



# Analysis of Environmental Issues of Mining Enterprises Basing on Integral Environmental Hazard Index

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## Summary

*In comparison with other industrial complexes, mining enterprises generate the most multifold negative impact on all environmental components: atmosphere, hydrosphere, lithosphere. In the current context of resource limitation, the objective assessment of the level of environmental safety of different technology concepts and organizational decisions, mining enterprises is a vital need. Today, there are three different approaches to environmental safety assessment of industrial enterprises. The main disadvantages of these approaches are complication in specific environmental consideration of mining enterprises; difficulty of top environmental target selection, subjectivity of enterprises ranking by level of environmental safety. It was proposed a new approach of environmental safety and negative impact assessment (with help of integral environmental hazard index of mining) in the light of specific features of mining. It is based on complex affine environmental, technology and geological factors. This approach is admitting to rank mining enterprises in negative impact descending order, define top environmental targets for mining enterprises and the most effective every environmental action.*

*Keywords: Environmental hazard, Environmental Safety, Integral Environmental Hazard Index of Mining, Mining, Environmental Safety Assessment.*

In comparison with other industrial complexes, mining enterprises generate the most multifold negative impact on all environmental components: atmosphere, hydrosphere, lithosphere. [1,2,3]. In the current context of resource limitation, the objective assessment of the level of environmental safety of different technology concepts and organizational decisions, mining enterprises is a vital need.

Today, there are three different approaches to environmental safety assessment of industrial enterprises: the approach, which is based on normalization principle [4], the approach, which is based on the principle of ecological risk (or environmental damage) [5], the ecological-and-economic approach, which is based on the principle of "integral criterion" [6]. The main disadvantages of these approaches [7] are complication in specific environmental consideration of mining enterprises; difficulty of top environmental target selection, subjectivity of enterprises ranking by level of environmental safety.

So, the development of method integrated environmental safety assessment of mining in order to optimize its negative impact on the environment in light of the available scientific approaches is a crucial task. In the opinion of the authors, optimization of negative impact of mining is the most effective engineering and technical decision making for top environmental target selection, which is based on environmental safety assessment of mining.

Negative impact of mining is in a great measure based on type of commercial minerals, relation, uplift, production practice.

The optimization of negative impact goes in two stages: 1. Integrated environmental safety assessment of mining and top environmental target selection; 2. The most effective engineering and technical decision making for top environmental target selection, which admit optimization of negative Impact of mining on environment.

For hazard evaluation it is necessary to integrally assess the negative impact of mining enterprise on the environment. Negative impact assessment of mining enterprise supposing its valuation on the all environmental components - atmosphere, hydrosphere, lithosphere. The environmental safety assessment supposing to make by 4 basic factors and 3 additional factors. In the opinion of the authors, basic factor is a factor which is typical for every enterprise (pollutant emission, pollutants discharge, wastes generation, disturbed lands). Additional factor is a factor which is typical for mining enterprise (mainly, it is type of commercial minerals). All these factors have different rating scales an physical significance and need in comparing with each other.

The quantitative description of the system, which is using for decision-making could be equate in objective function (1). [8,9,10]:

Tab. 1 Rating scale of the level of ecological hazard

Tab. 1. Skala oceny poziomu zagrożenia ekologicznego

Level of environmental hazard	Very low	Low	Middle	High	Very high	Extremely high
Score	0-0.20	0.21-0.40	0.41-0.60	0.61-0.80	0.81-1.00	>1

$$N_{ij} = \lambda_{ij} \left(1 - \frac{k_{ij \max} - k_{ij}}{k_{ij \max}}\right) \cdot \left(1 - \frac{\sum_{t=1}^n \frac{p_{tj \max} - p_{tj}}{p_{tj \max}}}{n}\right) \quad (1)$$

$N_{ij}$  - integral environmental hazard index of mining;  
 $\lambda_{ij}$  - importance weight of basic factor;  
 $k_{ij}$  - degree of negative impact of basic factor;  
 $k_{ij \max}$  - liminal intensity of influence of basic factor;  
 $p_{tj}$  - degree of negative impact of additional factor;  
 $p_{tj \max}$  - maximum degree of negative impact of additional factor;  
*i* - basic factor,  
*j* - environmental component;  
*t* - additional factor.

Integral environmental hazard index is dimensionless quantity and can take on a value from 0 to endlessly. Importance weight of basic factor defines endowment of basic factor in negative impact on the environmental component.

Integral environmental hazard index is calculating for every environmental component. Then we should calculate the cumulative integral environmental hazard index (2).

$$N_{ij} = N1_j + N2_j + N3_j + \dots + N_{ij} \quad (2)$$

$N_{ij}$  - cumulative integral environmental hazard index.

Cumulative integral environmental hazard index is a criteria of environmental component selection which is most impacted. Inside most impacted environmental component we should select a basic factor with maximum rating of integral environmental hazard index. This factor will define the top environmen-

tal target.

This approach is also making possible to rank mining enterprises in negative impact descending order. The authors developed rating scale of the level of environmental hazard for mining.

Maximum rating of integral environmental hazard index is a criteria of environmental hazard identification assessment.

After environmental safety assessment of mining and top environmental target selection it is necessary to choose some alternative decisions, which will be able to deliver on top environmental target. Then it should be defined the most effective decision. For this purpose it should be defined cumulative integral environmental hazard index for every environmental action (2). Those environmental action for which the cumulative integral environmental hazard index will be minimum such environmental action will be the most effective. Its environmental safety will be maximum.

In conclusion I want to say, that it was proposed a new approach of environmental safety and negative impact assessment in the light of specific features of mining. It is based on complex affine environmental, technology and geological factors. This approach is admitting to rank mining enterprises in negative impact descending order, define top environmental targets for mining enterprises and the most effective every environmental action. This approach was approved on 3 incumbent mining enterprises of Ural region, JSC "Uralasbest", JSC "Kachkanarskiy mineral processing plant", JSC "Vusokogorsky mineral processing plant". This approach could be used not only for mining enterprises but for every industrial enterprise in the light of its specific features.

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## Streszczenie

W porównaniu z innymi gałęziami przemysłu, przedsiębiorstwa górnicze generują najbardziej negatywny wpływ na wszystkie komponenty środowiska: atmosferę, hydrosferę, litosferę. W obecnej sytuacji ubożenia zasobów, istnieje potrzeba oceny poziomu bezpieczeństwa środowiskowego dla różnych technologii.

Obecnie istnieją trzy sposoby oceny bezpieczeństwa środowiskowego przedsiębiorstw przemysłowych. Główne wady tych rozwiązań to skomplikowane rozwiązania technologiczne przedsiębiorstw górniczych, trudności w wyborze rozwiązania docelowego, subiektywność rankingu rozwiązań. Zaproponowano nowe podejście do oceny bezpieczeństwa środowiskowego i oceny skutków dla środowiska za pomocą integralnego wskaźnika zagrożenia środowiska w górnictwie. Jest on oparty na złożonych czynnikach środowiskowych, technologicznych i geologicznych. Takie podejście pozwala ocenić przedsiębiorstwa górniczych pod kątem malejącego negatywnego wpływu na środowisko i wskazanie najbardziej skutecznych działań.

Słowa kluczowe: zagrożenia środowiskowe, bezpieczeństwo środowiska, Zintegrowany Indeks Środowiskowy dla Górnictwa, ocena bezpieczeństwa środowiskowego