

# TECHNIQUE OF THE COMPLEX GEOECOLOGICAL EVALUATION OF THE STATE OF NATURAL ENVIRONMENT UNDER THE INFLUENCE OF OPEN MINING OF THE COMMON MINERALS (CM)

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## **Abstract**

In the article the complex technique of the geoecological evaluation of the state of geosystems, influenced by open mining of common minerals on the territory of the Belgorod region is observed. During the research the areas within the region, characterized by various degrees of resistance to mining impacts and different acuteness of the geoecological situation caused by the extraction of common minerals were identified. The result of its comparison was a comprehensive evaluation of geo-ecological state of geosystems in the impact zone of the common minerals mining enterprises.

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## **Keywords**

common minerals (CM), geosystem, geoecological evaluation, extraction, mining impacts, reclamation activities.

Common minerals (CM) are one of the most important components of the resource potential of the Belgorod region, which is the raw material base for housing, industrial and road construction, as well as the basis for the building materials industry.

Currently more than 300 deposits of non-metallic CM are developed in the region: sand, clay, loam, chalk. Because of the shallow raw deposit and taking into account the economic benefits, the extraction of non-metallic common minerals in the region is provided by the open method, which has a powerful and complex impact on all components of the landscape.

In accordance with the Order of Ministry of regional development of the Russian Federation dated May 30, 2011 № 262, as well as by Decree of the government of Belgorod region of 23 January 2012 N 24-PP «On approval of the Strategy of development of the industry of building materials and industrial construction in the Belgorod region for the period till 2020» in the nearest future the volume of construction in the area will rapidly grow, and there will be further development of the industry of construction materials due to own the mineral resource base. This suggests that the impact of the CM extraction on the environment of Belgorod region will only increase. In this connection, the geoecological evaluation of the CM extraction impact on the environment for the further development of guidelines for the management of mining activities on the territory of the Belgorod region is an important task.

The comprehensive geoecological evaluation of the state of natural environment in the impact zone of the mining enterprises, extracting common minerals was carried out by us in 3 stages:

**1 stage** - on the basis of the technique of evaluation the sustainability of geosystems to the mining impact the isolated areas with different degree of resistance to mining production were allocated by us;

**2 stage** - on the basis of the technique of geoecological evaluation of the status of the extraction CM territories the some areas with different acuteness of the geo-ecological situation were defined by us;

**3 stage** - on the basis of the comparison of the areas characterized by different degrees of geosystems stability to mining impacts, and others which differ of the acuteness of geoecological situation, arising by the opening mining of common minerals, we managed to produce the complex evaluation of geoecological condition of geosystems in the impact zone of the mining enterprises on CM extraction [5].

**1 stage. The technique of evaluation the sustainability of geosystems to the mining impacts.** Sustainability geosystems is defined both the natural potential and the degree of the territory development and intensity of the different types of economic activity conduct ion [3].

To the group of natural factors that determine the stability of geosystem we carried: geological, geomorphological, hydrogeological, climatic, edaphic, and biotic; to the group of natural-anthropogenic - scale manifestations of soil erosion, ecological framework of the territory.

The method offering by us is based on determining the extent of geosystem stability to the mining impact on the complex of the selected factors, ranked by the importance for the conditions of open-pit mining.

Table 1: The distribution of points of the geosystems sustainability criteria to mining impact on the level of resistance

№ p/p	Criteria	The level of stability		
		low	middle	high
1	2	3	4	5
1	Surface incline	7,3	14,6	22
2	Type of sediments, forming the territory	6,6	13,3	20
3	Ground water depth	5,6	11,3	17
4	The structure of ecological frame (area of anthropogenic constituent of ecosystem)	4,6	9,3	14
5	Humus content in soils	3,6	7,3	11
6	The degree of soil erosion	2,6	5,3	8
7	Hydrothermic coefficient	1,6	3,3	5
8	The primary biological productivity	1	2	3
Total		min 32,9	66,4	max 100

Thus, the integral assessment, demonstrating the level of geosystem resistance to mining impact is as follows: low level of resistance (32,9 - 55.3); middle (55,4 - 77,8); high (77,9 - 100).

Geosystems with a *low level of the stability* to mining impact are affected by the rapid and intense changes, even at low mining pressing. To maintain an environmentally safe status id this geosystems in the shortest time is necessary to conduct a complex of actions on optimization of disturbed lands.

*The average stability* of the geosystems shows that they can withstand longer and more large-scale impacts, retaining the ability to self-recovery when conducting some kind of the reclamation works.

Having the high stability, geosystems can sustain long and heavy impacts. They are characterized by the active formation of technogenic succession that does not exclude the additional activities for reclamation in the frame of the project [1].

In the conducted scientific research, we rely on the scheme of geomorphological zoning of the Belgorod region offered by G.I. Raskatov. The main unit of the zoning is the area matching the neotectonic structure of the I-order - Central Russian upland. This is an area of the elevated erosion-denudation plain. Within the boundaries of the Belgorod region, this area unites 6 geomorphological zones: Seimsky, Pselsko-Vorskynsky, Sosninsko - Oskolsky, Oskolsky-Severodonetsky, Pravoberejny Donskoy, Kalitvinsko-Bogutcharsky.

Table 2: Assessment of the sustainability of areas to mining impact

The name of the area	$\Sigma$ of points	The degree of stability
Seimsky	90,6	High
Pselsko-Vorskynsky	68,8	Middle
Sosninsko – Oskolsky	56,8	Middle
Oskolsky – Severodonetsky	71,5	Middle
Pravoberejny Donskoy	60,1	Middle
Kalitvinsko-Bogutcharsky	58,8	Middle

УСТОЙЧИВОСТЬ АРЕАЛОВ К ГОРНОДОБЫВАЮЩЕМУ ВОЗДЕЙСТВИЮ

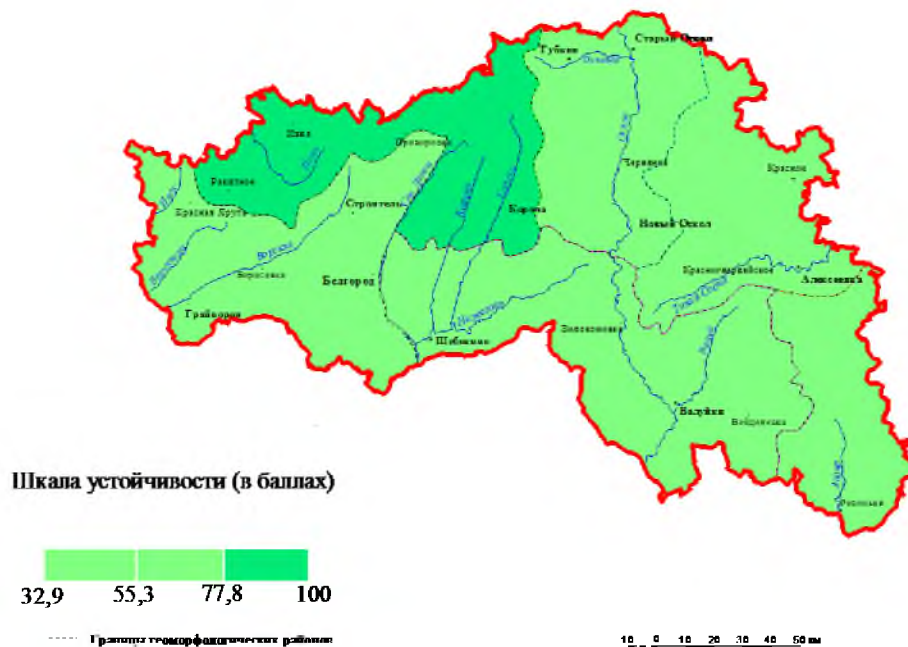


Fig.1: Stability of areas to mining impact

The carried out calculations have allowed allocating within the Belgorod region areas with different degrees of geosystems stability to the mining impacts. High resistance is characterized for Seimsky mining area (I). Pselsko-Vorskynsky (II), Sosninsko - Oskolsky (III), Oskolsky-Severodonetsky (IV), Pravoberejny Donskoy, Kalitvinsko-Bogutcharsky (V)

areas are corresponded to the average degree of stability. Areas with a low degree of stability to mining impacts on the territory of the Belgorod region are not represented.

**2 stage. Methods of geocological evaluation of the status of the territories where the extraction of common minerals is taken place.** Criteria to determine the acuteness of geocological situation in the territory with the open mining of CM can be the following: the stage of development of the mining landscape, type and volume of the extracted raw material, the efficiency of the mining allotment, the area of pit fields.

Table 3: The distribution of points of acuity geocological situation criteria on levels

№ p/p	Criteria	Levels		
		low	middle	high
1	2	3	4	5
1	Stage of the mining landscape development	11	22	33
2	Kind of the extracted raw	9	18	27
3	The amount of extracted raw materials (tons/year)	6,7	13,4	20
4	Area if the pit field	4,3	8,6	13
6	The efficiency of the mining claim (thousand tons/ha/year)	2,3	4,6	7
Total		min 33,3	66,6	max 100

Thus, the integral ecaluation, showing the acuity of geocological situation of the territory in the extraction of CM, is as follows: conflict geocological state of the territory corresponds (33,3 - 55,5); intense (55,6 - 77,8); satisfactory (77,9 - 100).

*Satisfactory geocological state of the territory* is characterized by the termination of mining operations (conservation of pits, conducting the reclamation activities), or small in scale and intensity violations of the geological environment. Overburden is suitable for biological reclamation (Quaternary loam, sandy loam) [2]. In career-dumping complexes the stage of technogenic succession is established, biota is restored, there is a process of deceleration of geodynamic processes.

With *tense geocological state of the territory* the mining impact continues, the sizes of the pit fields are increased, the vegetation is destroyed, hydrological conditions are not violated, or are affected slightly. Overburden is unsuitable for biological reclamation (sands) [2], the passing of technogenic succession is slow.

*Conflict geocological state of the territory* is observed in the case when all components of geosystem: the lithogenic base, hydrogeological conditions, atmosphere, biota are affected by mining activities This type of situation is typical for the largest pit-dumping complexes, in particular, it concerns the iron-ore pits of the Lebedinsky and Stoilensky mining complexes on which CM are associated raw materials, extracting from the thickness of overburden. As a rule, overburden in them is of little or no value (limestone, sandstone) [2,4] for biological reclamation, which complicates the conditions of restoration of natural functions, restoration of the landscape is required.

According to the data obtained in the course of calculations on the deposits and pits for the extraction of CM studied by us, all 3 stages of the acuteness of geocological situation are presented: satisfactory, tense and conflict.

3 stage Complex geoeological evaluation of the state of geosystems, located in the zone of influence of the mining industry, was carried out by us with using the comparison matrix of the sustainability geosystems levels to the mining impact with the acuteness of geoeological conditions of territories under the influence of CM extraction of minerals.

Table 4: Matrix of the geoeological evaluation of the state of geosystems, located in the zone of influence of the mining industry

Resistance to influence of the mining industry	The acuteness of geoeological territory state		
	satisfactory	tense	conflict
High	1	1	2
Moddle	1	2	3
Low	2	3	3

*The degree of conflict: 1 - acceptable, 2 - sharp 3 – critical*

This technique if the geoeological evaluation identifies 3 extents of the conflict between the natural and anthropogenic components of geosystems.

1. *An acceptable level* is characterized by the fact that the limit of geosystem stability has not been achieved yet, the functioning and the ability to recover from anthropogenic impact are sill presented. Remediation works will be effective.

2. *Acute*. The limit of stability is reached and the ability of geosystem to restore is fully involved. The increasing of the mining pressure is undesirable and it will only exacerbate the conflict. It is necessary to conduct active measures to restore natural components parallel with the conducting of mining works and, of course, their completion.

3. *Critical*. The threshold of geosystem stability is exceeded; mining load doesn't correlate with the potential of geosystem. Functioning and self-regulation are disturbed. The irreversible changes are possible. It is necessary to reduce the level of mining impacts and to adopt the comprehensive environmental measures on the landscape restoration.

On the basis of comparing the level of geosystems sustainability to the mining impact on the degree of geoeological situation in places of CM extraction, we made the skeleton map of placing pit-dumping complexes on CM extraction of the Belgorod region with varying degrees of conflict of natural and technogenic components of geosystems (Fig. 2.).

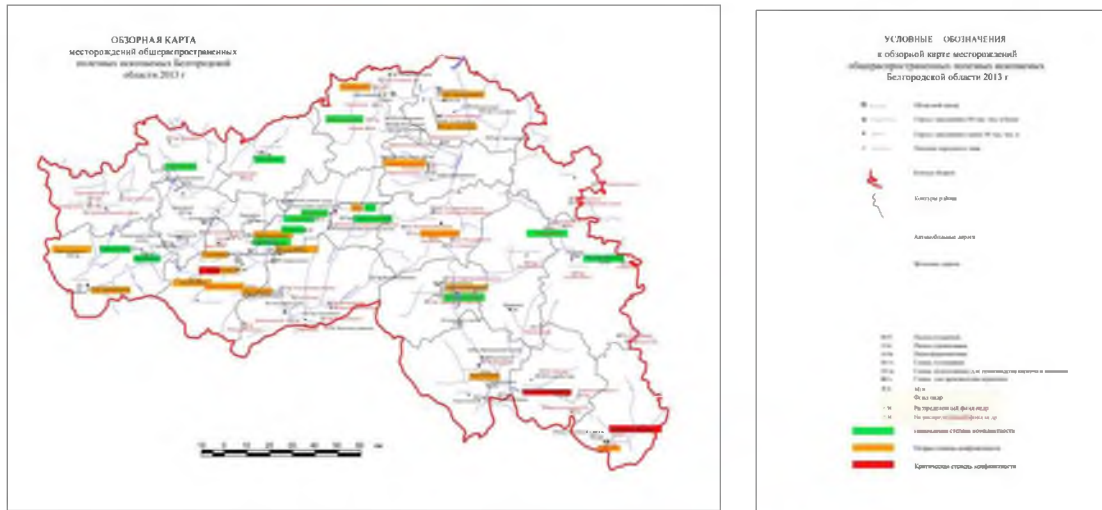


Fig 2: Accommodation of the pit-dumping complexes on CM extraction of the Belgorod region with varying degrees of conflict

As far as the large extent of the Belgorod region (II-VI mining areas) has a high degree of resistance to mining impacts, and the pits developing within these areas are characterized by the tense geoeological status, it can be concluded that the most part of the territory of the Belgorod region is characterized by acute degree of conflict in which the natural limit of geosystem stability is reached and the ability of geosystem to restore are fully involved. A further increasing of the mining impacts is extremely undesirable, it will exacerbate conflict. It is necessary to conduct active measures aimed at restoration of disturbed landscapes in parallel with the mining activities.

**Acceptable degree of conflict** is typical for all pits of the Seimsky mining area (I) except plot №2 of the Sinevsky field. Also the pits of the other mining areas with satisfactory acuteness of geoeological condition are characterized by the acceptable degree of conflict.

Acute degree of conflict is typical for most of the pits related to II-VI of the mining areas and is characterized by the tense geoeological situation.

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