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Technogenic Impact of Mining Industry on Natural and Social Spheres in Areas of Passage of Economic Corridors “China–Mongolia–Russia”

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Abstract—**The anthropogenic impact of mining industry on the environment and population is considered. Considerable attention is paid to the environmental safety of human life in terms of the toxicity of mineral raw materials mined in the areas of the “China- Mongolia-Russia” economic corridors. The objects of study are municipal districts and aimaks, through which the Trans-Siberian Railway, the Ulan-Ude-Ulan-Bator railways to the border with China and Karymskoe-Zabaikalsk pass. The study was conducted in accordance with the model presented in the previous article in this publication. A feature of our approach to solving the tasks is the use of the cartographic method as a tool and the result of the study. According to the developed system of indicators, an assessment of the technogenic load on a person is given, an integral map of the anthropogenic impact of mining production on the environment and population is compiled.**

Keywords—research model; economic corridors; mining industry; environment; technogenic load; transboundary territories; ecological maps

I. INTRODUCTION

In the context of economic sanctions and aggravation of relations with Western countries, the Eastern vector of development of Siberia and the Far East, aimed at cooperation with the countries of the Asia-Pacific Region (APR), is becoming increasingly important. In this regard, it is assumed that the modernization of transport communications will lead to an increase in investment in areas adjacent to economic corridors. This may lead to a possible increase in the dependence of Mongolia and Russia on exports of raw materials to China and the deterioration of the ecological status of the regions and hamper the transition to the sustainable development of the Baikal region [1-3]. The study was aimed at creating environmental safety areas, which requires an assessment of the anthropogenic impact of the mining industry, taking into account the toxicity of the extracted raw materials and products of its processing. To solve these problems in accordance with the accepted model of the study, we have compiled three maps.

II. RESEARCH METHODS

The studies used in this work are aimed at solving the basic problem of mountain ecology – the interaction of mining production and the environment [4].

This publication is the development of our research in the field of environmental safety of the development of mineral deposits [5, 6] and the continuation of work on the creation of economic corridors, discussed in the previous article of this publication. We consider various indicators of the ecological status of municipal areas and aimaks, such as the density of disturbances, man-made stress per person, and others, including those associated with the toxicity of the extracted raw materials. These indicators were obtained by analyzing the environmental situation at the mining sites (disturbed land area, type and toxicity of raw materials, method of mining) and extrapolating these data to territorial units of a certain rank. As such, the municipal districts and aimaks, through which the economic corridors pass, are considered. When mapping used the method of scoring. Qualitative indicators are evaluated in absolute values, and quantitative – in relative values, which allows for their comparative analysis and use for an integrated assessment.

III. THE RESULT OF THE STUDY

A specific feature of the work carried out is the use of the cartographic method of research - the method of using maps to study the laws of the spatial distribution of phenomena, their interconnections and development [7, 8]. The maps below are a tool and the main result of the study.

When mapping, the main estimates were the areas of disturbed land that arose during the extraction of raw materials of varying degrees of toxicity (Table 1).

TABLE I. THE TOXICITY OF VARIOUS TYPES OF MINERAL RAW MATERIALS, PRESENTED IN THE STUDY AREA (ACCORDING TO [9])

Raw	Toxicity
non-metallic raw materials (mica, magnesite, perlite, zeolite)	low
placer gold, tungsten, tin, plaster	moderate
black and brown coal, iron ore, talc, increased salts	increased
ores of non-ferrous and precious metals, fluorite	high
rare metal and radioactive ores, antimony	very high

On the map (Fig. 1), an environmental assessment of areas according to the toxicity criterion is given by the quantitative background method. It was determined by summing the private estimates obtained as a result of multiplying the toxicity class of the extracted raw materials and weight indicators - the share of areas disturbed during the extraction of raw materials of this toxicity. Stacked diagrams visually show the structure of violations according to the specified toxicity scale (Table I). The size and color of the elements of the diagrams reflect the spatial structure of man-made disruptions that have arisen during the development of minerals of certain toxicity.

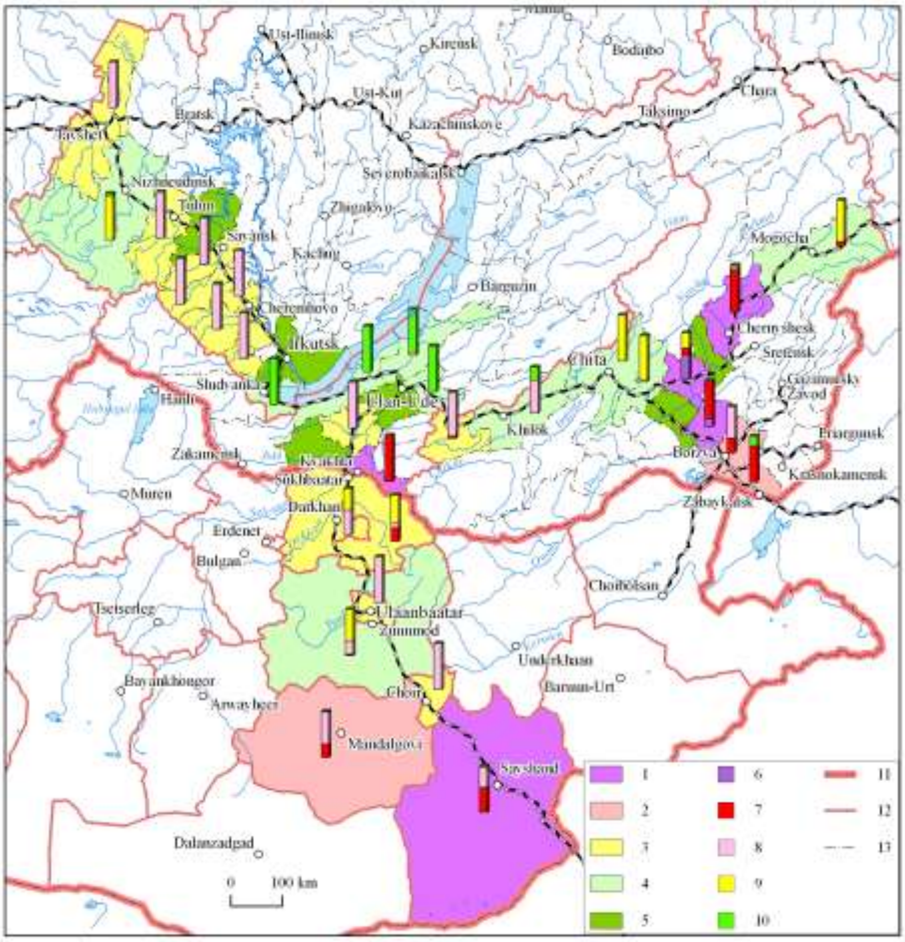

Fig. 1. “Toxic” hazard.
Toxicity in areas (aimaks): 1 – very high (more than 3.5), 2 – high (3.0–3.5), 3 – medium (2.5–3.0), 4 – low (1, 0–2,5), 5 – no violations identified. The toxicity of the main and associated raw materials: 6 – low, 7 – moderate, 8 – increased, 9 – high, 10 – very high. Borders: 11 – state, 12 – subjects of the Russian Federation, aimaks, 13 – municipal areas.

In general, in the study area, the toxicity of the toxic elements is low - as a result of the extraction of raw materials of a very high degree of toxicity, 2% of the land was disturbed, and high - 12% (Table II).

TABLE II. THE SHARE OF LAND DISTURBED IN THE PROCESS OF MINING OF VARIOUS TOXIC LEVELS IN ECONOMIC CORRIDORS WITHIN REGIONS,%

Regions / toxicity of extracted raw materials	**Mongolia**	**Trans-Baikal Territory**	**Republic of Buryatia**	**Irkutsk region**	**For all regions**
Low	-	-	21	3	2
Moderate	50	45	-	13	36
Increased	35	30	78	84	48
High	15	20	1		12
Very high	-	5	-	-	2

Practically all enterprises specialized in the extraction and processing of toxic raw materials are located in the Trans-Baikal Territory (Trans-Baikal, Zhireken, Sherlovogorsky GOKs, Davendinsky, Bom-Gorkhonsky, Kalanguysky mines, etc., currently most of them are suspended) and Mongolia (Har Ayrag, Urgen, Galshar mines and others). Waste from the production of existing and mothballed enterprises has a strong negative impact on the environment and humans. So, after the elimination of Sherlovogorsky mining and processing plant, there were left pits and pits, ore depots, overburden heaps, enriched with ore elements, which are exposed to water and wind erosion. The content of toxic chemical elements in soils and tailing reach, respectively (g / t): As 100 and 825-1000, Pb 70-340 and 2600-1850, Zn 100-1200 and 2950-5200, Cd 3.7 and 37.5, Sn 46 and 640. The contents of these elements exceed the clarks of the earth's crust and the MPC [10].

In the Republic of Buryatia, production waste resulting from the activity of the Kyakhta flosspark factory (now closed) continues to have a negative impact on the environment. The tailing dump area reaches 60 hectares, the volume of accumulated waste from ore beneficiation exceeds 2 million tons [11]. In Mongolia, in the areas of existing fluorite mines, elevated concentrations of fluoride in groundwater, including those used for drinking water supply are recorded [12].

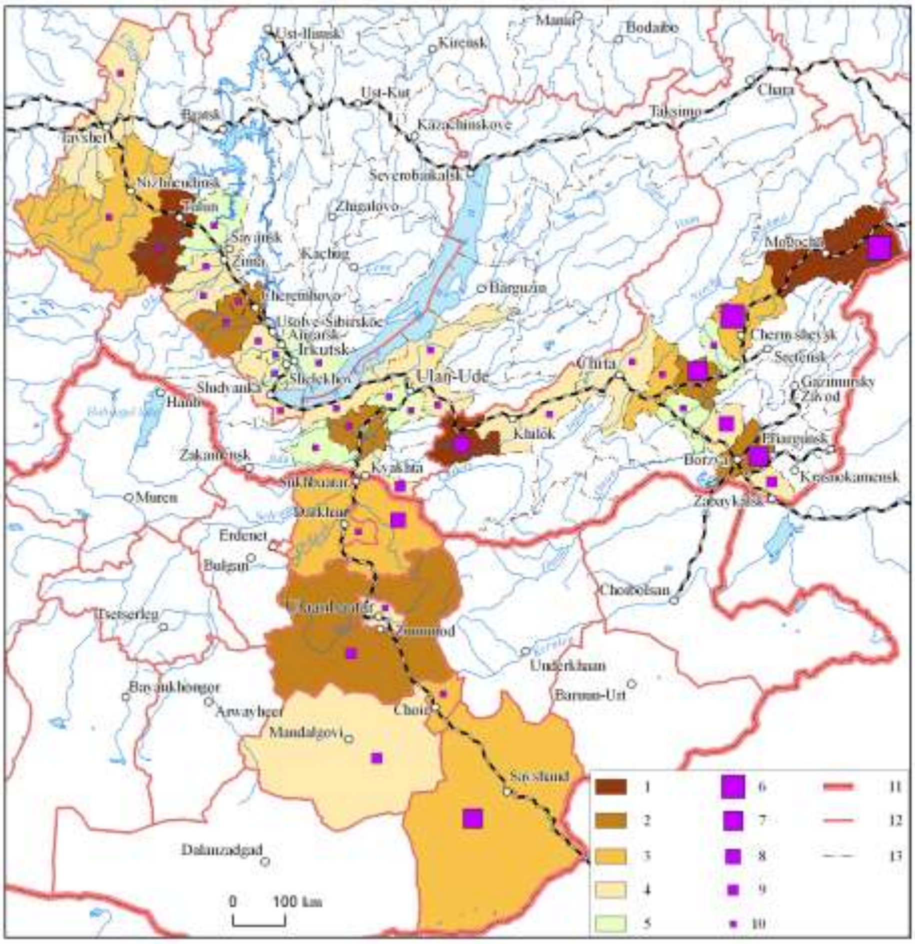

Fig. 2. Technogenic load on the population.The degree of anthropogenic impact on the population, km^2 / thousand pax.: 1 – more than 1.5, 2 – 0.3–1.5, 3 – 0.1–0.3, 4 – 0.001–0.1, 5 – no violations have been identified. Technogenic load on the population by the criterion of toxicity, km^2 / thousand pax.: 6 – more than 0.25, 7 – 0.10–0.25, 8 – 0.05–0.10, 9 – 0.01–0.05, 10 – no violations have been identified. Borders: 11 – state, 12 – subjects of the Russian Federation, aimaks, 13– municipal districts.

Disruption of the environment during mining has a strong negative impact on the health, living conditions and economic activities of the local population.

The map (Fig. 2) within the boundaries of the regions (aimaks) shows the technogenic load (per 1000 people) - general disturbance (quantitative background) and “toxic” (out-of-scale rectangular signs). The maximum values of the first indicator were revealed for the Mogochinsky, Petrovsk-Zabaykalsky, Tulunsky districts. In terms of toxicity, the maximum load falls on residents of the Mogochinsky and Chernyshevsky districts.

The population living near mining enterprises is in the most adverse environmental conditions. This situation, in particular, has developed for the residents of the village. Sherlovaya Gora and Haranor. Here, the danger is associated with dusting of waste from the tailing dump, pollution with arsenic, lead and zinc of varying degrees of intensity is observed up to 1 km from the source of pollution - 5. High concentrations of these substances can lead to intoxication, damage to the central nervous system, liver, kidneys and other organs, cancer and other diseases [14].

The integral assessment of the technogenic impact is given for administrative districts (aimaks) and is carried out on the basis of the indicators adopted in the maps considered in this and the previous article. Indicators of the degree of environmental impact are assessed on a five-point scale by increasing the degree of anthropogenic stress. Simple points are summed up and on the interval of values are converted into complex points of the integral assessment - also on a five-point scale.

For calculations, indicators are used that reveal the relationship, the ratio of parameters and the interaction of natural, man-made and social systems, special attention is paid to assessing the disturbance in the extraction of toxic types of raw materials. The following indicators are considered: the density of man-made violations; their total share in the total technogenic disturbance of the lands of the studied territory; man-made load per 1000 people; toxicity of areas; man-made load per 1000 people according to the criterion of toxicity.

On the map (Fig. 3), the method of quantitative background was used to display the total assessment of these indicators. The bar graphs show the range of environmental indicators and their contribution to the integral assessment (Table III, fragment).

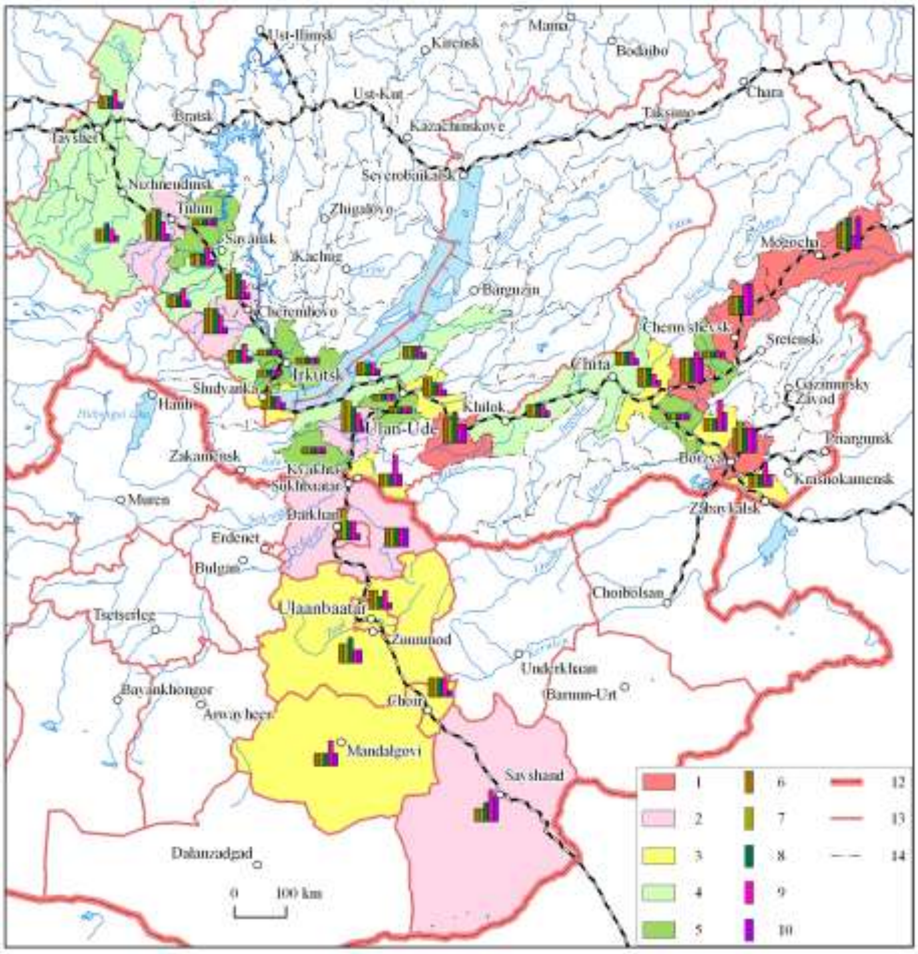

Fig. 3. Integral evaluation. Total assessment of technogenic impact, points: 1 – 5 (19–21, very high), 2 – 4 (15–18, high), 3 – 3 (11–14, moderate), 4 – 2 (9–10, low), 5 – 1 (5, insignificant – no violations revealed). Indicators of the integral assessment of the ecological condition, points (minimum size of the column – 1 point): 6 – density of violations, 7 – density of violations relative to the average along the corridor, 8 – man–made load per 1000 people, 9 – toxicity in areas, 10 – man–made load per 1000 people according to the criterion of toxicity. Borders: 11 – state, 12 – subjects of the Russian Federation, aimaks, 13 – municipal areas.

TABLE III. INTEGRAL ASSESSMENT OF ANTHROPOGENIC IMPACT (TABLE FRAGMENT)

Representative municipal districts, aimaks	Area estimates, points						
	*Ddl	Dvr	Dt	Tp	Tpt	SPP	IE
Shelekhovsky	**1	1	1	1	1	5	I
Pribaikalsky	2	2	2	2	1	9	II
Dundgov	2	2	4	2	2	12	III
Selenge	3	3	3	3	3	15	IV
Shilkinsky	4	4	5	4	4	21	V

* Ddl - density of disturbed lands; Dvr - density of violations relative to the average along the corridor; Dt - degree of toxicity; Tp - technogenic load on the population; Tpt - technogenic load on the population by the criterion of toxicity; SPP - the sum of prime points; IE - integral evaluation

** - degree of technogenic impact: 1 (I) - extremely low, 2 (II) - low, 3 (III) - moderate, 4 (IV) - high, 5 (V) - very high.

The highest level of anthropogenic impact on the totality of indicators is different for the Mogochinsky, Borzinsky and Shilka districts of the Trans-Baikal Territory. Here, in local areas, the ecological situation can be characterized as a crisis. At this level of ecological state in landscapes, very significant and almost poorly compensated changes occur, a significant depletion of natural resources occurs; the health of the population sharply deteriorates [15]. The category of ecologically safe areas includes Angarsky, Ivolginsky, Nerchinsky and other areas where mining operations (with the exception of common) are not conducted, the ecological system is not disturbed.

IV. CONCLUSION

The objectives of creating economic corridors are to create conditions for the development and expansion of trilateral cooperation between the People's Republic of China, Mongolia and the Russian Federation by implementing joint projects aimed at increasing trade, ensuring product competitiveness, facilitating cross-border traffic, developing infrastructure and strengthening environmental cooperation. This study reflects the results of our work on the assessment of the anthropogenic impact of mining on the environment and is of great importance for ensuring environmental safety.

The work carried out is systemic in nature - it is based on a structural-logical scheme – a research model. Its blocks represent components that interact with each other and provide structural and functional integrity. The leading role in the system is assigned to cartographic modeling. A series of interlinked complementary thematic maps has been compiled reflecting various aspects of the environmental impact of mining production. The stages of the research are presented in four maps that demonstrate the sequence of study of the topic. The final integral map is a generalization of various phenomena localized in the "points" – in the subsoil use areas, and in the areas in the areas of economic corridors. A joint consideration of various indicators on the mountain ecology of the study area makes it possible to significantly increase the depth of problem study through a synergistic effect. The obtained integral asset in solving environmental problems in the framework of an international agreement can be used to attract investments for the development and implementation of innovative environmental protection technologies.

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