PROBLEMS OF TRANSPORT ACCESSIBILITY AND CONNECTIVITY IN THE NORTHERN REGIONS

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ABSTRACT

The article, published in two issues of the journal, addresses the problems of development of transport infrastructure in the northern regions of Russia (Part I: priority of roads, land communications, Part II: how to avoid the «big earth» syndrome). The conclusion is substantiated that in order to ensure their attractiveness, comfort of living, increasing the population density, creating conditions for long-term sustainable social and economic development of the territories, it is necessary to deal more with the infrastructure of land transport and, above all, the railway, which would be of a supporting nature and would strengthen the position of the transport complex in the north. It requires strategic planning for development of each type of transport, taking into account the prospects for industrial development of low-income arctic regions and long-term needs of people in creating a comfortable environment and favorable conditions for active and full-fledged life, in conjunction with the natural and climatic features of the region and their projected changes.

Keywords: transport, northern regions, social and economic development, land transport infrastructure, natural and climatic conditions.

Background. *Russia is a northern country, almost 2/3 of which (more than 11 million km²) belongs to the regions of the Far North and regions equated to them. The economic importance of these regions is very high: they account for the bulk of oil and gas production, as well as phosphorus fertilizers, and timber production. In the northern regions, the extraction of diamonds and gold, non-ferrous and rare-earth metals, and considerable energy capacities are concentrated.*

Reserves of minerals that can be used in the future are great. So, according to some estimates, in the Arctic, a large part of which belongs to the Russian North, 20–25 % of the world's oil and gas reserves are located [1].

At the same time, less than 10 % of Russia's population lives in the North, and at the end of the last century and the beginning of this century a massive outflow of population from the northern regions arose [2, p. 375], which certainly worsens the prospects for their development. After all, in the modern economy it is human, and not material capital, that is the main component of national wealth and the basis of economic growth. According to the study [3], the volume of human capital in Russia is about 13 times higher than the country's GDP and 5.5 times – the volume of physical capital. At the same time, economic development is provided by the synergy of human and physical capital, natural resources. Reducing the population of the Russian North, which naturally leads to a reduction in the human capital of this macroregion, also means a reduction in the opportunities for such synergies.

Objective. *The objective of the authors is to consider transport problems, which arise in the northern regions of Russia.*

Methods. *The authors use general scientific methods, statistical method, retrospective method, scientific analysis.*

Results.

Part I: priority of roads, ground structures

The origins of the problems of the North and the importance of transport

The current problems of social and economic development of the Russian North are largely due to the policy of development of the northern regions during the centrally planned economy.

On the one hand, during this period there was a mass migration of people to the northern regions. So, only from 1926 to 1939 the population of the Far North increased almost threefold. In the second half of the 1930s, the annual increase was up to 15 % [4, p. 133]. However, this was not the result of increasing the attractiveness of the regions for people's lives. As R. Aliev points out, «The north of the country was assigned a special role in the plans of the Soviet leadership – at first it was regarded as an ideal place of isolation for the undesirable part of the population, and later as an inexhaustible source of natural resources <...>. But no matter how its main purpose was changed, the material basis for developing the region was provided by forced labor» [5, p. 245].

As a result, from the end of the 1920s to the early 1990s, the average temperature of the winter months, recalculated for the distribution of the population across Russia, decreased by 1°C (from –11.6°C to –12.6°C). Over the same period in the other largest northern country – Canada – the average population temperature (for winter months), on the contrary, increased by 1°C (from –9.9°C to –8.9°C) [2, pp. 373–374]. Thus, if in Canada the population was concentrated in the zones of a milder climate, then in Russia – of more severe.

At the same time, the main task of developing the North in our country was the extraction of natural resources. The issues of social development, creation of attractive conditions for resettled people, stimulation of their «rooting» in these regions were often of secondary importance. The main driving factor of resettlement to the North (if such resettlement was voluntary), as a rule, was high wages, and the goal – the accumulation of funds in order to then safely settle in a more comfortable region of the country. The development of such «diligent» psychology was facilitated by the low transport availability and availability of northern places, creating a sense of «isolation» from the «Big Land» and psychological discomfort [6]. It is not by chance that when the state mechanisms for ensuring attractive pay in the northern regions ceased to function, many of their residents began to make the utmost efforts to move to the «Big Land».

It should be noted that one of the first documents adopted by the Russian government at the very beginning of market reforms was the «Concept of Social and Economic Development of the North» [7]. It analyzed the socio-economic problems of the northern territories and outlined systemic reforms aimed at «implementing a multisectoral diversification of the Russian North's economy». At the same time, it was noted that «the issues of creating the infrastructure... necessary for the effective functioning of the social and market mechanism will gradually occupy the leading strategic importance in the

Table 1

Level of development of infrastructure of land transport and general socioeconomic development of the Northern regions of Russia

Region	Population density, people/km²	GRP per capita, thous. rub.	Availability of railways			Availability of roads		
			$d_S^{rail.}$	$d_{pop.}^{rail.}$	$d_e^{rail.}$	$d_S^{road.}$	$d_{pop.}^{road.}$	$d_e^{road.}$
Murmansk region	5,29	396,3	6,00	1,14	2,61	22,70	4,29	9,87
Karelia republic	3,50	276,8	12,33	3,52	6,59	46,96	13,40	25,09
Arkhangelsk region	2,01	428,1	3,00	1,49	2,11	20,83	10,38	14,70
Komi republic	2,07	560,0	4,05	1,95	2,81	15,36	7,40	10,66
Khanty-Mansiisky autonomous district-Yugra	3,01	1753,8	2,03	0,67	1,17	10,32	3,42	5,94
Yamalo-Nenetsky autonomous district	0,70	2540,5	0,63	0,89	0,75	2,83	4,03	3,37
Tyva republic	1,86	134,2	–	–	–	20,30	10,91	14,88
Sakha republic (Yakutia)	0,31	595,8	0,17	0,55	0,31	3,69	11,88	6,62
Magadan region	0,32	584,7	–	–	–	5,26	16,42	9,29
Chukotsky autonomous district	0,07	927,4	–	–	–	0,89	12,73	3,37
Kamchatka region	0,68	410,9	–	–	–	4,10	6,00	4,96
Sakhalin region	5,6	1369,0	9,59	1,71	4,05	21,70	3,87	9,16

Notes: $d_S^{rail.}$ – density of public railway network, which characterizes transport provision of the territory, km/1000 km²; $d_{pop.}^{rail.}$ – density of public railway network, which characterizes transport provision of population, km/1000 people; $d_e^{rail.}$ – complex indicator of density of public railway network (Engel coefficient); $d_S^{road.}$ – density of public road network (with hard surface), which characterizes transport provision of the territory, km/1000 km²; $d_{pop.}^{road.}$ – density of public road network (with hard surface), which characterizes transport provision of population, km/ 1000 people; $d_e^{road.}$ – complex indicator of density of public road network (Engel coefficient).

restructuring of the economic systems of the North», and the transport system was named the first among the production ones requiring centralized management, i.e. priority attention from the federal level of management.

This priority of the transport aspect in the development of the North is not accidental. In the methodology developed by the Canadian scientist L. Amlen to establish «northern» wage increments based on the proposed «northness» scale of four economic factors (taken into account along with six natural and climatic factors), two directly relate to transport. These are «ground transport accessibility» and «availability and quality of air communication» [7]. Two other economic factors: the «population in a populated area» and the «level of economic activity»,

Table 2

Rating of the level of development of land transport infrastructure and general social and economic development of the northern regions of Russia

Region	Population density, people/km²	GRP per capita, thous. rub.	Availability of railways			Availability of roads		
			$d_S^{rail.}$	$d_{pop.}^{rail.}$	$d_e^{rail.}$	$d_S^{road.}$	$d_{pop.}^{road.}$	$d_e^{road.}$
Murmansk region	2	10	3	5	4	2	9	5
Karelia republic	3	11	1	1	1	1	2	1
Arkhangelsk region	6	8	5	4	5	4	6	3
Komi republic	5	7	4	2	3	6	7	4
Khanty-Mansiisky autonomous district – Yugra	4	2	6	7	6	7	12	9
Yamalo-Nenetsky autonomous district	8	1	7	6	7	11	10	11
Tyva republic	7	12	(9–12)	(9–12)	(9–12)	5	5	2
Sakha republic (Yakutia)	11	5	8	8	8	10	4	8
Magadan region	10	6	(9–12)	(9–12)	(9–12)	8	1	6
Chukotsky autonomous district	12	4	(9–12)	(9–12)	(9–12)	12	3	12
Kamchatka region	9	9	(9–12)	(9–12)	(9–12)	9	8	10
Sakhalin region	1	3	2	3	2	3	11	7

Table 3

Grouping of the northern regions of Russia in terms of population density and the provision of the territory with railways and highways

Population density	Provision of the territory with railways			
	low		high	
	Обеспеченность территории автодорогами		Обеспеченность территории автодорогами	
	low	high	low	high
low	Kamchatka region, Yamalo-Nenetsky autonomous district, Sakha republic(Yakutia), Magadan region, Chukotsky autonomous district	Tyva republic	–	–
high	–	–	Khanty-Mansiisky autonomous district-Yugra	Sakhalin region, Murmansk region, Karelia republic, Arkhangelsk region

taking into account the nature of the socioeconomic development of a given place of residence, as shown in [8, 9], are also crucially dependent on transport security. Therefore, the development of transport is a key aspect for the northern regions, creating there more attractive conditions and at least partial leveling (rather than aggravating, as it is now) of the severe natural and climatic circumstances of life.

In the research and initial development of the Far North, the leading role was played by sea and river, and later – by air vehicles [4, 5]. However, the possibilities of using water transport are limited by the geographical location of a particular locality, and in the northern regions also by a short navigation period. Air communication is of high cost and low carrying capacity. The presence in the region of only water and air communication in socio-economic terms makes it an «island», separated from the «Big Land», even if this region is part of the continent. Therefore, for the socio-economic development of the northern regions in Russia, it is extremely important to develop land-based modes of transport (which, of course, does not reduce the role of water and air traffic).

Analysis of land infrastructure

Since official statistical information on the transport infrastructure and socio-economic development is given for each region – a subject of the Russian Federation, the analysis was carried out for those regions which entire territory belongs to the regions of the Far North or equivalent areas. Accordingly, those subjects of the federation, in which only certain areas belong to the Far North or equivalent areas, are not included in the analysis.

Based on this approach, levels of infrastructure development for land transport and general socio-economic development are analyzed for twelve northern regions (Table 1).

Indicators of socio-economic development – population density and gross regional product (GRP) per capita – are taken directly from official statistical information [10], and indicators of the availability of land transport infrastructure – railways and highways – for land and population are calculated on the basis of data from the same source.

The use of GRP (the cost of all final goods and services produced in all sectors of the economy in the region) per capita, as a key indicator of regional economic development, probably does not require comments. As for population density, this is not only a key socio-demographic, but also a key economic indicator. The economic role of population density is determined by the fact that the division of labor, specialization and co-operation in the process of economic activity, which are the basis of economic growth and the improvement of people's well-being, and the opportunities for the development of culture, education and health, depend on its level. (It is difficult, for example, to imagine multi-disciplinary educational or medical institutions in sparsely populated areas). Finally, just for effective development of the territory, the population density must exceed some minimum necessary level.

To characterize the level of development of the land transport infrastructure, the indicators characterizing the transport coverage of the territory and the population (for rail and road transport), as well as the complex indicator of the density of the railway and road network– Engel coefficient are used:

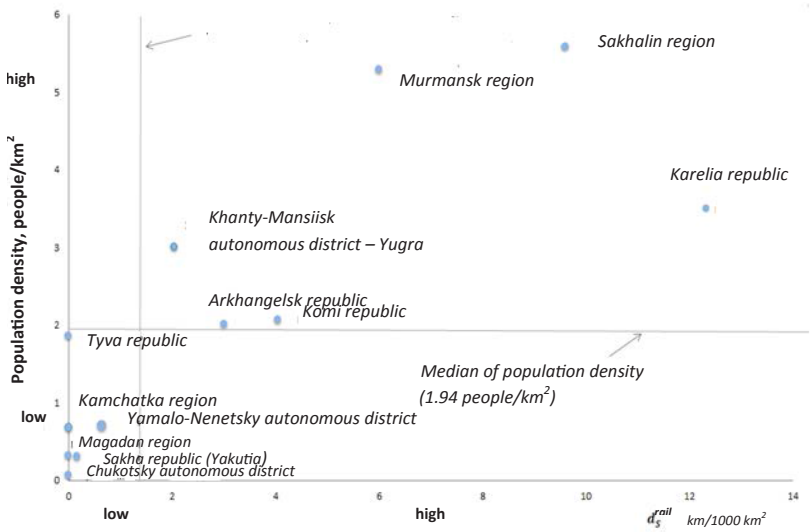
$$d_e^{rail.} = \sqrt{d_S^{rail.} * d_{pop.}^{rail.}};$$

$$d_e^{road.} = \sqrt{d_S^{road.} * d_{pop.}^{road.}}.$$

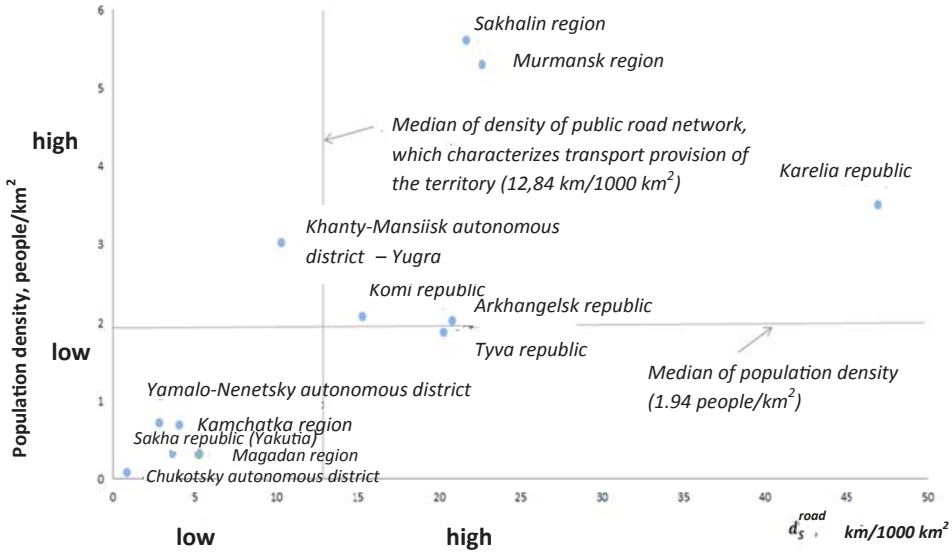
Comparison of all these indicators for the northern regions of Russia (Table 1) gives a rather «colorful» picture, for ordering which Table 2 shows the ratings of regions for each indicator.

From the analysis of Table 2, we can conclude that in the northern regions of Russia there is no clear connection between population density and GRP per capita: the ratings of more than half of the regions differ significantly in these indicators. This situation is a consequence of the existing model of the development of the North, aimed at extracting natural resources, in which the economic indicators of the region are formed due to the availability of such resources and their exploitation. As a result, for example, the Yamalo-Nenetsky Autonomous District, where significant volumes of hydrocarbon raw materials are produced, is in the first place in terms of GRP per capita at very low population density, and the «deprived» of hydrocarbons Murmansk region and Karelia with relatively high (for the northern regions) population density have extremely low levels of GRP per capita.

However, the resource and raw material model of the economic development of the northern regions, as well as the whole of our country, is not promising. The world, starting with the most developed countries, enters the knowledge economy period when the relative importance of raw materials is reduced, and the



Pic. 1. Segmentation of the northern regions of Russia in terms of population density and the provision of the territory with rail infrastructure.



Pic. 2. Segmentation of the northern regions of Russia in terms of population density and the provision of territory with road infrastructure.

importance of human capital becomes the leading and will continue to grow. And since individuals act as bearers of human capital, the density of the population, together with the opportunities for personal development, including the existence of a comfortable environment for life, including transport, is a key factor in terms of the prospects for the development of the northern regions.

Table 2 shows the relationship between population density and indicators of the provision of the territory with rail and road infrastructure. This relationship is even more evident from Pic. 1 and 2 and Table 3. And this is the relationship – in fact, to ensure even a relatively high population density, it is necessary to have a stable regular transport communication, and the development of such a communication, in turn, requires an increase in population density.

In other words, there is a positive reverse connection between the population density and the transport provision of the territory. It is noteworthy that in Pic. 1 and 2 points in the areas of low population density and low provision of the territory of the regions with rail and road infrastructure are concentrated, and in areas of high population density and high provision of the territory with transport infrastructure[1] – scattered. This can be interpreted as the existence of a kind of «trap of unexplored territory», which consists in the fact that low transport provision of the territory hinders its settlement and economic development (a small number of people is mainly concentrated in a limited number of uninhabited places with air or water transport communication), and this, in turn, does not create prerequisites for the development of transport, does not allow to economically justify the construction of land transport main lines.

[1] Of course, with reference to the northern regions, one can speak of high population density and high availability of transport infrastructure only in a relative sense.

If the transport provision of the territory is improved and the critical level of density of railways and public roads is exceeded, based on the analysis, it can be estimated at about 1–2 km / 1000 km² for railways and 10–15 km / 1000 km² for highways) the density of the population varies widely, under the influence of a combination of a large number of natural and economic factors.

It turns out that the task of exceeding the «critical» (the minimum necessary for successful socioeconomic development) level of transport provision of the territory is key to overcoming the «trap of undeveloped territory» and the formation of long-term socio-economic prospects. This task can be solved on the basis of the construction of «pioneer» transport main lines and subsequent economic development and settlement of the territories with the support of these main lines. One of the illustrative examples is construction of Murmansk railway and development on its basis of the poorly-populated Karelo-Murmansk region – will be considered below.

Of course, the given levels of the «critically needed» density of railways and highways are indicative. For each region, they should be evaluated taking into account local conditions – natural, economic, social. Nevertheless, it is noteworthy that when the average provision of Russian territory with railways reached the level of 1 km / 1000 km² in 1883, and in subsequent years exceeded it, it became a powerful impetus to accelerate the country's economic development, a «big breakthrough» in industrial production in the 1890s years [8, 11]. At the same time, proper development of transport is a necessary, but insufficient condition for socio-economic progress. It must go hand in hand with institutional development [12].

Let's now consider the comparison of population density with other indicators of transport provision.

The ratings of the population density and provision of population with rail infrastructure are close to more than half of the regions under consideration, the population density ratings and the Engel coefficient in the part of the railway infrastructure are for the majority.

As for similar ratings relating to the road infrastructure, the relationship is weaker there.

Thus, to ensure the attractiveness of the northern regions for permanent residence, to increase the density of population there, to develop human capital and to create conditions for long-term sustainable socio-economic growth, it is necessary to increase the provision of the territories of these regions with land transport infrastructure and, above all, the railway, which would be of supporting nature for the integrated development of transport in the North.

Conclusion. In the strategic plan, it is advisable to develop long-term target parameters of transport provision of the territory of the northern regions of Russia. These parameters, on the one hand, should reduce existing disproportions (which are clearly visible from Table 1), and on the other hand, they should be linked with the projects of new rail and road lines, infrastructure of sea, river and air transport. Undoubtedly, it is impossible to «simply» increase the indicators of the transport provision of the territory. A project approach is needed, and each project must be supported by a comprehensive assessment of economic and social efficiency at the sectoral, regional and macroeconomic levels, so that new roads do not turn into the leading ones «to nowhere», as has already happened in the history of the development of the North [5, p. 269–272].

REFERENCES

1. Semenikhin, Ya. N., Novoseltsev, E. M. Features of transport development in the Arctic zone [*Osobennosti transportnogo razvitija v Arkticheskoj zone*]. [Electronic resource]: www.dniimf.ru/rus/files/transport.development_in_the_ArcticArea.pdf. Last accessed 21.06.2016.
2. Gaydar, E. T. Long time. Russia in the world: essays of economic history [*Dolgoe vremja. Rossija v mire: ocherki ekonomicheskoj istorii*]. 2nd ed. Moscow, Delo publ., 2005, 656 p.
3. Kapelyushnikov, R. I. How much does the human capital of Russia cost? Part II [*Skol'ko stoit chelovecheskij kapital Rossii? Chast' II*]. Voprosy ekonomiki, 2013, Iss. 2, pp. 24–46.
4. Vize, V. Yu. The Sea of the Russian Arctic: In 2 volumes. Volume II [*Morja Rossijskoj Arktiki: V 2-h tomah. Tom II*]. Moscow, Paulsen publ., 2016, 256 p.
5. Aliev, R. The origin of the white. Arctic from Vikings to Papaninians [*Iznanka belogo. Arktika ot vikingov do papanincev*]. Moscow, Paulsen publ., 2016, 408 p.
6. Macheret, D. A. The Influence of Transportation on Object Environment of Civilization. *World of Transport and Transportation*, Vol. 10, 2012, Iss. 6, pp. 4–9.
7. The concept of socio-economic development of the North. Approved by the decree of the Government of the Russian Federation dated January 18, 1992 No. 107-R [*Koncepcija social'no-ekonomicheskogo razvitija rajonov Severa. Odobrena rasporjazheniem pravitel'stva Rossijskoj Federacii ot 18 janvarja 1992 goda № 107-R].* [Electronic resource]: docs.chtd.ru/document/901607038. Last accessed 21.06.2016.
8. Macheret, D. A. Economic notes on domestic railways [*Ekonomicheskie zapiski ob otechestvennyh zheleznyh dorogah*]. Otechestvennye zapiski, 2013, Iss. 3, pp. 162–176.
9. Macheret, D. A. Socio-Economic Assessment of Transport on the Basis of Historical Comparisons. *World of Transport and Transportation*, Vol. 14, 2016, Iss. 1, pp. 256–271.
10. Regions of Russia. The main characteristics of the subjects of the Russian Federation. 2015: Stat. col. [*Regiony Rossii. Osnovnye harakteristiki sub'ektov Rossijskoj Federacii. 2015: Stat. sb.*]. / Rosstat. Moscow, 2015, 672 p.
11. Lapidus, B. M., Macheret, D. A. Macroeconomic aspect of the evolution of rail transport [*Makroekonomicheskij aspekt evoljucii zheleznodorozhnogo transporta*]. Voprosy ekonomiki, 2011, Iss. 3, pp. 124–137.
12. Macheret, D. A. Transport and Institutes [*Transport i instituty*]. Vektor transporta, 2015, Iss. 3, pp. 5–8.

(To be continued) ●

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