreign scientists and specialists in the field of spatial economics and organization of mineral resource centers in the Arctic.

When performing the study, a set of methods is used, including general methodological provisions, systemic and economic analyses, economic and mathematical forecasting, economic evaluation of the effectiveness of an investment project for the spatial organization of the Arctic MRC on the basis of the communication system that provides integrated development and diversification of directions of supply of energy resources in conditions of geopolitical instability.

Mechanisms and sources of the multiplier effect when organizing mineral resource centers

In order to form and develop new MRCs, significant investments are required; the sources of financing may be the own funds of subsoil users or other production organizations. One of the important directions in MRC organization is to attract support from the state in connection with the national significance of some projects along with the interests of subsoil users.

The formation of new MRCs is one of the strategic tasks for the state in terms of the development of underdeveloped territories, the construction of engineering and social infrastructure. At the same time, in order to obtain the greatest effects from MRCs organization, it is necessary to coordinate the interests of the state and companies that bear the corresponding costs. Under budget financing, the main task of the state is to meet the needs of the population, so it is important to consider the ability of a particular project to provide indirect social and economic ef-

fects. It should be noted that the consistency between investing parties is related to the final results of the evaluation of investment projects from the standpoint of the interests of each participant, as well as taking into account the indirect effects associated with other sectors of the economy.

Evaluation of the effectiveness of investment projects is associated with certain difficulties of quantitative analysis:

- external effects: the problem of quantifying external effects is to comply with a detailed presentation of project results through qualitative indicators;
- indirect effects, that is, benefits and costs of economic entities that are not direct participants of the project.

At the same time, the account of external and indirect effects is necessary because the decision about reasonability of the investment project depends on it. During estimation of economic effectiveness of investment projects, after obtaining commercial efficiency, an assessment of budgetary, sectoral, regional or national economic efficiency is made.

National and regional efficiency implies accounting the socio-economic consequences of the project, both in the form of direct benefits and costs, and indirect environmental, social and other external economic effects. If we talk about the regional effect, the effects from the implementation of the project within a particular region, coming from the external environment, are taken into account.

Analysis of multiplicative effects evaluation methods (Table 2) is necessary for choosing a method of investment project evaluation, including organization of new MRCs.

Table 2

Theoretical and methodological analysis of assessment of multiplicative effects of national projects [2]

Name of the theory	Scientific contribution to development	Main characteristics
Multiplier as a tool for economic growth	R.F. Kahn, J.M. Keynes, M.Yu. Ksenofontov, A.A. Shirov, D.A. Polzikov, A.A. Yantovskiy, O.A. Donichev, I.V. Tozhokin etc.	It is characterized by a wide variety of multipliers; Main methodology: •Economic-mathematical models that characterize intersectoral production relationships in the country (“input-output” model); •Multi-regional general equilibrium models (CGE models); •Econometric models (regression-correlation analysis)
Multiplier as a tool for making managerial decisions	A.V. Andreichikov, O.N. Andreychikova, V.P. Osipov, V.A. Sudakov, V.A. Shakirov, P.S. Pankratyev T.A. Luciana, B. Roy, P. Vincke, E. Beinat, P. Nijkamp, J.S. Dodgson,	It is used in making managerial decisions in the presence of quantitative and qualitative criteria; Methods: • Multicriteria analysis (MCA, MCDM); • Analytical hierarchy method

[2] Source: compiled by the authors.

	M. Spackman etc.	
Assessment of the social effectiveness of investment projects	Yu.A. Petrova, D.S. Aleksanov, E.A. Yashkova, V.N. Livshits, P.L. Vilenskiy, A.V. Brovkin, M.E. Razumovskaya, A.B. Kogan etc.	It takes into account mainly the indirect effects from the implementation of the project for the state, related industries and the population; corresponds to the classical theory of evaluating the effectiveness of investment projects; Main method: • Cash flow model (discounted)
Assessment of social efficiency of invest-ment projects	A.V. Nogovitsyna, O.M. Fokina, L.N. Chudinova, E.I. Semenov, S.N. Naumov, A.G. Tyurikov etc.	Subsystem of the theory of social efficiency of investment projects; Methods: • Value for Money, • Social WelfareFunctional, • Cost-effectiveness analysis
Territorial impact assessment	E. Medeiros, M. Golobic, N. Marot, T.B. Fischer, O. Sykes, T. Gore, M. Golobič, W. Zonneveld, B. Waterhout etc.	Refers to the general direction of impact assessment (IA) and is an extension (com-bination) of IA approaches; • allows assessing economic, social, envi-ronmental, cultural and other impacts (tak-ing into account development targets); • includes methods of the above theories and a wide range of other methods in the field of forecasting and evaluating structur-al interactions.

The study used methods of hydrocarbon production forecasting at MRC fields and assessing the effectiveness of investments in the spatial organization of MRC, which allowed quantitative and qualitative estimation of the effects of new Arctic MRC implementation at the national and corporate level. The assessments will reflect public, social and territorial effects and contribute to making decisions on investments and spatial development of the territory, which integrates previously developed theoretical and methodological approaches to assessing multiplier effects from the implementation of national projects into a single system.

The implementation of hydrocarbon profile projects in the Arctic zone makes it possible to clarify the importance of the development of energy resources as a factor in revitalizing business activity and investment attractiveness of the regional economy, as well as means of revival of the settlement system by overcoming the detrimental effects of depopulation; this together ensures the unity of spatial development and the territorial integrity of Russia. This effect is achieved through the formation of a large number of infrastructure units at the Arctic MRCs. Due to the chain of multiplicative effects, the infrastructure of the oil and gas sector creates and maintains a significant number of jobs [5].

Results and discussion

Within the framework of this study, the assessment of qualitative and quantitative effects was carried out on the example of two MRCs in the Arctic zone of Russia — the Yenisey MRC and the Kola MRC.

Yenisey Mineral Resource Center

The territorial boundaries of the Yenisey MRC are determined by the presence of a large-scale resource base and the anchor subsoil user — PJSC Rosneft Oil Company.

The promising center is characterized by the interrelation of localization of the largest deposits of strategic raw materials and the presence of potentially usable sea ports with access to the Arctic and the Pacific Oceans [17] (Fig. 1).

The Yenisey MRC is located within the Yenisey-Khatanga and Pur-Tazovsk oil and gas fields, which corresponds to the Vorkuta and Taimyr-Turukhansk support zones.

The total recoverable oil reserves of the Yenisey MRC, according to the IPGGG SB RAS, amount to 2.43 million tons, natural gas — 517 billion m^3. Oil resources are estimated at 1.94 million tons, natural gas — 359 billion m^3 [11, p. 32; 18, p. 2].

Among the main fields of the Yenisey-Khatanga OGF, which are part of the Yenisey MRC, a special place in terms of the raw material base is occupied by the Payakhskoe field (1341 tons of hydrocarbon equivalents), which in 2013 was transferred to the JSC Independent Oil and Gas Company, and in December 2020 — to PJSC Rosneft Oil Company, as well as the nearby Zapadno-Irkinskoe field (511 tons of hydrocarbon equivalents), discovered by the company in 2020 [19, Provornaya I.V., Filimonova I.V., Komarova A.V., Zemnukhova E.A., pp. 11–12].

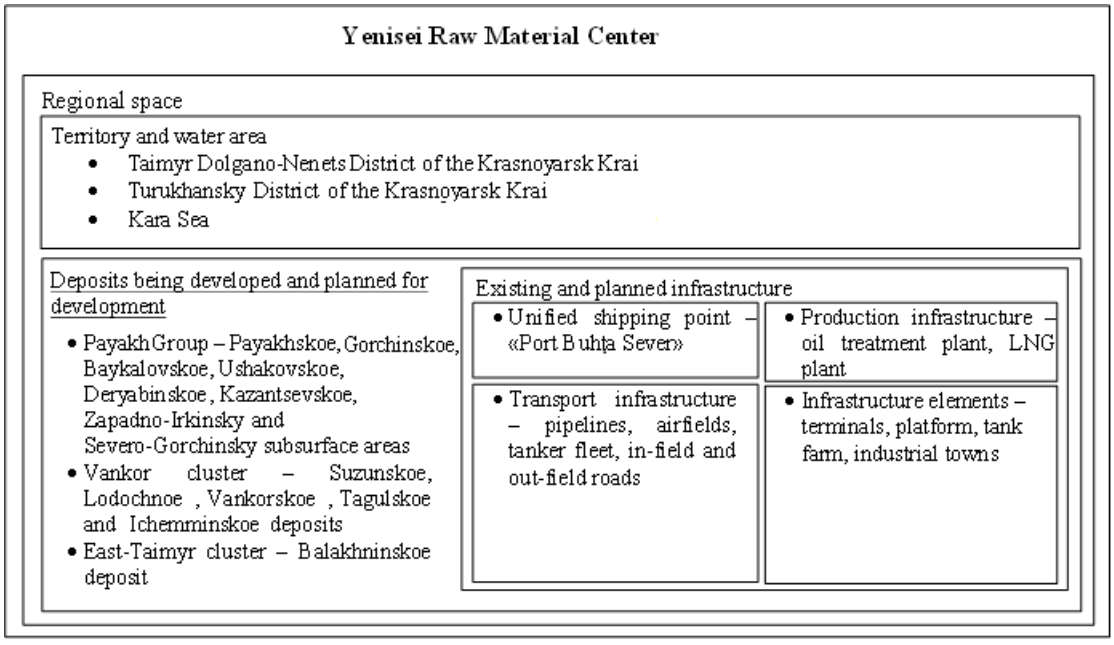

Fig. 1. Spatial structure of the Yenisey MRC [3].

The option of creating a new oil export route through the NSR with access to the Atlantic and Pacific markets is considered as the main route for raw material sales from the fields of the Yenisey MRC. Oil sales through supplies require functioning main oil pipelines linking the fields of the Vankor cluster, the Payakh group and the East Taimyr cluster of fields. Implementation will require the construction of an oil loading terminal, to which oil will be delivered via the main oil

[3] Source: compiled by the authors.

pipeline. The inclusion of the Vankor cluster in the oil pipeline system in the future will enable the use of high-quality oil for supplies through the ESPO system [19].

Kola Mineral Resource Center

For the purpose of strategic planning from the standpoint of the spatial economy in the Western Arctic, it is advisable to organize the Kola MRC on the basis of a single point of oil shipment to the federal transport system. A single point of shipment is located in the water area of the Kola Bay (Fig. 2).

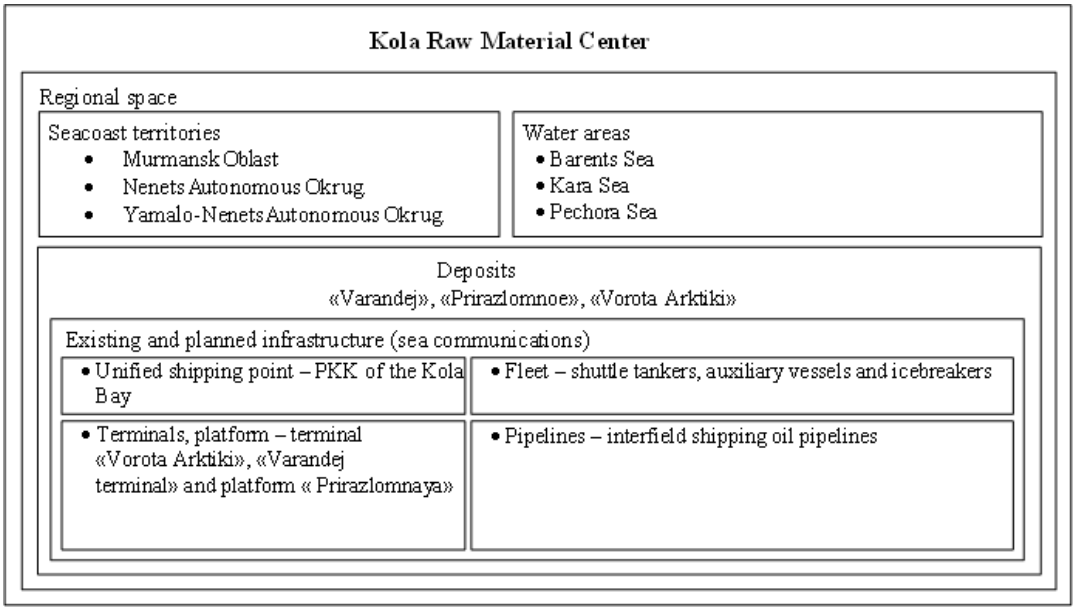

Fig. 2. Spatial structure of the Kola MRC [4].

The terminal is designed to ship oil, which is produced at the oil fields of the Timan-Pechora OGF, the largest of which are R. Trebs (Varknavtskoe) and A. Titov. The deposits are located to the north-east of Naryan-Mar at a distance of 220 km (R. Trebs) and 238 km (A. Titov) in the zone of specially protected natural areas of district significance. As of December 31, 2015, proven oil reserves amounted to about 31 million tons. The peak load of 4.8 million tons was reached in 2020 [20].

The project includes the Varandeyskoe OGF and the Toraveyskoe OF (licensed by LLC Naryanmarneftegaz), located 15 km north of the R. Trebs field in the area of the Varandey settlement and connected by oil pipelines to the Varandey terminal. The Medynskoe, Toboyskoe and Myadseyskoe oil fields are located near the Varandey shift camp.

The option of forming sea communications is being considered. The basis of the Arctic communication system is the NSR. Marine communications are laid along the traditional (southern) route in the latitude 70^0–78^0 N, bounded from the north by the parallels of the Vilkitskiy Strait (78^0 N) and Cape Carlsen (77^0 N) of the Novaya Zemlya archipelago, as well as in the middle (78^0–82^0 N) and high (82^0–85^0 N) latitudes along the northern (above the parallel of Cape Arkticheskiy (81^0 N) of the Severnaya Zemlya archipelago) and pole (above the parallel of Rudolf Island (82^0 N) of the Franz Josef Land archipelago) routes. The length of the route from the Providenie Bay to the

[4] Source: compiled by the authors.

port of Murmansk along the three routes differs slightly, within no more than 50 miles. From the point of view of the spatial organization of the regional economy, the southern route is the main one, which connects the near sea zone with the Arctic coast and the waters of the great Siberian and large Arctic rivers [21].

Impact of the economic activities of the Arctic MRCs on the dynamics of regional development

The work uses a set of methods, including system analysis, geological and economic modeling and forecasting, assessment of the investment attractiveness of MRC. The authors have developed a methodology for a comprehensive assessment of the effects of development of the Arctic territories (Table 3).

Table 3

Methodology for a comprehensive assessment of the effects of the Arctic territories development [5]

Investigated objects: Yenisey MRC Kola MRC		
No.	Methodical section	Main characteristics
I.	Algorithm for forecasting the production of energy resources at the MRC fields for diversifying hydrocarbon supplies to premium markets	The forecasting algorithm includes: 1. Forming a forecast of oil and gas reserves at fields under development (Q^d(t)). 2. Forecast of oil and gas production at explored fields (Q^s(t)) and those projected to be discovered (Q^f(t)). 3. Forming the final forecast of oil and gas production at the MRC (Q^*(t)). The level of oil and gas production at the MSC will be determined by: $Q^*(t) = Q^d(t) + Q^s(t) + Q^f(t)$. (1)
Investigated objects: Yenisey MRC		
II.	Assessment of the investment attractiveness of the spatial organization of the MRC, including the forecast of the cost of creating a communication system and infrastructure elements	The methodology for evaluating investment efficiency was applied in accordance with the Guidelines for evaluating the effectiveness of investment projects (approved by order of the Ministry of Economic Development of Russia, the Ministry of Finance of Russia and the State Construction Committee of Russia dated June 21, 1999 No. VK 477). The forecast of capital investments is detailed by groups of investments in geological exploration, drilling of wells, construction of field facilities, creation of transport and processing infrastructure, is calculated using aggregated standards.
Investigated objects: Kola MRC		
III.	Constructing a latitudinal model of the spatial development of the Arctic MRC	Justification of the choice of principles of multilayer rational planning of the regional economy, which consists in a combination of production, education, infrastructure elements, supplemented by the factor of defence capability, energy and economic security.
Investigated objects:		

[5] Source: compiled by the authors.

	Yenisey MRC Kola MRC
IV.	Justification of the qualitative and quantitative effects of the spatial organization of the MRC at different levels

The oil production forecast is based on information on the volume and structure of the resource base by categories of reserves and resources. Simulation modeling is used as a method, which makes it possible to bring the production curves obtained by the authors closer to real data in retrospect and thereby improve the accuracy of the prediction. For forecasting oil production in fields under development, an important indicator is the degree of depletion and the design level of production laid down in the development documents. For forecasting oil production in fields that are being explored and forecast to be discovered, the degree of exploration is more informative, indicating the level of readiness of the field and the time of commissioning.

The production curve for the entire MRC is drawn up taking into account the oil production dynamics at each field and the year of putting the undiscovered fields into operation.

Yenisey Mineral Resource Center

Development of the Yenisey MRC involves large-scale capital investments. Investments include geological exploration, subsequent development and exploitation of the MRC, formation of production and transport infrastructure. The authors generated a model for assessing the economic efficiency of the spatial organization of the Yenisey MRC, including interconnection of geological exploration (GE), well drilling, field development, communication system, operating costs, tax deductions, financial and economic result. Based on the calculation of all production and financial and economic indicators, the dynamics and structure of their quantitative assessment were obtained [22].

The revenue structure is made up of income from the sale of oil — due to the export of oil through the NSR to the countries of the Asia-Pacific Region and Europe, as well as income from the sale of natural gas in the form of LNG (liquefied natural gas).

If we consider the cost structure, a significant share is allocated to capital investments related to communications. This section is the basis for ensuring the sale of both oil and LNG, as it involves primarily the construction of pipelines, a seaport, an LNG plant, tank farms, production camps, new power plants, purchase of tankers, gas carriers and other equipment.

In order to connect the fields of the East Taimyr cluster with the Payakhskaya group and the Vankor cluster, which, in turn, will be connected to a new oil loading terminal, as well as to connect the fields of all groups to the ESPO system (through the Vankor–Purpe oil pipeline), it is necessary to build infield (7 000 km) and trunking (800 km) oil pipelines. Oil pipeline construction costs account for 46% of communication costs [23].

The cost structure for the construction of port infrastructure includes: a seaport — 172 billion rubles, 2 airfields with a total cost of 300 million rubles, 1 heliport and 13 helipads worth 18 million rubles.

The construction of an LNG plant with a processing capacity of 48 billion m^3 per year (the maximum level of gas production) requires investments corresponding to 3247 billion rubles; this indicator makes 48% in the cost structure of investments in communications. The indicator is calculated on the basis of construction parameters of the Yamal LNG plant — capacity 21.6 million tons per year, cost — 26.9 billion dollars, and Yakutsk LNG — capacity 12 million tons per year, cost — 10 billion dollars [22].

The structure of capital investments in the communications system includes: 3.5 thousand km of electric grid facilities, 2 thousand MW of power generation, 15 field camps (200 people), in-field and external-field roads with a total length of 4.5 thousand km, as well as three tank farms with a total cost of 34 billion rubles.

Comprehensive assessment of exploration work within the Yenisey MRC includes 2D and 3D seismic surveys and drilling of prospecting and appraisal and exploration wells. Geological exploration at developed (Vankor cluster) and explored (Payakhskaya group, East Taimyr cluster) deposits in the structure of capital investments in the spatial organization of the Yenisey MRC is 185 and 864 billion rubles, or 18% and 82%, respectively, in the structure of exploration costs [23].

Field development costs are calculated on the basis of industry standards, taking into account average indicators per a well, a cluster and 1 km of linear facilities. The costs of environmental protection work are calculated as 1.5% of the total capital investment for drilling and field development [24]. Thus, the main economic indicators of the organization of the Yenisey MRC were obtained (Table 4).

Table 4

Final financial and economic indicators of the organization of the Yenisey MRC for the period up to 2050 [6]

Indicator	MRC
Oil production, mmt	2631
Projected oil production, mmt/year	115
Gas production, bcm	1 109
Projected gas production, bcm/year	48
Revenue, billion rubles	110 775
Capital investments, billion rubles	15 615
Geological prospecting and exploration	1049
Drilling of wells	4164
Field development	3674
Communication installation	6727
Operating costs, billion rubles	71 574
Taxes, billion rubles	50 841
Profit before income tax	23 062
Income tax	4612
Net profit, billion rubles	18 449
CF, billion rubles	18 449
NPV, billion rubles	-3142
IRR, %	6.5 %
Profitability index, units	0.7
Payback period without discounting	17
Payback period including discounting 10%	30

[6] Source: compiled by the authors.

The project has a high multiplier effect on related industries and spatial development of the northern territory of the Krasnoyarsk Krai. The created communication system involves the participation of companies related to subsoil users in the field of energy and transport, as well as a wide range of specialists of various qualifications. Therefore, the authors systematized these effects with details at the national and corporate levels, some are presented in quantitative terms (Table 4), some of the effects are presented qualitatively due to the lack of information (Table 5).

Table 5

List of key indicators of the multiplicative effect of spatial organizations of the Yenisey MRC [7]

National level	Corporate level
– Growth of tax revenues to the federal budget (MET, export duty); – Increase in state revenues (dividends from state participation, international reserves, NWF); – Growth of macroeconomic indicators (GDP); – Ensuring the national security of the Arctic region and the country as a whole; – Territorial integrity, protection of state borders; – Trade load of the Northern Sea Route; – Population income growth, etc.	– Growth of the company's capitalization; – Attracting foreign investors; – Public-private partnership; – Growth of fixed assets; – Possible tax incentives; – Company development through horizontal and vertical integration of production processes and assets; – Leading position as an oil and gas supplier in the domestic and foreign markets; – Entry into the promising market of liquefied natural gas (LNG); – Growth of labor productivity, etc.

For similar oil and gas projects, the effect at the national level can be manifested in the oil and gas revenues (MET, export duty) to the federal budget, which is calculated during investment design. Along with the main sources of federal budget revenues, revenues from hydrocarbon production are a significant component of the trade balance, as well as the basis of international reserves and funds [17].

The source of dividends is a part of the profit from the project; the value of this indicator can be calculated taking into account the dividend policy of the subsoil user company.

One of the main multiplier effects at the national level is the increase of population and quality of life in regions with low social and demographic indicators. Russia has a similar experience of oil and gas industry development through the formation of the MRC West Siberian petrochemical complex (on the example of the Khanty-Mansi Autonomous Okrug). This large-scale project was financially supported by the state and led to an increase in the population level, the formation of new cities, towns, enterprises, and the creation of a transport system integrated into international traffic flows. Population growth was ensured by the policy pursued by the state, focused on ensuring the population's settling in this territory [23].

The spatial organization of the MRC involves the interaction of national and corporate interests in the implementation of such large-scale projects, since without state support tools (public-private partnership, preferential loans, subsidizing part of the costs, targeted lending, land

[7] Source: compiled by the authors.

lease benefits, attracting foreign investment, preferential taxation of profits when lending, etc.), this project will not be beneficial for the subsoil user.

Kola Mineral Resource Center

For the spatial organization of the Kola MRC, the development of oil reserves of two discovered oil fields on the continental shelf of the Pechora Sea in the zone of economic activity of the Kola MRC — Medynskoye-Sea and Varandey-Sea fields — is considered.

Maximum production of the first one (5.5 mmt) is achievable in 2024–2025 with a decrease to 3.2 million tons (2035) and less than 1.0 million tons in 2050. The maximum production of the second field (2.2 million tons) can be achieved by 2030–2032 with a decrease to 1.1 million tons (2035) and almost to zero in 2050 [5].

Thus, on the time lag of the current planning horizons, the total production of offshore fields in the transit zone of the Pechora Sea and the share of the use of sea communications of the NSR will be maintained at the level of 5.5–6.0 million tons in 2021.

As regards the modernization of sea communications, it is necessary to equip the service fleet (icebreaking, rescue and auxiliary vessels) to the level required to ensure safe year-round navigation in the Arctic seas and along the NSR routes. The structure of marine communications is organically complemented by a system of basing and terminals requiring reconstruction, as well as the creation (modernization, construction) of a network of seaports along the southern route of the NSR and logistics points on the islands and lands.

Various types of energy resources are located in the regions of the Arctic, Siberia and the Far East, but most of these regions are characterized by a significant lack of human resources and the availability of competencies in management of the regional economy, but, most importantly, by heterogeneity of socio-economic development and depopulation as its consequence [5].

The principles of multi-layer rational planning of the regional economy should be integrated into the basis of the spatial development of modern Russia. Thus, a transition is being made from a point (focal) model of spatial development to a strip (latitudinal) model. As one of the components of a multilayer latitudinal network, the regional space that ensures the functioning of the dominant activity, as well as infrastructure and other supporting industries is considered (Fig. 3).

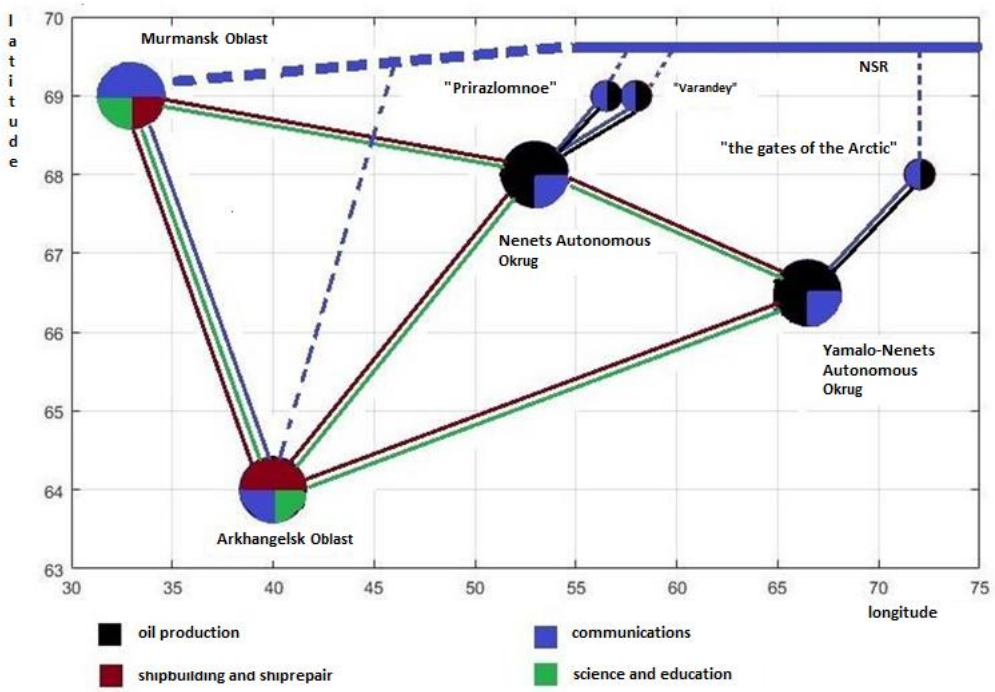

Fig. 3. Scheme of transition to the multilayer marker spatial organization of the Kola MRC [8].

Each layer is characterized by marker activities and represents a mobilization component of Russia's spatial development, capable of ensuring the full functioning of these activities, as well as the production and social infrastructure of the geostrategic space.

Regionalization for Russia is a means of layer-by-layer "assembly" of heterogeneous spaces. The planning of spatial development should move from the principle of concentration and consolidation (formation of large agglomerations and concentration of the bulk of resources in these agglomerations) to the ordering and distribution of resources and competencies throughout the territory of Russia [5].

Conclusion

The instruments of state incentives for the development of MRCs are determined primarily by the effects that oil and gas projects have at the national level, as well as by the results of the activities of the operating companies of these projects, whose activities are of a technological and socio-economic nature for the development of territories and the state significance of the tasks being solved.

At the moment, despite a significant number of legal documents of the state level, neither agglomerations nor mineral resource centers are full-fledged objects of strategic planning, they do not have specialized management bodies.

The analysis of the experience of domestic research on this topic allows us to conclude that the main problems are identified in terms of economic-geographical and production-technological components in the organization of mineral resource centers. When the issue of identifying the directions of some institutional and regulatory and methodological problems arising during the real-

[8] Source: compiled by the authors.

ization of the national policy for the formation and development of centers of economic growth based on mineral resource centers is insufficiently covered, according to the Spatial Development Strategy of the Russian Federation for the period up to 2025.

For the effective development of economic growth centers of any type, it is necessary to have a system of strategic planning and management. A set of measures for the organization and further functioning of MRC as centers of regional development of the constituent entities of Russia requires further elaboration as best practices are accumulated and generalized in the regions of Russia and abroad. In addition, it is necessary to take into account the previous experience of our country in the formation and management of territorial production complexes, transport and industrial hubs in Siberia and the Far East.

References

1. Granberg A.G. Regional'naya ekonomika i regional'naya nauka v Rossii: desyat' let spustya [Regional Economy and Regional Science in Russia: Ten Years Later]. *Region. Ekonomika i sotsiologiya*, 2004, no. 1, pp. 57–81.
2. Artobolevskii S.S., Baklanov P.Y., Treivish A.I. Prostranstvo i razvitie Rossii: polimasshtabnyy analiz [Russia's Space and Development: A Multiscale Analysis]. *Vestnik RAN* [Herald of the Russian Academy of Sciences], 2009, vol. 79, no 2, pp. 101–112.
3. Minakir P.A., Demyanenko A.N. Prostranstvennaya ekonomika: evolyutsiya podkhodov i metodologiya [Spatial Economics: Evolution of Approaches and Methodology]. *Prostranstvennaya ekonomika* [Spatial Economics], 2010, no. 2, pp. 6–32. DOI: 10.14530/se.2010.2.006-032
4. Tatarkin A.I. Regional'naya napravlennost' ekonomicheskoy politiki Rossiyskoy Federatsii kak instituta prostranstvennogo obustroystva territoriy [Regional Targeting of the Economic Policy of the Russian Federation as an Institution of Regional Spatial Development]. *Ekonomika regiona* [Economy of Region], 2016, vol. 12, no. 1, pp. 9–27. DOI: 10.17059/2016-1-1
5. Ivanova M.V., Koz'menko A.S. Spatial Management of the Shipping Routes in the Russian Arctic. *Economic and Social Changes: Facts, Trends, Forecast*, 2021, vol. 14, no. 2, pp. 92–104. DOI: 10.15838/esc.2021.2.74.6
6. Chen A., Lantz T.C., Hermosilla T., Wulder M.A. Biophysical Controls of Increased Tundra Productivity in the Western Canadian Arctic. *Remote Sensing of Environment*, 2021, vol. 258 (2): 112358. DOI: 10.1016/j.rse.2021.112358
7. Doel R.E., Wråkberg U., Zeller S. Science, Environment, and the New Arctic. *Journal of Historical Geography*, 2014, no. 44, pp. 2–14. DOI: 10.1016/j.jhg.2013.12.003
8. Nong D., Countryman A.M., Warziniack T. Potential Impacts of Expanded Arctic Alaska Energy Resource Extraction on US Energy Sectors. *Energy Policy*, 2018, vol. 119, pp. 57–584. DOI: 10.1016/j.enpol.2018.05.003
9. Malinauskaite L., Cook D., Davidsdóttir B., Ögmundardóttir H., Roman J. Ecosystem Services in the Arctic: A Thematic Review. *Ecosystem Services*, 2019, vol. 36, pp. 512–525. DOI: 10.1016/j.ecoser.2019.100898
10. Wassmann P., Carmack E.C., Bluhm B.A., Duarte C.M., Berge J., Brown K., Grebmeier J.M., Holding J., Kosobokova K., Kwok R., Matrai P., Agusti S., Babin M., Bhatt U., Eicken H., Polyakov I., Rysgaard S., Huntington H.P. Towards a Unifying Pan-Arctic Perspective: A Conceptual Modelling Toolkit. *Progress in Oceanography*, 2020, vol. 189, pp. 329–342. DOI: 10.1016/j.pocean.2020.102455
11. Tabata Sh., Otsuka N., Goto M., Takahashi M. Economy, society and governance in the Arctic: Overview of ArCS research project in the field of humanities and social sciences (2015–2020). Polar Science, 2020, vol. 27 (1): 100600. DOI: 10.1016/j.polar.2020.100600
12. Donskoi S.E., Grigoriev M.N. Podkhody k vydeleniyu mineral'no-syr'evykh tsentrov nefti i upravleniyu razvitiem ikh resursnoy bazy [Approaches to Distinguishing Mineral-Raw Material Centres of Oil

and Their Resource Base Development Management]. *Geologiya nefti i gaza* [Russian Oil and Gas Geology], 2010, no. 5, pp. 24–28.
13. Burshtein L.M., Grekova L.S. Lokal'no-statisticheskiy metod kolichestvennogo prognoza perspektiv neftegazonosnosti (na primere gorizonta Yu_1 zapadnoy Sibiri) [Statistical Method for Quantitative Oil-Gas Prospects Prediction (At the Example of J_1 Horizon in the Western Siberia)]. *Geologiya nefti i gaza* [Russian Oil and Gas Geology], 2016, no. 4, pp. 30–38.
14. Lipina S.A., Cherepovitsyn A.E., Bocharova L.K. The Preconditions for the Formation of Mineral and Raw Materials Centers in the Support Zones of the Arctic Zone of the Russian Federation. *Arktika i Sever* [Arctic and North], 2018, no. 33, pp. 29–39. DOI: 10.17238/issn2221-2698.2018.33.29
15. Rozhdestvenskaya I.A., Rostanets V.G. Mineral'no-syr'evye tsentry kak novye ob"ekty upravleniya i strategicheskogo planirovaniya na makroregional'nom urovne [Mineral Resource Centers as New Objects of Management and Strategic Planning at the Macro-Regional Level]. *Vestnik RAEN* [Bulletin of the Russian Academy of Natural Sciences], 2021, vol. 21, no. 2, pp. 83–87. DOI: 10.52531/1682-1696-2021-21-2-83-87
16. Palkin I.I., Redkina T.M., Okrushko V.Ya. Kompleksnyy podkhod k realizatsii mer po strategicheskomu razvitiyu territorii na osnove otsenki osnov gosudarstvennoy politiki RF v Arktike na period do 2035 goda [A Comprehensive Approach to the Implementation of Measures for the Strategic Development of the Territory Based on the Assessment of the Russian Federation's State Policy in the Arctic for the Period up to 2035]. *Ekonomika i predprinimatel'stvo* [Journal of Economy and Entrepreneurship], 2020, no. 3, pp. 275–277. DOI: 10.34925/EIP.2020.116.3.055
17. Zemnukhova E.A. *Prostranstvennaya organizatsiya arkticheskikh mineral'no-syr'evykh tsentrov: dis. kand. ekon. nauk* [Spatial Organization of the Arctic Mineral Resource Centers: Cand. Econ. Sci. Diss.]. Apatity, 2022, 152 p. (In Russ.)
18. Filimonova I.V., Provornaya I.V., Komarova A.V., Zemnukhova E.A. Ustoychivye tendentsii izmeneniya regional'noy struktury dobychi nefti v Rossii [Sustainable Trends in Changing the Regional Structure of Oil Production in Russia]. *Neftegazovaya geologiya. Teoriya i praktika* [Petroleum Geology. Theoretical and Applied Studies], 2019, vol. 14, no. 3, pp. 1–16. DOI: 10.17353/2070-5379/33_2019
19. Provornaya I.V., Filimonova I.V., Komarova A.V., Zemnukhova E.A. Zakonomernosti razvitiya neftegazovykh resursnykh regionov Rossii s uchetom transportnoy obespechennosti (okonchanie) [Patterns of Development of Oil and Gas Resource Regions of Russia Taking into Account Transport Security (Ending)]. *Ekologicheskiy vestnik Rossii* [Ecological Bulletin of Russia], 2020, no. 2, pp. 20–24.
20. Kontorovich V.A., Ershov S.V. Neftegazovyy rezerv Zapadnoy Sibiri [Oil and Gas Reserves of West Siberia]. *Nauka iz pervykh ruk* [Science First Hand], 2010, no. 3, pp. 26–29.
21. Veretennikov N.P. Formation and Development of Logistics Infrastructure in the Arctic Regions. *Sever i rynok: formirovanie ekonomicheskogo poryadka* [The North and the Market: Forming the Economic Order], 2019, no. 1 (63), pp. 89–98. DOI: 10.25702/KSC.2220-802X.1.2019.63.89-98
22. Zemnukhova E.A. Problems and Prospects for the Formation of Mineral Resource Centers in the Arctic Zone of Russia. *Ekonomika i predprinimatel'stvo* [Journal of Economy and Entrepreneurship], 2021, no. 3 (128), pp. 443–448.
23. Kontorovich A.E., Krasnov O.S., Livshits V.R. Algoritm perspektivnogo planirovaniya geologorazvedochnykh rabot na osnove imitatsionnogo modelirovaniya protsessa vyyavleniya mestorozhdeniy nefti i gaza: sbornik nauchnykh trudov [Algorithm for Prospective Planning of Exploration Works Based on Simulation Modeling of the Process of Identifying Oil and Gas Fields: A Collection of Scientific Papers]. *Metody perspektivnogo planirovaniya geologorazvedochnykh rabot na neft' i gaz* [Methods of Prospective Planning of Geological Exploration for Oil and Gas], 1989, no. 1, pp. 16–27.
24. Filimonova I.V., Zemnukhova E.A. Spatial Organization of the Communication System of the Arctic Mineral Resource Center. *Ekonomicheskie nauki* [Economic Sciences], 2021, no. 200, pp. 131–138. DOI: 10.14451/1.200.131

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