

Geoinformation mapping of transport in the Baikal region

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Abstract. Transportation of the Baikal region is one of the components of a united transport complex of our country and Mongolia. We developed a semantic classification of cartographic symbols of transport systems with a view to streamlining the structure of thematic layers and the system of cartographic sign mapping of transport. Using this classification, geoinformation mapping of the transport of the Baikal region was carried out. To represent the transport of this territory, several semantic parameters were chosen that characterize both the transport complex and its possible impact on the environment (main transport types, infrastructure facilities, density of highways). The existing and projected constructions of railway tracks, highways, as well as pipelines are shown as linear objects. Point features show major airports, ports and piers. The background is the density of motor roads in the administrative regions of the Baikal region and aimaks of Mongolia. Therefore, the transport of the Baikal region was analyzed with an integrative approach on the basis of the created map, and also using other literary sources and statistical data. The main types of transport in the region, their spatial location, as well as infrastructure of transport facilities are considered. Prospects for the development of regional transport are presented.

1. Introduction

The development of the Baikal region has some specificity due to the fact that the region has a limited nature management regime. The economic and geographical position of the Baikal region determined its strategic role in the development of the country, since the main highways in the region are part of the intercontinental transport corridors. The regional development strategy is to maximize the beneficial effects of territorial factors, including transport. The study of the transport development system can be carried out effectively using a modern information system based on digital thematic maps and atlases.

To develop the content of maps, we built a semantic database. The structure of the database is revealed with the help of our transport-defined semantic classification of cartographic signs [1]. This classification is based on the research of scientists in the field of mapping semiotics [2]. The structure of our semantic classification is largely determined by the sequence of the logic of spatial analysis of transport networks and structures.

2. Objects, data and methods

The territory of mapping covers a macroregional transboundary level - the subjects of the Baikal region and aimaks of Mongolia located in the basin of Lake Baikal. The initial layers characterizing the transport of the Baikal region are the different types of transport routes and their features. Railway lines are divided into operating, under construction and contemplated. The routes are shown with line



thickness as the main and others, and highlighted with a color as roads and tracks. Also, the dotted line shows the roads to be designed for construction. Pipeline transportation is represented by operating oil pipelines and gas pipelines designed for construction. The next thematic layer is the characterization of the quality parameters of transport knots - airports, river ports and piers. The background layer shows the density of paved roads in the administrative regions of the Baikal region and the aimaks of Mongolia.

The transport map of the Baikal region was prepared for a cartographic information system based on the scientific concept of system ecological mapping, developed in the V.B. Sochava Institute of Geography SB RAS [3].

3. Results and discussion

Cartographic analysis showed that in the Baikal region almost all types of transport, except for sea transport, are represented. Railway transport is represented by the section of the Transsiberian Railway, the western section of the Baikal-Amur Mainline Railway, the Khrebtovaya–Ust'-Ilinsk, Ulan-Ude-Naushki, Karymskaya–Zabaikal'sk, Borzya-Solovyovsk, Kharanor-Priargunsk, Kuenga-Sretensk, Chernyshevsk- Bukachach, the Circum-Baikal railway, the section of the branch line Rechoty-Karabul, the eastern section Abakan-Taishet. In Mongolia, the railway base is represented by a section from the Russian border through Ulaanbaatar to the border with China, leading to Beijing. The main railway within the Lake Baikal basin is connected to Erdenet, Sharyn Gol and Baganuurbay the branch lines.

The railways pass through the most developed regions of the Baikal region with majority of population, main industrial centers and agricultural lands located here. In 2015, most of all cargo and passengers transported by rail were in the Irkutsk region (table 1).

Table 1. Rail transport statistics in 2015

	Freight, MT	Passengers, thou.ppl
Republic of Buryatia	14.8	905
Irkutsk region	50.6	12967
Transbaikal region	9.5	1856
Mongolia	19.99	2600

The road network is represented by the federal roads Novosibirsk – Taishet – Irkutsk, Irkutsk - Ulan-Ude - Chita, Kultuk - Mondy, Ulan-Ude – Kyakhta - the border with Mongolia, Chita - Zakamensk, and regional highways. On the territory of Mongolia, paved roads are represented by the road from the border with Russia to Ulaanbaatar and further to the border with China, as well as its branch: Darkhan -Erdenet - Bulgan. From Ulaanbaatar two roads lead to Arwaikheer and Underkhaan. The remaining roads on the territory of Mongolia are unpaved or just rural tracks. Up-to-date the technical condition of roads in Russia and Mongolia is being improved.

Irkutsk region is also the leader in the transportation of goods by road, and Mongolia in passenger transportation (table 2).

Table 2. Road transport statistics in 2015

	Freight, MT	Passengers, thou. ppl
Republic of Buryatia	12.1	78.8
Irkutsk region	55.0	147.7
Transbaikal region	33.3	50.9
Mongolia	20.4	260.7

In recent years, there has been a steady increase in the motorization of population. However, the development tempo of roads lags behind the motorization tempo, which leads to the overload of roads (table 3).

Table 3. Private cars in the subjects of the Baikal region and Mongolia, per 1000 ppl

	2012	2013	2014	2015
Republic of Buryatia	208.5	231.1	234.1	238.9
Irkutsk region	229.5	237.6	247.5	253.6
Transbaikal region	251.5	271.8	270.5	271.3
Mongolia	120.5	131.3	146.1	157.6

Inland waterway transport provides mainly the delivery of goods to the northern hard-to-reach areas of both the Irkutsk region and the Republic of Sakha (Yakutia). Within the Baikal region, the river network is represented by basins of the rivers Yenisei, Angara, Lena and Amur. Regular navigation is carried out along the rivers Angara and its tributaries, Lena, Lower Tunguska, Nepa, Vitim, as well as Lake Baikal and Lake Khubsugul in Mongolia.

The Angara river is divided into three sections by two dams of the Irkutsk and Bratsk hydroelectric power stations. The largest ports are located in the cities: Irkutsk, Usol'e-Sibirskoe, Svirsk, Bratsk, and Ust-Ilimsk. On the Lena river regular navigation with guaranteed depths is carried out to Ust'-Kut (upstream to the village of Zhigalovo navigation is possible only with small-sized vessels). On the Kirenga river from the mouth (of the Lena river) to the Karam village shipping is not regular. On the Vitim river regular navigation is available from the mouth (of the Lena river) to the city of Bodaibo. Here, large ports are located in the town of Ust'-Kut (the Osetrovo port) and in the town of Kirensk. On the Lower Tunguska river goods are delivered from Podvololoshino up to Nakanno. Also, the regular delivery of goods takes place along the river Nepa from the mouth (the Lower Tunguska river) to the Nepavillage. The passenger traffic dominates mainly on Lake Baikal to Nizhneangarsk, Ust'-Barguzin and other settlements.

The tourism-oriented administration of the Irkutsk region and the Republic promotes the growth of passenger transportation. In the water area of Lake Baikal the largest port is the port of Baikal, as well as piers are in the villages Kultuk, Ust'-Barguzin and Nizhneangarsk.

The fleet involved in Lake Baikal transportations and in 2015 comprised on the classification record of the East Siberian Branch of the Russian River Register is represented by: 1) traveling, walking, search and rescue vessels; 2) dry cargo, passenger, expedition, scientific research vessels; 3) cargo and cargo-passenger ferries; 4) self-propelled tugs; 5) dynamically positioned vessel; 6) buoy tenders [4]. The largest ship owner, engaged in economic activities in the water area of Lake Baikal and the Angara river, is the "East Siberian River Shipping Company" (in 2015, 20 units of the fleet were operated, including passenger ships - 9, cargo-passenger vessels - 2, tugs - 1, dry cargo barges - 2, auxiliary vessels -2, 4 units of the racket fleet).

On the Lena river cargo and passengers are transported by OJSC "Lena United River Shipping Company" (328 units). Passenger transportation is effected from Ust'-Kutto Peledui by a subsidiary LLC "Lenaturflot".

Many navigable waterways ceased to be used in the post-Soviet period. Potentially suitable waterways for navigation, which were used earlier, are the following areas: in the Irkutsk region - Kirenga, Lena from Zhigalovo to Kachug, Vitim above Bodaibo, lower currents of the Chara, Zhuya and Mama; in the Republic of Buryatia-Selenga, the lower reaches of the Chikoi, Khilok, Barguzin and the Upper Angara, the upper and middle course of the Vitim at the border with Transbaikal region; in the Transbaikal Territory the Ingoda, Shilka and Argun'.

For population and economy of the Baikal region aviation transport plays an important role. This is due to the large area of the region, poor conditions for the construction of land communications (mountain relief, permafrost, high seismicity of the territory), and low population density. Air transport at long and ultra-long distances carries out passenger communications of the region with the cities of the European part of the country, Siberia and the Far East, and at short distances within the region with isolated areas and settlements that do not have other types of regular communication. In the last decades of the last century, due to uneven growth in tariffs, there have been changes in the structure of passenger transportation. A significant increase in the cost of air tickets led to the switching of passenger traffic to more affordable rail transport.

There are 14 airports operating in the Baikal region, including 9 airports in the Irkutsk region (Bodaibo, Bratsk, Erbogachen, Irkutsk, Irkutsk-2 (Vostochnyi), Kirensk, Mama, Nizhneudinsk and Ust'-Kut), 3 in the Republic of Buryatia (Nizhneangarsk, Taksimo and Ulan-Ude (Mukhino)), 2 in the Transbaikal Territory (Chita (Kadala) and Chara). The main share of air transportation is carried out by five international airports - Irkutsk, Ulan-Ude, Chita, Ulaanbaatar and Bratsk. There is direct communication of both domestic inter-regional air traffic (Moscow and other cities of Russia) and international (China, Japan, South Korea and Germany) through these ports. Prior to 1995, 72 secondary airports operated, 46 of which were transferred to the landing sites, and 22 were closed.

On the territory of the region pipeline transport is represented by the underground main oil pipeline Omsk-Angarsk (two lines), providing the West Siberian oil to the Angarsk petrochemical company; Petrochemical pipelines Angarsk-Irkutsk and Angarsk-Sayansk, intended for supplying respectively the aviation kerosene of the Irkutsk airport and ethylene for the enterprise Sayanskkhimplast, as well as the East Siberia-Pacific Ocean (ESPO) oil pipeline, through which oil is exported to the APAC countries.

The perspective development of transport in the Baikal region is determined by several documents approved by the government of the Russian Federation. The further development of transport and transport network of the Baikal region is connected both with an intensive use of its transit position between Europe and Asia on the basis of the existing railways, and with the construction of new railways and highways, oil and gas pipelines. According to the Transport Strategy of the Russian Federation for the period up to 2030, and the Strategy for the Development of Railway Transport in the Russian Federation until 2030, the following railways are planned to be built in the region: the eastern section of the North Siberian Railway Ust'-Ilimsk – Lesosibirsk–Nizhnevartovsk, the lines of Ust'-Kut – Kirensk – Nepa – Lena, New Uoyan – Mogzon, Naryn – Lugokan. The construction of the Priargunsk-Berezovskoye railway was started. Also one of the significant projects is the project of modernization and expansion of the capacity of the Trans-Siberian and Baikal-Amur Mainlines. At the Baikal-Amur Main Line, the construction of the second railway line has already begun on some sections. The construction of the Vilyui highway in the direction of Ust'-Kut – Nepa–Mirnyi will give the Republic of Sakha (Yakutia) another year-round access to the main road network of Russia. A draft of the pipeline "Power of Siberia" from the Kovykta gas condensate field was prepared, as well as gas pipelines from this field to Sayansk and Angarsk and oil pipelines from the northern oil fields (Verkhnechonskoe and others) to the main oil pipeline ESPO.

4. Conclusion

The compiled original of the transport map of the Baikal region was included in the "Ecological Atlas of the Baikal Region" in the form of an electronic resource on the geoportal "Atlas"[10]. The transport map is presented in both raster and vector form. The vector map layers on the geoportal contain the necessary database of transport indicators. Secondary transport-related sector maps of the region can be compiled using the basic digital maps.

The mapping of the transport network of the Baikal region has shown that the southern most developed and inhabited regions of the Baikal region have a developed transport network. In the northern regions inland waterways and air transport are of great importance. There are a number of intra-regional problems: weak development of the northern territories of the Baikal region; low density

of highways in comparison with the all-Russian; reduction of navigable sections of rivers; closing of airports or their transfer to temporarily operated landing sites. Solving these problems will improve the efficiency of the transport infrastructure.

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