New Transport Project: Threats to the Regional Geosystem Diversity

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Abstract. Currently the China’s Belt and Road Initiative (BRI) attracts the attention of the rest of the world. Two transport corridors, the sea and the land routes, will link China with Europe. For Russia the transportation component of the BRI has gained special significance, because it will allow to unlock the export and transit potential of Russian economy. The eastern transport corridor crossing Transbaikalia is a very interesting project for the Trans-Baikal Territory. One of the priority directions of this project is the possible building of a high-speed railway (HSR). The study purpose is the assessment of the impact of HSR building on the regional landscapes in the context of a) identification and evaluation of risks of loss for the most valuable natural areas and b) necessity of inclusion of these areas in the existing network of natural protected areas. The spatial analysis performed using GIS technologies shows that the HSR project will affect 35% of diversity of the regional landscapes. Fragile natural complexes were revealed among them. Moreover, the greatest impact can be asserted on the “Dzeren Valley” Federal Reserve, a part of natural complexes of which will be covered by the 10-km impact zone. The measures to mitigate and to compensate the negative impact of the new transport infrastructure on the regional geosystems are suggested.

1. Introduction

In 2013 the Chinese leaders have launched “the Belt and Road” initiative (BRI) [1]. This initiative is a ground-breaking global strategy for achieving the “Chinese Dream” [2]. The BRI is undertaken as a “geo-functional institutionalist” project that increases its feasibility [3]. Two corridors forming the BRI, the Silk Road Economic Belt and the XXIst Century Maritime Silk Road, will link China with Europe. Despite the fact that BRI is aimed at solving problems of the Chinese economy [4], one of its objectives is «to connect Asian, European and African countries more closely and to promote mutually beneficial cooperation to a new high level and in new forms» [5]. China’s initiative attracts the attention of the rest of the world. Also, China invites to international cooperation all countries located in the zone of the land and maritime Silk Road Routes. According to the existing estimates [6, 7], the project will cover from 40 to 65 countries with 2/3 of the world population. In particular, the Silk Road Economic Belt (SREB) concept, as a part of the BRI, provides a comprehensive strengthening of trade-economic, transport, and logistical links between the countries of the Asia-Pacific region (APR). Moreover, an environmental aspect of this initiative is very important: environmental safety is a part of SREB strategy. The documents on SREB also clearly formulate environmental goals, “the core
ideology is to respect nature, to follow nature, and to protect nature, and to drive human sustainable development” [8, p. 69].

This project includes a large number of components [9]. For Russia the transportation component of the BRI has gained special significance, because it will allow to unlock the export and transit potential of Russian economy. One of the tasks in this regard is the China intendance of early modernization of the Trans-Siberian and Mongolian Railways [4], the creation of eastern transport route, which will serve customers in north-eastern and eastern China via Manzhouli checkpoint and the Trans-Siberian Railway. Accordingly, the project is very interesting for Russia and Transbaikalia in particular. A priority direction of cooperation is the creation of the infrastructure that will link APR member states (China, Russia, and Mongolia). In the first place the possibility of building a high-speed traffic artery is being considered.

The Trans-Baikal Territory (TBT) is located in the south of Eastern Siberia, far away from sea transport routes and borders with China and Mongolia. In terms of nature it is a mountainous land [10-11], which is located in a region of intense response to climatic changes [12], of high landscape and biological diversity [13]. At the same time, the area has a special biosphere value: most of it is located within three globally significant eco-regions identified according to Global 200 initiative of the World Wildlife Fund [14]. Therefore, the risk assessment for natural complexes during high-speed railway (HSR) construction is an urgent task.

The study purpose is the assessment of the impact of HSR building on the regional landscapes in the context of a) identification and evaluation of risks of loss for the most valuable natural areas and b) necessity of inclusion of these areas in the existing network of natural protected areas (NPAs).

2. Methodology
The task to identify risks for natural geosystems from HSR project implementation in the region was divided into 2 parts:

- to identify which natural systems of the region are most likely to be affected or changed, to analyze whether these areas are included in the existing network of NPAs;
- to determine whether the existing and planned protected natural areas of TBT will be significantly affected.

The task was solved in the GIS application – ArcGIS for Desktop, by using both typical (such as overlay and proximity analysis, buffering) and specially created authoring tools – geoprocessing models (cumulative effects analysis, surface creation and analysis) [15, 16, 17].

In ArcGIS, we built an impact zone along the planned HSR 10 km wide. It was constructed as a buffer zone of 5 km from the both sides of the planned transport facility.

Moreover, to obtain qualitative and quantitative landscape assessments we calculated some spatial parameters for each landscape (numbered \( i \)) such as:

- its total area within HSR impact zone (\( S_{i,HSR} \)),
- its total area in the Trans-Baikal Territory (\( S_{i,TBT} \)),
- share of its total area within HSR impact zone in its total area in TBT (\( d_{i,HSR} = S_{i,HSR} / S_{i,TBT} \)),
- share of the total landscape area in the total area of TBT, which characterizes the landscape rarity (\( r_{i,TBT} = S_{i,TBT} / S_{TBT} \)),
- its total area within actual NPAs in TBT (\( S_{i,ac,NPA} \)),
- share of the landscape in actual NPAs in TBT (\( d_{i,ac,NPA} = S_{i,ac,NPA} / S_{ac,NPA} \)), which characterizes the landscape representation in the existing network of NPAs,
- its total area within projected NPAs in TBT (\( S_{i,pr,NPA} \)),
- share of the landscape in projected NPAs in TBT (\( d_{i,pr,NPA} = S_{i,pr,NPA} / S_{pr,NPA} \)), which characterizes the landscape representation in the projected network of NPAs.
The spatial analysis was performed using some vector thematic layers of the map “The Landscapes of the South of the Eastern Siberia” of 1: 1 500 000 scale [18], existing NPA network circuits and designed protected areas in Trans-Baikal Territory. In addition, the results of the authors’ earlier studies were used for the landscapes evaluation and classification [13, 19, 20].

3. Results and discussion
The Trans-Baikal section of the high-speed trunk-railway (according to the one of the most promising options) will pass along the existing railway line, starting from Zabaykalsk Station, to the City of Chita and further to the City of Petrovsk-Zabaykalsky. According to the physical and geographical zoning scheme, HSR line crosses Central Asian desert-steppe region and two South Siberian mountainous area provinces – Ingoda-Onon basin midmountain area and Khilok-Udinsk steppizated midmountain area [11].

3.1. Analysis of the HSR impact on landscapes
Performed spatial analysis allowed us to distinguish landscapes and protected areas falling into the impact zone. As a result, we discovered that, according to the landscape map [18], 43 of 122 geosystems fall in this zone. This is 35% of the landscape diversity forming the landscape structure of TBT. Hereinafter the names of landscapes classes and their numbers (indicated in brackets) are given in accordance with the landscape map [18].

The spatial analysis allowed us to identify 5 rare landscape types, 6 landscape types that are not included in the existing network of NPAs, and 3 geosystem types, the total share of which in the Trans-Baikal network of NPAs is less than 2%. For these natural complexes there is the greatest threat to be lost as a result of HSR construction and economic activity intensification, which it induces.

Thus, Rocky slope short-grass and Artemisia lithophile (198) and Folds bottoms, low-bushgrass spotted in combination with halophytic-meadow (217) landscapes, very rare for TBT, were observed in the impact zone among steppe geosystems. The latter ones are sufficiently represented in other areas of TBT, but the extinction danger of the first one is amplified by the fact that their share within HSR impact zone will be 72% of their total area in TBT ($d_{HSR}^i$). Basins bottoms (piedmont) tallgrass feather-wheat grass (202) landscape, 95.7% of which in Transbaikalia fall in the planned HSR impact zone, are fragile.

Among boreal landscapes, the most typical geosystems are slope larch, larch-birch and larch-pine forests with mixed undergrowth. In TBT there is a very limited number of the analogues of Southern Siberia natural geosystems (dark coniferous and pine subtaiga geosystems) and representatives of the Amur-Sakhalin subtaiga area. The planned impact corridor will cover the territory of the valleys, alluvial cones, lower parts and foot of the slopes, so here we deal with a number of geosystems, stenotopic in TBT. Slope larch pine grass-cowberry landscapes also fall in the HSR impact corridor. They are the rarest of TBT taiga geosystems because they cover only a very small proportion of TBT – less than 0.01%, 99% of which fall in the impact corridor of the planned HSR. Transbaikalian rare landscapes also include formations of Amur-Sakhalin landscapes. The impact zone contains a parcel of piedmont subtaiga birch landscapes of Dahurian type with meadow steppes and bushes, but its share in this geosystem total area in TBT ($d_{HSR}^i$) is 1.1%. And it is almost completely affected by human activities so far.

In addition, among the taiga geosystems all completely or partially pine landscapes have a special natural and economic value. These landscapes have limited distribution, in Transbaikalian landscape structure their share ranges from 0.16% to 1.55% [13, [21]]. The greatest risk in the result of the new project implementation exists for plain and valley subtaiga pine landscapes with Dahurian rhododendron undergrowth. They represent pine forests, limitedly located along the sides of the river valleys confined to sandy soils. The planned transport corridor covers about 25% of these landscape areas in TBT ($d_{HSR}^i$). According to estimates, from 60 to 80% of their area were subjected to cutting downs, fires or were allocated for construction of buildings [22, [23]]. For this reason their territory in
the HSR impact zone cannot be included in NPAs of TBT. Consequently, it is necessary to find other parcels of these landscapes that remained the most pristine.

Increasing social and economic effect of population growth and urbanization lead to increased burden on landscapes and their subsequent fractures. It is so-called delayed construction effect which must also be taken into account when predicting the load on the region ecosystems and planning of environmental protection measures. In general risk of loss for natural complexes decreases if a landscape is widespread and it considerably decreases if landscape is included in the network of the NPAs. Thus, as a GIS analysis result, we identified 6 types of taiga landscapes as widespread geosystems. There are the following facies classes of landscapes: Planed surfaces with mixed undergrowth, with a predominance of bushy birches (47); Slope drift deluvium with mixed undergrowth (48); Flat surfaces with dumetosous undergrowth (73); Slope, with dumetosous undergrowth, with a predominance of Dahurian rhododendron (74); Slope grassy steppe (76) and Slope with an admixture of pine and an undergrowth of Dahurian rhododendron (79).

To landscapes adequately represented in the existing NPAs we identified only three types of taiga and subtaiga landscapes (Slope with cedar and mixed undergrowth (58), Larch piedmont elevations with birches and herbal dumetosous undergrowth (88), Terraces and trails with rare herbal undergrowth, sometimes steppizated (92)) and two types of steep landscapes (Slope salsoloetum-gramineous (200) of Mountainous Trans-Baikal of Dahurian type and Gently slope salsoloetum-feathergrasses combined with fescue steppes (214) of High Plains and Denudation Outliers Onon-Argunsk gemicyrophile formation.

In addition, the proportion of protected parts of two more landscapes can be increased to the optimum size by including them in the projected NPAs. There are Slope larch pine with mixed undergrowth facies class (126) of Mountain taiga South Siberian formation and Gentle slope (in depressions) cleistogenes-anenuolepidium facies class (216) of High Plains and Denudation Outliers Onon-Argunsk gemicyrophile formation.

Moreover, there is a need to expand the NPA network. This can be done by including in it the following landscapes primarily: Valley, of wetland meadows combined with swamps and bushy birches class (71) of Intermountain depressions and valleys, larch taiga, of limited development formation; Valley dumetosous meadows facies class (85) of Piedmont and intermountain depressions of larch taiga, of optimal development formation and Valley steppizated meadows class (138) of Piedmont subtaiga pine formation. These landscapes are least represented in the existing and projected NPAs of TBT. This can be explained by the geomorphological features of the Trans-Baikal Territory, as a result of which valleys and intermountain depressions are the main islands of settlement and economic development [[24]].

On our opinion, in the implementation of this project as compensation measures, all geosystems considered above should be included in the network of NPAs. These are (a) all rare landscapes, (b) landscapes, that are not yet represented in the regional NPA network, (c) landscapes, the share of which in existing regional NPA network of the is less than 2%.

3.2. Analysis of the HSR impact on specially protected natural territories

The current network of specially protected natural territories of TBT includes 91 NPAs of different categories: 3 national parks, 2 reserves and 2 state nature reserves of federal status; 17 state nature reserves of regional status; 2 nature parks and 65 natural monuments. In accordance with the Concept of development of the NPA system of regional status in the Trans-Baikal Territory (2016), the creation of some new NPAs of various categories is planned. This Concept includes the NPAs located in the immediate proximity to the considered transport project.

The new transport infrastructure does not cross the boundaries of any existing NPAs [20]. But in the proximity to it there are some protected areas in which risk of reduction of their environment formation and, consequently, of natural protection functions exists. These are the “Daursky” State Nature Biosphere Reserve (northern cluster and “Adon-Chelon” area), the “Dzeren Valley” Federal
Reserve, 1 reserve of regional status, 1 natural park, 14 natural monuments, and 3 recreational facilities (resorts and health and recreation areas).

Spatial analysis has shown that the greatest impact can be asserted on the “Dzeren Valley” Federal Reserve since in the buffer zone of impact there will be 88.5 km$^2$ of its area. The “Ivano-Arakhleysky” natural park (0.33 km$^2$ of its area) and the “Ichthyocenososes of Onon River” projected regional reserve (its extreme north-eastern section with area of 4.88 km$^2$ will also be covered by the 10-km impact zone). This zone will cover 10 landscape facies classes that are located in these protected areas. These are Slope mesophitic mixed herbs fescue-feathergrass (199), Slope salsoletum-gramineous (200), High denudation sur-faces, prairie herbal-tansy (210), Flat interfluve mixed feathergrass (213), Gently slope salsoletum - feathergrass combined with fescue steppes (214), Folds bottoms, low bunchgrass spotted in combination with halophytic meadow (217), Lowland meadow iris combined with aneurolepidium-steppes and salt marshes (218), Valley meadow-bog, sometimes saline (219); and Planed surfaces with mixed undergrowth, with a predominance of bushy birches (47), Slope, with dumetosous undergrowth, with a predominance of Dahurian rhododendron (74) facies classes of boreal landscapes.

Thereby, there is no safety guarantee for ecosystems under numbers 217 and 218 since the risk of their loss increases.

4. Conclusions and recommendations
Certainly, the creation of new transport infrastructure will reduce the diversity of the regional landscape structure. In order to avoid the loss of some landscapes and their environmental functions in the existing regional NPA network, a number of compensatory measures is needed. These are:

all landscapes rare for TBT that are not represented in the existing NPAs should be excluded from planned transport corridor as well as those of landscapes, the share of which in existing regional NPA network of the is less than 2%;

to include in the Comprehensive scheme of development of the Transbaikalian NPA network the following geosystems: Flat with undergrowth of Dahurian rhododendron facies class (132) of Piedmont subtaiga pine formation; Valley dumentosous meadows facies class (85) of Piedmont and intermountain depressions of larch taiga, of optimal development formation; Slope pine-larch cowberry forb facies class (81) of Intermountain depressions and valleys, larch taiga, of limited development formation; Rocky slope short-grass and artemisia lithophile facies class (198) of Mountain Western Tans-Baikal of Dahurian type;
to provide at the planning stage that the HSR route passes only through the areas previously affected by anthropogenous influence..

The authors believe that the proposed measures implementation will reduce threats of the regional landscape diversity reducing and will contribute to sustainable economic development of the territories adjacent to the transport corridor. And it will allow us to hope that the new transport infrastructure project of “the Belt and Road” initiative will be a way to the “green” economy for the Trans-Baikal Territory [[25], [26]].

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