

Stability of landscapes in the areas of creation of economic corridors "China-Mongolia-Russia"

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Abstract. The article considers assessment and mapping of landscape sustainability in the zone of creation of economic corridors "China - Mongolia - Russia". Research was carried out within the borders of Mongolia and the Baikal region of Russia. Various natural and transformed landscapes are presented here. We should expect an increase in their transformation within the economic corridors in the creation of transport and infrastructure complexes. There is a need to determine the permissible level of negative impact of anthropogenic factors. We developed a model that reveals the directions, structure, stages and results of research in their logical sequence. The assessment and mapping of the sustainability of landscapes is based on the interpretation of landscape maps. The research was carried out on regional and topological level. For each level, the taxonomic rank of the assessed landscape, types of impacts, types of sustainability, a system of indicators and criteria are determined. For the calculations the scoring method was used. The characteristic of landscapes and their general stability for Mongolia and the Baikal region is given for all territory, but in the economic corridor China-Mongolia-Russia these characteristics are given more detailed. Prospects and directions of further research work are determined.

1. Introduction

The strategic goal of creating economic corridors is to create conditions for the development and expansion of tripartite cooperation between the People's Republic of China, Mongolia and the Russian Federation through joint projects aimed at increasing trade turnover, ensuring product competitiveness, facilitating transboundary transportation, infrastructure development, and environmental protection. The implementation of the Program for the Creation of Economic Corridors and its constituent projects will strengthen the trade and economic cooperation of the three states, and contribute to the creation of transport and infrastructure complex and socio-economic development of the transboundary regions. However, the development of the territory will lead to an increasing anthropogenic impact on the environment and intensification in landscape transformation. Therefore, there is a need in environmental measures, which require information on landscape state and their resistance to anthropogenic pressures. Landscape stability is the most important indicator which can determine the permissible level of anthropogenic impact, followed by irreversible changes in the natural environment. The paper considers research methods and obtained results presented by conjugate landscape stability maps of regional and topological level.

Based on the indices of landscape stability to anthropogenic pressure, standards of permissible impact can be determined. These standards are taken into account in environmental design,



environmental impact assessment in the construction and operation of enterprises, facilities and other objects.

2. Models and methods

A model has been developed that gives an interpretation of the landscapes with respect to the properties of stability. The model simplifies the most significant aspects of such a study. The model presents two series of blocks representing the regional and topological levels of the study. The map is a model of the phenomena under study is presented in this system as the main research tool. The map provides visibility of perception, visual distinguishability of elements and details of the cartographic image, ability to see the main patterns of location and interrelation of objects, the main elements of their structure. The map serves as a tool for understanding the structure and functioning of the landscapes represented on it, their interpretation with respect to their stability.

We used remote methods in creating maps. Their application provides the regularity and fast obtaining reliable information on a large territory, which enables dynamics monitoring. Degree of anthropogenic transformation and the stability of landscapes was determined using scoring method. A promising research is the use of digital terrain models, which allow quantifying the morphometric parameters of the relief and exogenous geological processes.

3. Results and Discussion

On the basis of the conducted studies, two conjugate maps of landscape stability of regional and topological levels were compiled.

3.1. *The map of landscape stability of regional level of Mongolia and the Baikal region*

The initial map information is the landscape maps [1]. Mapping the landscape stability is a continuation and deepening of previously performed works in this direction [2]. This map represents sustainability of regional geographic landscapes (table 1). A geom is the lowest subdivision of geomers of regional dimension, uniting classes and facies groups of a certain zone or belt affiliation [3]. The stability of geoms is determined by the level of natural ecological potential of landscape, based on the index of biological efficiency of climate [4].

The natural ecological potential of landscapes provides population with a favorable habitat. Various components of the landscape participate in the formation of landscape ecological potential. However climatic factors determined by the optimal ratio of heat and moisture are of particular importance.

The integral index of heat and moisture availability is the index of biological effectiveness of climate proposed by N.N. Ivanov. This indicator represents the product of the annual sum of air temperatures above 10° C by the wetting factor (the ratio of annual precipitation to annual volatility). Depending on the size of this indicator landscapes are distributed according to the level of ecological potential: 4 or less - very low, 4-8 - low, 8-12 - moderate, 12-16 - relatively high, 16 - 20 - high.

According to the index values of biological effectiveness of climate and ecological potential, landscapes are divided into five ecological groups, which are assigned the appropriate values of stability, ranked on a five-point scale. The sustainability potential is a universal indicator for natural and anthropogenic factors of influence and therefore such stability is considered to be general.

In the landscape structure of the Baikal region and Mongolia, there are mountain-taiga and mountain-hollow steppe landscapes consisting of 16 geoms.

The compiled map represents territorial diversity of these landscapes and degree of their potential sustainability. Mountain and foothill taiga and mountain-hollow steppe geoms of medium-level stability, which occupy most of the territory, dominate in the landscape structure. North-Asian alpine landscapes with the lowest stability and foothill-taiga and south-taiga with the highest one are represented by a small number of geoms, but are relatively wide-spread. Within the economic corridors in the quantitative and spatial sense foothill taiga and mountain taiga landscapes of effective development prevail with a higher value of stability than in the whole territory.

Table 1. Landscape stability of the Baikal region and Mongolia.

North-Asian alpine, taiga and steppe				Central Asian steppe	
North-Asian alpine and subalpine	Mountain-taiga of Baikal-Dzhugzhur type	Plains-highlands Middle Siberian	Steppes	Mountainous western Siberian and northern Mongolian	High plains of denudation buttes Onon-Argun
I class , the most unstable, ecological potential is very low, index of climate biological effectiveness - 4 and less					
1. North-Asian alpine type and mountain tundra					
II class , unstable, ecological potential is low, index of climate biological effectiveness 4-8					
2. Mountain-taiga of reduced development		3. Intermountain depressions and plains taiga of reduced development		4. Plains and bottoms of depression steppe-meadow cryogenic meadow-boggy	
III class , moderately stable, ecological potential is medium, index of climate biological effectiveness 8-12					
6. Mountain-taiga of reduced development		7. Piedmont intermountain depressions and plains taiga of reduced development		8. Mountain steppe	
				9. Piedmont plains and bottoms of depression steppe meadow-bush	
IV class , stable, ecological potential is relatively high, index of climate biological effectiveness 12-16					
11. Mountain-taiga of effective development		12. Pine coniferous	13. Piedmont meadow-steppe		14. Plain and valley steppe
V class , especially stable, ecological potential is high, index of climate biological effectiveness 16-20					
15. Piedmont taiga of effective development and subtaiga		16. Southern taiga			

The stability of geoms of landscapes of regional level is considered as a background, as these geosystems constitute a regional landscape-ecological background and a subject to the general geographic patterns of landscape-forming processes. Therefore, background stability is taken into account when correcting geosystems of topological level - groups of facies forming a geom. At the regional level it is possible to reduce the stability of the Central Asian steppe landscapes located at the edge of their area, separated by the North Asian alpine-taiga landscapes [5].

3.2. Map of the landscape stability of topological level of the key site

A system of assessing indicators was developed, which formed the basis for the map of landscape stability to anthropogenic impacts on the key site (figure 1, table 2).

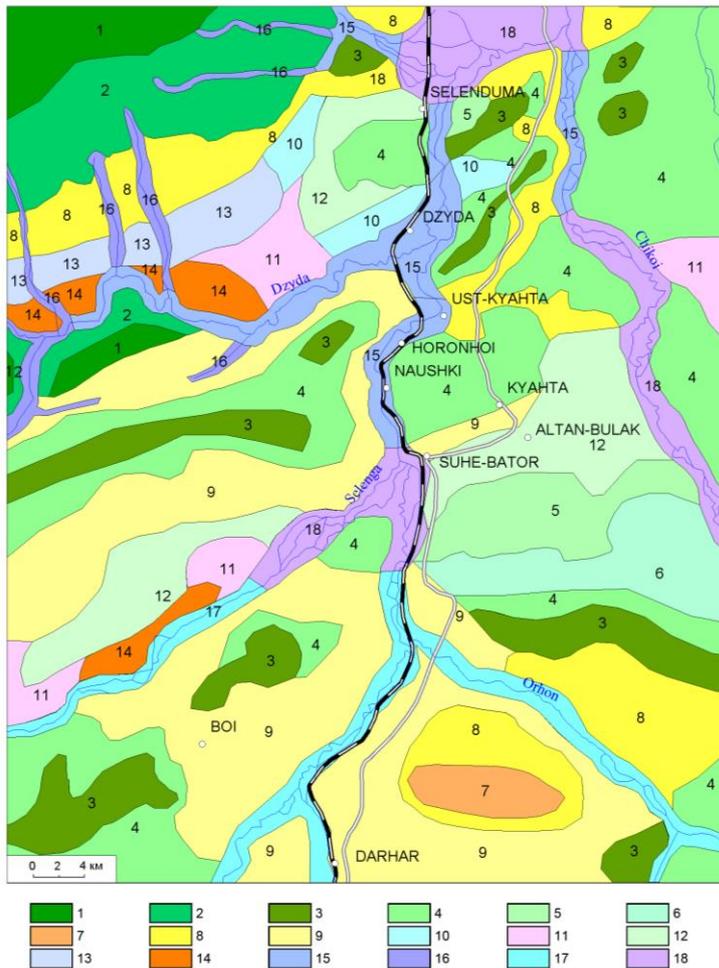


Figure 1. Landscapes stability to anthropogenic impact within the economic corridor of the transboundary territory of Buryatia and Mongolia. The stability of landscapes in table 2.

North Asian alpine-taiga

Baikal-Dzhugdzhur mountain-taiga

Mountain-taiga larch forests with Siberian pine and Siberian dwarf pine in the undergrowth of limited development: 1. Deplanate and weakly dissected tops of pine-larch with Siberian pine shrubby-moss, with an undergrowth of Siberian dwarf pine on podburs, podzols and cryozems (I- indigenous). 2. Flat and medium steepness of pine-larch slopes with Siberian pine grass-shrub on soddy-podzolic soils, brown soils and podburs (P-pseudoindigenous).

South Siberian mountain-taiga

Mountain-taiga pine with larch with rhododendron in the undergrowth grass-shrub of effective development: 3. Deplanate and weakly dissected tops pine-larch surfaces with Siberian pine grass- shrubs on podburs podzolized (I). 4. Sloping larch-pine grassy slopes with rhododendron on sod podzolized podburs (M). 6. Steep deeply dissected slopes pine-larch steppe and forest-steppe on eroded low-power chestnut soils and lithozems (C-series).

Central Asian steppe

West Transbaikalian Daurian type mountain steppe: 7. Deplanate tops steppe on chestnut soils (I). 8. Gentle steppe slopes on chestnut and chernozemic soils (P). 9. Steep, deeply dissected slopes of dry steppe on eroded soils and lithozems (S).

North Mongolian Khangai type hollow-steppe and dry steppe: 10. Plains accumulative dry steppe on chestnut and chernozemic soils (I) 11. Plains eluvial-accumulative halophytic (P). 12. Gentle slopes and terraces of erosion-accumulative steppe on chestnut soils with areas of water and wind erosion (P, S). 13. Elevated gentle-inclined plains erosion-denudation meadow-steppe on low erosion chernozems and chestnut soils (P, S). 14. Denudation buttes in the bottoms of hollows on lithozems (S).

Valley azonal

Mountain rivers: 15. Valleys of small and medium rivers with steep slopes and underdeveloped flood plain erosion (S) 16. Antecedent narrow deep valleys of large rivers with steep slopes on the areas of growing uplifts erosional (S).

Plain rivers at the bottom of the hollows: 17. Erosion-accumulative with underdeveloped floodplain (S). 18. Accumulative with a developed floodplain and wide meandering channels (S).

Table 2. Landscapes stability to anthropogenic pressure of the key site (fragment).

Landscapes (groups of facies), landscape numbers correspond to figure 1	Stability indicators												Points	
	Geological and geomorphological					Soil-ecological		Ecological-climatic		Landscape and environmental			Amount of simple numbers	Integral evaluation
	Gc	Ss	Rf	Fc	Cs	Hr	Hf	Fh	Eb	Cd	Tt	Gc		
<i>North Asian alpine-taiga</i>														
Mountain-taiga of Baikal-Dzhugdzhur type														
Mountain-taiga larch with Siberian pine and Siberian dwarf pine in undergrowth of limited development (area stability – III points*, according table 1)														
1 Deplanate and flat tops	5	5	5	4	3	4	3	2	5	4	5	5	45	V ²
2 Flat slopes and of mean steepness	5	4	4	5	2	4	3	3	5	4	4	5	48	IV ¹
<i>South Siberian mountain-taiga</i>														
Mountain-taiga pine-larch rhododendron of effective development (area stability – IV class)														
3 Deplanate and flat tops	5	5	5	5	3	5	5	4	5	5	5	4	56	V ¹
4 Flat slopes and of mean steepness	5	4	4	5	3	5	5	4	4	5	4	4	52	V ¹
5 Piedmont plains	3	4	5	4	5	3	3	5	4	3	3	4	46	III ⁴
6 Steep slopes	4	1	1	2	3	1	1	3	2	2	1	4	25	I ⁶
<i>Central Asian steppes</i>														
Transsiberian Daurian type and North Mongolian Khangai type mountain-hollow														
Mountain-steppe (area stability – III class)														
7 Deplanate and flat tops	5	5	5	5	5	3	2	4	2	3	5	3	47	V ²
8 Flat slopes and of mean steepness	5	4	4	4	5	3	3	3	2	4	3	3	43	IV ¹
9 Steep slopes	4	1	1	1	5	1	1	1	1	1	1	2	20	I ⁵
Hollow steppes and dry steppes (area stability – III class)														
10 Plains accumulative dry steppes	3	5	5	5	5	5	5	4	2	4	5	3	51	V ²
11 Plains alluvial-accumulative halophytic	2	5	5	4	4	3	3	3	2	2	2	2	33	III ³

Stability indicators: geological and geomorphological (Gc - ground conditions, Ss -steepness of the slopes, Rf - vertical fragmentation of the relief, Fc - factor of the territory cover by exogenous geological processes, Gc - geocryological conditions), soil-ecological (Cs - capacity of soils, Hr - humus reserves), ecological-climatic (Hf - hydrothermal factor, Fh - factor of humidifying), ecological-landscape (Eb - biological efficiency, Cd - dynamic categories, Tt - factor of anthropogenous territory transformation).

Quantitative assessment of stability degree, points, for individual indicators (1) and in integral expression (I) - 1 (I) - lowest, 2 (II) - low, 3 (III) - medium, 4 (IV) - high, 5 (V) - highest.

The integral evaluation of stability degree, determined from the intervals of total values of simple points: I - ≤ 25; II - 25-32; III - 32-39; IV - 39-45; V is ≥ 45.

***Correction of facies group stability with respect to background stability of geoms:**

¹it is possible to reduce stability by 1 class;

²it is possible to reduce stability by 2 class;

³without change;

⁴it is possible to increase stability by 1 class;

⁵it is possible to increase stability by 2 class;

⁶it is possible to increase stability by 3 class.

The key site is located within the economic corridor Ulan-Ude-Ulaanbaatar-Beijing within the transboundary territory of Russia and Mongolia. These are the areas of the Selenginskii (South Buryatia) and Orkhon-Selenginskii (Northern Mongolia) middle mountains, in the zone of development of the Transbaikalian depressions. The depressions and the ridges separating them determine the landscape structure of the territory. The key site is located in the ecotone zone, where

penetration and interaction of the North Asian alpine-taiga and Central Asian steppe geosystems occur.

We revealed that the highest stability degree is characteristic of the indigenous mountain taiga and steppe landscapes of deplanate tops and bottoms of hollows. The most unstable are the serial landscapes of steep, deeply dissected mountain slopes.

The stability evaluation carried out at the regional and topological levels is probabilistic. It is necessary to expand the depth of research with a more detailed level of elaboration on the basis of data obtained during engineering surveys [6].

Modernization of transport systems will be accompanied by additional environmental pressures, leading to increased dependence of Mongolia and Russia on raw materials exports [7].

4. Conclusion

Landscape stability evaluation, carried out on two levels, reveals different sides and stability properties, complementing each other. Area stability is determined at the regional level, which is taken into account when solving socioeconomic and environmental security issues of the entire transboundary territory. At the topological level landscape stability within the corridor is detailed.

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