

The Impact of Mining Clusters on Spatial Development of Territories

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Abstract—Mining clusters, which are large industrial formations, specialized in functional characteristics and located in a relatively small area, have a complex effect on the spatial development of the territories of their presence for a long time. The impact of mining clusters of ferrous metallurgy on the spatial development of territories where they are located has been considered in the paper. The authors have revealed several key interrelated aspects of the influence of mining clusters of ferrous metallurgy on the spatial development of territories: production and economic, financial, social, environmental and integration ones. The highlighted aspects of the impact on the spatial development of territories have been considered on the example of the Kursk-Belgorod mining cluster, formed at the richest iron ore deposits of the Kursk-Belgorod magnetic anomaly. The mining cluster is based on a complex of enterprises specializing in the extraction of iron ore. The Kursk-Belgorod mining cluster has been operating for many decades. Practically all aspects of production and infrastructure projects, social development, technological development, budget replenishment, and the environmental situation depend on the activities of cluster enterprises. There are two pretty big mono-cities on the cluster's territory, the livelihoods of which are completely dependent on the cluster's enterprises.

Keywords—*mining cluster, ferrous metallurgy, spatial development of territories, Kursk-Belgorod magnetic anomaly.*

I. INTRODUCTION

The relevance of the research is due to the necessity of assessment the impact of Russian mining clusters upon the spatial development of the territories in which they are located.

In the industrial structure of most Russian regions, enterprises of basic industries, which traditionally ensure their socio-economic development, remain the main ones. Recently, scientists have been interested in industrial clusters i.e. large industrial formations, specialized in terms of functionality and located in relatively small areas. In case of

effective management, such clusters can become economic, social, material and technical basis for the spatial development of territories of presence [1; 2].

Currently, mining clusters of ferrous metallurgy technologically and organizationally combine enterprises for the extraction, enrichment and processing of ore raw materials, which include iron, chromium and manganese ores, and non-metallic raw materials, including refractory clays, lime or magnesian flux ores, etc. [3-5].

II. METHODS

The research is based on an integrated approach, which made it possible to determine the impact of mining clusters on the development of territories, taking into account production, economic, social, environmental, financial and integration aspects.

The object of the research is mining clusters formed on the Russian Federation's iron ore resource base.

The choice of mining clusters of ferrous metallurgy as objects of our research is explained by the special role of this branch of industry for the national economy.

The development of industrial mining clusters from the standpoint of achievement of the production and economic results is considered, in particular, in the works of Russian and foreign researchers. Analyzing financial flows, M. Cehlár with co-authors [6], T. Skufina and M. Mitroshina [7], G.S. Feraru and E.A. Stryabkova [8] support their stand that industrial clusters, including mining ones increase the investment attractiveness of the territories where their enterprises are located, attracting national and foreign investments. The role of large industrial formations in the development of innovative processes is considered, including in the works of J.H. Gruenhagen and R. Parker [9], M.T.W. Rosenfeld with co-authors [10].

The social factors of the mining cluster are usually studied from three perspectives. First, the level of safety of production processes at the mining cluster is being studied [11]. Second, the social responsibility of the cluster's enterprises [12; 13]. Thirdly, the impact on the quality of life of the population in the regions of the presence of mining clusters is assessed [14-16].

A lot of work concerns the environmental aspects of industrial clusters. This is due to the long and intense load on the natural environment, which cannot be excluded in the process of extraction, processing, transportation of mountain mass [17-19].

Acknowledging the significance of the results of these and other scientific research, the authors emphasize that currently in Russia there are no unified approaches to assessing the factors of the influence of mining clusters on territorial development. All this makes the presented research actual.

III. MAIN PART

Aspects of the impact of mining clusters on the spatial development of the territories

The influence of mining clusters on territorial development is explained by the special role of these large industrial formations. This particular role was the result of the influence of several key aspects (fig. 1).

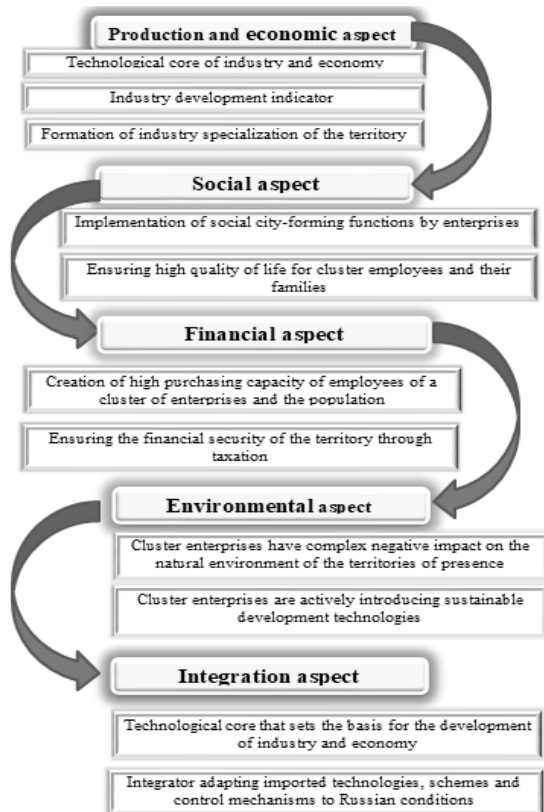


Fig.1. Key aspects of the impact of mining clusters of the steel industry on the spatial development of the territories (compiled by the authors)

Firstly, the production and economic aspect. The iron and steel industry unites more than 1,500 industrial and auxiliary non-industrial enterprises. In their aggregate, as of 2020, metallurgical enterprises make a significant contribution to

Russia's economy. They account for: 1.5% of GDP, about 12% of industrial production and more than 6% of exports.

Mining clusters are interconnected with almost all other major sectors of the economy, ranging from heavy industries (mining and chemical production) to social infrastructure sectors that functionally support people's livelihoods. Thus, mining clusters of ferrous metallurgy provide sustainable operation of enterprises in many other sectors of the national economy. The creation and maintenance of production functional chains between enterprises of various industries and filling the consumer market of territories of presence in many respects depends on the activities of mining clusters.

The second aspect is social. As of 2020, more than 660 thousand people worked at ferrous metallurgy enterprises. It is important for the national economy that more than 70% of enterprises of mining clusters of ferrous metallurgy are city-forming. The development or crisis of such enterprises directly affects the development trend of the urban settlements where these enterprises are geographically located. As a rule, no more than 5-10% of the population work directly at the city-forming enterprises. But it is these enterprises that form the sectoral specialization of the city are its functional "core". Their activity allows the development of industrial enterprises of related industries, as well as enterprises of production and social infrastructure [20]. The influence of city-forming enterprises on such cities' economy is of concern not only to Russian, but to foreign researchers as well. In South America, in the USA and Canada, in Eastern and Western Europe, similar problems associated with the obsession with the activities of mono-towns and city-forming enterprises take place as well [21; 22].

What is also important in the social aspect is the fact that many enterprises of mining clusters of ferrous metallurgy directly finance and support enterprises of social infrastructure. They are either direct customers of the services of sports and health centers, public catering enterprises, transport enterprises of the city, etc. or provide sponsorship assistance to schools, kindergartens, cultural and entertainment institutions, etc. This is the most important aspect of the activities of ferrous metallurgy enterprises as city-forming ones. Remuneration that mining clusters of the iron and steel industry pay to their employees is quite high.

The third aspect is financial. High wages create high purchasing power for employees in mining clusters of the ferrous metallurgy and for population as a whole. People actively spend money and fill the territorial economy with money supply, maintaining high demand for commodity products and services.

From the standpoint of taxation the financial aspect of the mining clusters from the standpoint of ensuring of Russia's financial security is important as well. Preserving and increasing the income of mining clusters of ferrous metallurgy makes it possible to pay taxes in full to budgets of various levels. Many enterprises are city-forming. But some of them are not only city-forming, but district-forming as well. It means that taxes from the activities of such enterprises form a significant share of not only the local budget, but also the regional one. In aggregate, the mining clusters of the ferrous metallurgy make a significant contribution to the country's budget.

The fourth aspect is environmental. Mining clusters of ferrous metallurgy have a complex negative impact on the

natural environment. The complexity of the impact lies in the fact that the enterprises of the clusters simultaneously pollute all elements of natural environment: atmospheric air, surface and underground waters, soil. Mining leads to the most significant, irreplaceable changes in the natural environment - the extraction of minerals, changes in landscapes, lowering the level of groundwater [23; 24]. Most ferrous metallurgy enterprises in our country use outdated, environmentally dirty production technologies []. Many researchers note that the energy intensity of Russian mining clusters of ferrous metallurgy is many times higher than power intensity of most enterprises in developed countries [8; 18; 20]. Moreover, as in the case of mono-towns, the environmental problem of mining clusters is international and alarms both Russian researchers, and foreign ones [11; 17; 25].

The fifth aspect is integration. As long as ferrous metallurgy is interconnected with many other sectors of the national economy, it can be considered the basis for the development of the technological core of the entire Russian industry and then the economy. The quality of the products of the mining cluster enterprises actually ensures the quality of products of other enterprises which use iron ore products as raw materials. The following quality chain can be easily traced. The quality of steel depends on the quality of iron ore pellets. This, in turn, affects the quality of metal products, for example, rolled metal that are used in tube manufacture. The quality of tubes directly affects the activities of enterprises in the oil and gas sector, whose products are the basis of Russian exports. And such chains are innumerable. Therefore, the technologies used by enterprises of mining clusters of ferrous metallurgy provide the basis for the development of many industrial and non-industrial sectors of the Russian economy.

The issue concerning world integration is also important. In the globalizing world, it is especially important for Russian economy to integrate into the world economic space. For this, Russian production must be competitive in the world market, and Russian technologies must meet requirements of modern world quality standards. For ferrous metallurgy enterprises, this aspect is especially important, as long as products of that branch of industry are actively exported abroad. This is due to the fact that, according to experts, in recent years Russia has produced more metallurgical products than is necessary for its home consumption.

The impact of the Kursk-Belgorod mining cluster on the spatial development of the territories

Kursk-Belgorod mining cluster may serve as an example. The region specializes in iron ore mining and steel production. The resource base of the region's economy is the reserves of ferruginous quartzite from the deposits of the Kursk-Belgorod magnetic anomaly. The cluster contains 40% of Russia's iron ore reserves. Iron ore is extracted by open and closed-cut mining, circulated and then used for steel production or for export. The production and economic, social, financial, environmental and integration aspects of the impact of the Kursk-Belgorod mining cluster on the spatial development of territories are obvious.

The mining cluster is based on the complex of enterprises specializing in the extraction of iron ore:

- JSC Lebedinsky Mining and Processing Plant (MPP), the part of the Metalloinvest corporation is located in the Belgorod Region near the town of Gubkin with a population of 86,229 people (for 2020) gave the first iron ore

in 1967; iron ore is extracted by open-cut mining; the products are iron ore, iron ore pellets, as well as boron-bracketed iron - the highest quality iron ore product; in 2019 iron ore mining came to 50 million tons; the number of employees is 6413 people;

- JSC "Kombinat KMAruda", part of the Industrial and Metallurgical Holding is also located near the town of Gubkin, Belgorod Region; it was opened in 1953; iron ore is extracted through the system of mines; the product is iron ore concentrate; in 2019 the extraction of iron ore came to 4.8 million tons; the number of employees is 2380 people;

- JSC "Mikhailovsky MPP named after A.V. Varichev " is a part of the Metalloinvest corporation; it is located in the Kursk region near the town of Zheleznogorsk with a population of 100,446 people (for 2020); it has been operating since 1957; iron ore is extracted by open-cut mining; the product is sintered ore, iron ore concentrate, iron ore pellets; in 2019 iron ore mining came to 95.4 million tons; the number of employees is 9459 people;

- JSC Stoilensky MPP is a part of the NLMK Group; it is located in the Belgorod Region near the town of Stary Oskol with a population of 223,921 people (for 2020); it has been operating since 1961; iron ore is extracted by open-cut mining; the product is iron ore, iron ore concentrate, iron ore pellets; in 2019 iron ore mining came to 36.8 million tons; the number of employees is 7540 people;

- JSC Yakovlevsky MPP has lost the status of a legal entity and has been absorbed by Severstal since 2019; it is located in the Belgorod region near the village of Yakovlevo with a population of 2,656 people (for 2020); iron ore is extracted by closed-cut mining; in 2019 the products are iron and sinter ore; iron ore mining came to 1.2 million tons; the number of employees is 1528 people.

The Kursk-Belgorod mining cluster makes a significant contribution to the country's economy. The cluster supplies 34% of the total production of iron ore, 33% of iron ore pellets and 100% of hot briquetted iron. Iron ore products are used both by Oskol Electrometallurgical Plant JSC, the steel enterprise located in the cluster and by other Russian metallurgical enterprises. The significant share of metal products is exported to near and far abroad countries.

The social influence of the cluster is great. First of all, the labor remuneration in mining clusters of the ferrous metallurgy is quite high. To confirm this statement, the authors compared the average monthly wages of workers in the Belgorod region related to iron ore mining and other activities (Table I).

TABLE I Average monthly wage in the Belgorod region in 2017-2019 (based on the materials of the site Audit-it.ru [26])

Type of activity	Average monthly wage, rub.		
	2017	2018	2019
<i>Belgorod region</i>			
Average for all kinds of activities	29065.6	31851.9	34614.5
Mining of metal ores	43997.5	47003.7	52321.2
Provision of services in the field of mining	61312.5	38828.1	53256.5
<i>Russian Federation</i>			
Average for all kinds of activities	39167.0	43723.7	47866.8
Mining of metal ores	61121.9	70720.8	78519.9
Provision of services in the field of mining	76361.1	85286.5	90829.2

As can be seen from the submitted data, the average wage of employees engaged in the field of metal ores extraction is 1.5 times higher than an average one for people employed in other kinds of activities for the Belgorod region. Employees engaged in the provision of services in the field of mining (first of all, exploration and development of new deposits) also get higher pay: in 2017 a wage rise was 2.11 times, in 2019 – 1.53 times. These wages provide high quality of life for employees engaged in the mining cluster of the ferrous metallurgy.

In the Russian Federation, the wage gap is even more significant. The wage-rate difference between employees engaged in metal ores extraction and people employed in other kinds of activities is 1.56-1.64 times. At the same time, the wage gap is increasing. The growth rate of wages for employees engaged in metal ores extraction outpaced the growth rate of wages in the country on average. The exceeding of wage over an average one for employees engaged in the provision of services in the field of mining is 1.90-1.95 times; the gap widened until 2019.

Single-industry settlements on the territory of the Kursk-Belgorod mining cluster deserve special attention. Such towns as Gubkin (population of 86229 people as of 2020), Zheleznogorsk (population of 100446 people) and the village of Yakovlevo (population of 1528 people as of 2020) are single-industry settlements and directly depend on the activities of the city-forming enterprises of the Kursk-Belgorod mining cluster. Almost all aspects of mono-industrial settlements' life depend on the activities of the cluster's enterprises: population's employment and incomes, infrastructure, budget filling, directions of specialists training in higher and secondary educational institutions u.a.m. It is not for nothing that such settlements are called "company settlements" all over the world [21].

IV. CONCLUSION

As long as almost all mining enterprises of the Kursk-Belgorod cluster, with the exception of the Yakovlevsky MPP, have been operating since the 50s-60s of the twentieth century, their negative impact on the natural environment is powerful and irreversible in a number of parameters. The development of mines and open-cast mines, accompanying the extraction of iron ore, leads to some changes in landscapes, drainage of water-bearing horizons, pollution of soil, atmosphere and surface waters [23; 24]. Ore deposits are gradually being depleted, although, according to experts, the reserves will last for another 200-300 years [27].

At the same time, the enterprises of the Kursk-Belgorod mining cluster, which are part of the largest national and transnational corporations, are actively involved in the introduction of the principles of sustainable development to business processes. Gradually, all enterprises of the cluster are switching to reporting in the field of sustainable development based on the international GRI Standards, which comprehensively combines economic, social and environmental indicators. Thus, in addition to the ecological aspect there is another one of the cluster's influence on spatial development – the integration aspect.

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