Assessment and mapping of transport load in the central ecological zone of the Baikal natural territory to ensure tourism and recreational activities

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Abstract. Without a stable working transport infrastructure, intensive development of tourism and recreational activities is impossible; therefore, it is necessary to assess the possibilities of transport on the territory of the Central Ecological Zone of the Baikal Natural Territory (CEZ BNT). For this purpose, the author has analyzed the transport infrastructure in CEZ BNT within the boundaries of the districts of the Irkutsk Region. The author has studied in detail the main types of the transport system, their geographical location as well as infrastructure facilities of transport in the territory of CEZ BNT. Moreover, the author has assessed the functioning of transport in this area to ensure the development of tourism and recreational activities. The author has also analyzed the volume of transported passengers in the regular passenger routes and the number of transported passengers and vehicles on ferry crossings. The analysis of transport has identified some problems, the solution of which is necessary for better service to the population and the economy. In this regard, the author has proposed some recommendations for solving problems as well as scenarios for the optimal development of transport in the territory of CEZ BNT. For a more holistic analysis of the territory, geoinformational mapping of transport areas of the Irkutsk Region included in CEZ BNT has been performed, which shows the main types of transport (railways, highways and waterways), temporary accessibility to the regional center and main infrastructure facilities (gas stations, ports, wharves, airports, runways, and helipads).

1. Introduction
Transport is one of the most important components in the socioeconomic development of a country and its regions where the effective functioning of transport is an integral part. On the coast of Lake Baikal, the flow of tourists annually increases, and this creates a certain load on the existing transport system. According to many scientists [1–7], transport plays a huge role in the development of tourism. A comprehensive study of transport systems can be conducted productively using a geographic information system based on digital thematic maps [8].

2. Models and methods
Based on the experience of previous works [9–11], geoinformation mapping of the Central Ecological Zone of the Baikal Natural Territory (CEZ BNT) was performed.

There are following types of transport on the territory of CEZ BNT: rail, road, river, and air. The bulk of the work of transport is associated with passenger transportation, transportation of goods:
timber, coal, sand and gravel, and oil products, machinery and equipment, food, and consumer goods. Improving transport infrastructure is one of the main strategic directions for the development of the territory of the Irkutsk Region.

The railways on the territory of CEZ BNT within the Irkutsk Region are represented by a small section of the Transsiberian Railway with a length of 110.37 km and the Circum-Baikal Railway with a length of 89 km. They are part of the branch of OJSC Russian Railways – the East Siberian Railway. The Circum-Baikal Railway is single-track and non-electrified. Sightseeing trains from Irkutsk and electric trains from Slyudyanka to the settlement of Baikal also run along this railway.

The main share of local and interregional freight and passenger transportation is carried out by the road, on federal, regional, and local roads. The road network in this territory includes the federal highway R-258 Baikal (Irkutsk – Ulans-Ude), which runs parallel to the Trans-Siberian Railway, and a small section of the federal road Kultuk – Mondy, the border with Mongolia. In addition to these highways, in the central ecological zone, there are sections of regional roads of Irkutsk – Listvyanka (58.6 km), Irkutsk – Bolshoye Goloustnoye (114.1 km), Bayandai – Elantsy – Khuzhir (147.8 km), Togot – Kurna (28.6 km), Kosaya Step – Buguldeyka (40.9 km), and Petrova – Buguldeyka (29.7 km) [12]. There are also local roads that maintain villages and towns.

The connection of the settlements from these areas with the regional center by road is carried out by municipal transport and private carriers with regular trips en-routes: Irkutsk – Khuzhir; Irkutsk – Sahyurta; Irkutsk – Buguldeyka; Irkutsk – Listvyanka; Irkutsk – Bolshaya Rechka; Irkutsk – Kultuk; Irkutsk – Slyudyanka; Irkutsk – Maloye Goloustnoe; Irkutsk – Bolshye Goloustnoe; Shelekhov – Listvyanka; Angarsk – Khuzhir; and Angarsk – Listvyanka [13]. Departure from Irkutsk is carried out from both the bus station and the Central Market of Irkutsk. There are up to seven trips per day to Khuzhir, each taking approximately five hours, nine trips per day to Listvyanka, taking approximately one hour, and four trips per day to Slyudyanka, taking from one and a half to two hours.

During the period of freeze-up and thaw, transport links to the island of Olkhon are carried out by the Khivus hovercraft. This event is within the framework of the district’s authority responsible for local issues. In August 2017, Vladimir Putin at a meeting on the environmental development of the Baikal Natural Territory instructed to complete the road on the island of Olkhon.

In CEZ BNT, aviation is used in the implementation of geological research, forest conservation, aerial photography, agriculture, and some other sectors of the economy. Helipads are available in the settlements of Khuzhir and Listvyanka. In Soviet times, there was an airport in the Khuzhir settlement. Currently, it does not function, but there is a runway.

Shipping is carried out on Lake Baikal and the Angara River. The fleet currently deployed on Lake Baikal is represented by dry cargo, passenger, expeditionary, research vessels, freight and passenger-and-freight ferries as well as self-propelled vessels. In the waters of Lake Baikal and the Irkutsk reservoir, the largest shipowner involved in the carriage of passengers is OJSC East Siberian River Shipping Company (PJSC "VSRP"). PJSC "VSRP" has some structural divisions on Lake Baikal: the Baikal port (106.834 thousand m²) and the Kultuk marina (18.0 thousand m²) [14].

Passenger traffic by water is carried out by the following routes: Irkutsk – Taltsy - Listvyanka – Irkutsk (duration of one-way trip is three hours); Irkutsk – Cape Tolstoy (CBR) – Cape Polovinny – Irkutsk (two hours); Irkutsk – Listvyanka – B. Koty – Irkutsk (two and a half hours); Irkutsk – B. Peschanaya – the Baikal dunes – Irkutsk (four hours); and Irkutsk – Listvyanka – Zagli Bay – Khuzhir – Irkutsk (six and a half hours). In 2017, trips to Nizhnegansarsk and Ust-Barguzin did not operate. In 2018, a trip from Irkutsk to Tankhoi appeared, with a trip duration of two and a half hours. According to PJSC "VSRP", the most common is a trip to the Bolshiye Koty settlement. In 2017, 29.3 thousand people were transported there. The second most popular trip is Irkutsk – Bolshie Koty; 4.9 thousand people took this trip in 2017. In August 2016, after the commissioning of the cargo-passenger self-propelled ferry "Semyon Batagaev" to maintain the Sakhyurta – Olkhon ferry service, crossing capacity approximately in 2.5 times increased.

Every year, there is an increasing demand for cruise tourist ships plying along the western and eastern coasts of Lake Baikal with access to popular tourist sites: Olkhon Island, settlements Baikalsk,
Severobaykalsk, Nizheangarsk, Khakusy, Tompa, Davsha, Ust-Barguzin, Tankhoy, Gremyachinsk, etc. Eastland Group of Companies, one of the largest holdings in Eastern Siberia, transported more than 35,000 people in 2017: motor ship "Nikolai Eroshenko" – 404 people; "Empire" – 487 people; “Alexander the Great” – 219 people; pleasure motor ship "Babushkin" – 8520 people and 25541 people (walks along the Circum-Baikal Railway). Additionally, pleasure ply boats along the Irkutsk reservoir, the Lake Baikal coast and around Olkhon Island.

3. Results and discussion

Existing problems in the development of road infrastructure have a negative impact on the entire structure of the region’s economy. A large degree of depreciation increases transport expenses, creates conditions for a rise in the cost of manufactured products and services as well as tariff growth. The most problematic sections of the roads, which are in poor condition and, at the same time, attractive to tourists in the Irkutsk Region, are the Maloye Goloustnoye – Bolshoye Goloustnoye section of the highway, and the Kurma – Onguren section of the Olkhonsky District.

Several settlements on the territory of CEZ BNT do not have transport links with a hard surface to public roads with a hard surface.

Currently, the existing road network has some shortcomings, the solution of which will solve a whole range of social and economic problems. The main shortcomings include the low density of roads with a hard and improved surface, poor condition of the roadway; poor technical equipment of roads and lack of roadside service as well as the weak level of inter-district interconnections and transport links.

The construction of new facilities, an increase in traffic intensity and tourist arrivals by road in CEZ BNT led to the emergence of exits from roads by cars in the water protection zone of Lake Baikal, exit roads to the ice of Lake Baikal in the winter; destruction of the topsoil and damage to local landscapes; occurrence of spontaneously rolled dirt roads in the water protection zone of rivers and ponds as well as forest fund lands; violations of the rules for placing motor vehicles during construction and repair work.

The main point of basing water transport is the Baikal port in the Baikal settlement. The existing fleet of ships in the Baikal port as well as that assigned to Listvyanka and Khuzhir marinas have practically exhausted their resource and need to be replaced and modernized. The quays of the marinas are worn out and require major repairs.

Improving transport infrastructure is one of the main strategic directions for the development of the territory of the Irkutsk Region, which should be implemented both through the reconstruction and modernization of the existing transport network as well as the construction of new transport infrastructure facilities.

The prospective development of the transport complex in Russia and its regions is determined by several documents approved by the government of the Russian Federation as well as other documents concerning the long-term development of the Irkutsk Region. To ensure the necessary volume of freight and passenger traffic, it is important to take measures for the capital construction of new and reconstruction of existing infrastructure facilities for road, rail, air, and water transport.

One of the projects on the territory of CEZ BNT in the Irkutsk Region is the modernization and expansion of the throughput capacity of the Trans-Siberian and Baikal-Amur highways (JSC Russian Railways). In the future, a corridor is reserved for high-speed transport from the city of Irkutsk to the Listvyanka settlement at a distance of 65.5 km. To ensure an increase in freight traffic along the Trans-Siberian Railway, the construction of a third line is envisaged on the Bolshoy Lug – Slyudyanka section. To accelerate the transit traffic of trains, reconstruction of the Slyudyanka-2 station is envisaged. To ensure non-stop traffic, the construction of an overpass through railways in the area of Kultuk is in process. Furthermore, the modernization of the Circum-Baikal Railway is planned.

At present, the priority in the road industry is the construction, reconstruction and expansion of the road network with improved coverage as well as the provision with the maximum convenience in the transport movement of the population and the development of roadside service. The construction of
roads to settlements that are not linked to a network of public hard-surface roads is planned to continue.

It is necessary to organize a large parking lot for cars in front of the ferry quay in the Sakhyurta settlement to reduce the burden of the arriving transport. At the same time, it is necessary to increase the number of bus routes on Olkhon Island from the ferry to the Khuzhir and further to the north of the island.

4. Conclusion
We can conclude that the existing complex of transport infrastructure in CEZ BNT generally meets the needs of the population. The main settlements are located in the area of transport accessibility. Passenger traffic by road, rail and water transport cope with the tourist flow directed to the coast of Lake Baikal. However, there are some problems, the solution of which will significantly improve the transport infrastructure in CEZ BNT. The main efforts should be concentrated on the improvement of existing roads, the construction of parking lots in places of mass staying of tourists, the reconstruction of all ports and marinas, and the renewal of the ship fleet. All these measures will significantly improve the quality of services provided by transport as well as create new prerequisites for the further development of transport with environmental protection in CEZ BNT.

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