

Analysis of Economic Evaluation Methods of Environmental Damage at Calculation of Production Efficiency in Mining Industry

Grigory B. Malyshkov¹, Leonid S. Sinkov² and Liubov A. Nikolaichuk³

*Department of Economics, Accounting and Finance, Saint-Petersburg Mining University,
Vasilyevsky Island, 21 Line, 2, Saint-Petersburg, 199106, Russia.*

¹ORCID 0000-0001-5279-4349, ²ORCID 0000-0002-7793-0666, ³ORCID 0000-0001-5013-1787

Abstract

Currently in the Russian Federation there is a large number of methods for determining the economic damage from environmental pollution. They make it possible to assess the quantitative damage caused by the industry to the environment and consider the environmental pollution factor when calculating the economic performance of enterprises.

In general, all methods can be reduced to three main types, whose main advantages and disadvantages, as well as applicability for adjusting the performance of enterprises, and inclusion in environmental performance assessment are discussed in this article.

The authors proposed a step-by-step procedure for including the factor of negative impact on the environment in the evaluation of companies' performance. First, a preliminary consolidated assessment is made by the method of specific damage. Secondly, the economic effect is calculated by the method of generalized indirect estimates. If necessary, clarification of calculations by the method of direct calculation is carried out. When calculating production efficiency indicators, considering the nature protection activities of the enterprise, a method of accounting for the prevented damage is proposed.

Keywords: Economic Assessment of Environmental Damage, Method of Specific Damage, Method of Generalized Indirect Estimates, Method of Direct Calculation, Prevented Environmental Damage.

INTRODUCTION

The Russian mineral and raw materials complex is the main source of revenues of the budgetary system and traditionally provides more than half of the federal budget revenues. Export of hydrocarbon raw materials and products of its processing provides more than 50% of all foreign exchange earnings to the country. In 2016, the share of revenues from exports of products of the fuel and energy complex was 62%, despite the low prices for oil. Another 10% of export earnings fell on metals and products from them [1], which shows the high importance of oil and gas as well as mining complexes in the country's economy.

The active development of the mining industry and the high demand for the products of its processing lead to an increase

in the negative impact on the environment. In a complex of existing environmental problems, the mining and processing industries play a key role. Industrial pollution of the environment is in the first place [2].

The impact on the environment is manifested in the form of a number of costs. On the one hand, it is the economic damage caused by the negative impact on the environment, on the other - the costs of preventing pollution or implementing environmental measures. From the point of view of rational management of mining enterprises, it is important, first, to determine the optimal ratio of these two types of costs, and, secondly, it is rational to take them into account when assessing the effectiveness of enterprises. For this, first of all, it is necessary to estimate as accurately as possible the quantitative damage caused by industry to environment.

Economic assessment of damage caused by mining enterprises to the natural environment is carried out based on methods of mathematical modeling, specific damage (calculation by mono-pollutant), generalized indirect estimates, or by direct calculation. The practice of calculating the prevented environmental damage is also used to assess the negative impact.

The essence of the methods, their main advantages and disadvantages, as well as their applicability in the assessment of the adjusted performance indicators of companies are considered further.

MATERIALS AND METHODS

Economic damage from environmental pollution is a complex value, and is composed of damage, imposed to individual types of recipients within the contaminated zone. Methodological difficulties in determining the damage lead to the fact that it is practically not included in the system of generalizing indicators of the activities of enterprises, and, especially, in the operational economic control of production. The economic assessment of the value of damage includes a number of sequential stages: the determination of the composition and quantity of emissions and discharges, the assessment of natural damage and the calculation of the economic damage itself.

The damage assessment in the Russian Federation is governed by an extensive list of normative and methodological

documents approved at the federal and regional levels. Distinctive features of the current system of economic evaluation of environmental damage are the component approach and, therefore, the lack of comprehensiveness in the calculations, as well as the prevalence of regulatory assessment methods in the absence of legally recognized methods of damage assessment. Normative methods are methods associated with the use of certain approved value parameters and mathematical formulas.

The method of specific damage

The basis for determining the total damage is the specific damage caused at a certain level of pollution to the usual unit of account (1 thousand people, 1 hectare of land, 1 million rubles of fixed assets, etc.). It is most simple to use the average specific loss factor per 1 ton of emissions and discharges. This method is the basis for determining the prevented environmental damage [3].

The method is based on a simplified procedure for calculating with a single formula. Economic damage, within the framework of this system is determined by the following formula:

$$U = \gamma * G * \sum A_i * m_i$$

Where:

- U – total economic damage in monetary terms;
- m_i – amount of emission of the i-th pollutant;
- A_i – the coefficient of reduction of various impurities to a mono-pollutant;
- G – is a coefficient that considers regional peculiarities of the territory exposed to harmful effects;
- γ – monetary estimation of the emission unit.

In accordance with this formula, all production emissions are aggregated, and then adjusted to a coefficient that considers regional features of the territory and is multiplied by the coefficient γ , which serves to measure the monetary estimate of the given emissions. In practice its value must additionally be adjusted due to inflation

Method of generalized indirect estimates

The calculation of economic damage by the method of generalized indirect estimates is the basis for the modern system of payments for environmental pollution in Russia [4]. According to a simplified interpretation of this method, the total economic damage to the environment caused by man-made pollution is defined as the sum of the damages from pollution of the atmosphere (U_a), water (U_w), soil (U_s).

Calculation of economic damage for individual objects is carried out according to the following formula:

$$U = P_i * M_i * K_e$$

Where:

- U – economic damage from environmental pollution, rubles/year;
- P_i – base rate of payment for pollution of environment, rub/t;
- M_i – mass of pollutants emitted to the environment by individual ingredients, t;
- K_e – coefficient of ecological situation and ecological significance of the area.

The basic rate of payment is calculated based on the annual fee rates for negative impact from emissions, discharges and waste disposal [5].

Method of direct calculation

For more accurate calculations it is advisable to use the method of direct calculation based on direct comparison and analysis of indicators characterizing the negative consequences of pollution effects on recipients in the mining area [6].

The method consists in determining the sum of the losses from all resources that have undergone negative impact.

Knowing the amount of negative impacts by type of pollutants (emissions, discharges of pollutants, generation of waste) (V), we want to calculate all the losses caused by these emissions. Denote by U the monetary valuation of the damage. Then:

$$U = U_1(V) + U_2(V) + \dots + U_n(V),$$

Where:

- U_1 – specific economic damage caused by the emission of pollutants into the air, rubles / year;
- U_2 – the specific economic damage caused by the annual discharge of contaminants into water sources, rubles / year, etc.

The following calculation sequence is the basis of the direct counting method:

1. determination of the level of environmental pollution;
2. determination of natural damage;
3. determination of economic damage;
4. The final stage.

The first stage of calculations involves an analysis of the volume, composition and concentration of emissions. They are carried out on the basis of actual measurements by the corresponding instruments.

At the second stage, the assessment of the natural impact on the environment and economic activities is made on the following types of damage:

- material damage;
- damage to the health and life of the population;
- damage to the natural resource system.

The evaluation of natural changes in monetary meters using market prices is the definition of the actual economic damage from pollution of the natural environment - the third stage of the monetary evaluation of physical changes in the components of the natural environment.

Economic damage is summed up from individual types of damage within the contaminated zone and is estimated by the formula:

$$U = \sum x_i * p_i$$

Where:

- U – total economic damage caused by changes in all factors;
- x_i – the natural measurement of the i -th factor in time;
- p_i – a monetary estimate of the i -th factor.

The last, final stage is necessary, because not all consequences of pollution of the natural environment can be expressed in monetary form. Any ecosystem is a complex and unique object. At this stage, an analysis is made of those factors that are not considered by monetary valuation, or inertial ones, which can show themselves in years.

RESULTS AND DISCUSSION

The undoubted advantage of the method of specific damages is the simplicity of calculations, which makes it possible to use it for the rapid assessment of the environmental hazard of mining enterprises at the local level. However, this advantage is also a drawback, since the results of the calculations are not accurate enough. In addition, this method does not take into account the peculiarities of the adjacent territories, agricultural and forestry lands, the initial characteristics of biotic components and health indicators of the population.

The need to consider the inflationary effect also derogates the accuracy of this method, however, it should be noted that this drawback is inherent in all methods of economic evaluation of pollution.

The method of generalized indirect estimates makes it possible to calculate the necessary payments for the negative impact on the environment and take them into account when assessing the effect of environmental measures from reducing emissions, discharges and waste disposal. As a minus, it should be noted that this method cannot be applied in the case of assessing the impact of physical factors, soil contamination and land withdrawal from economic circulation.

As an advantage of the method of direct calculation, we note its greatest accuracy. An essential shortcoming of determining the total economic damage by direct counting is its extreme labor intensity. It requires a large amount of diverse information, since calculations are made for all the ingredients and for each source of pollution, and there are a lot of them in any enterprise.

We propose the following procedure for including the factor of negative impact on the environment in the evaluation of companies' performance:

1. A preliminary consolidated assessment is made by the method of specific damages.
2. The economic effect is calculated. The amount of the saved money resources from payments for negative impact, calculated by the method of generalized indirect estimates, is subtracted from the cost of environmental protection measures.
3. If necessary, clarification of calculations by the method of direct calculation is carried out.

Calculation of production efficiency indicators including environmental activities can be proceeded in two ways. The first is applicable in the case when the cost of protecting the environment can not be separated from the total costs (for example, the implementation of low-waste technologies, etc.). The second - directly for calculating the effectiveness indicators of environmental protection funds.

To determine the level of overall profitability, including the nature protection activity of the enterprise, the first way is to take into account the prevented damage in addition to profit. Then the profitability is calculated by the formula:

$$p = \frac{\sum_{i=1}^n P1 + Eep}{A1}$$

Where:

- $\sum_{i=1}^n P1$ – The total profit calculated including the nature protection activity of the enterprise;
- Eep – environmental protection effect equal to the prevented damage from environmental pollution;
- A1 – fixed and current assets including environmental protection funds.

In the second way, when the costs of protecting the environment can be separated from the total costs (for example, the costs of treatment plants), it is better to apply the criteria and methods for assessing the effectiveness of direct environmental protection funds, for example, as shown in the equation. Calculations of performance indicators are cut to the definition of relative estimated values. Their use in assessing the effectiveness allows to identify ecologically inadequate or unacceptable production processes that are uneconomic in terms of economic goals, and to determine the priority of the implementation of environmental protection measures.

CONCLUSION

The system for evaluation of the impact of mining enterprises on the natural environment should be aimed at solving the problem of transition of mining enterprises to modern technologies of extraction and processing of mineral raw materials, which provide a minimally negative impact on the environment.

These tasks can not be performed without a quantitative monetary assessment of the damage caused by the enterprises to the environment. All performance indicators of companies should be adjusted considering environmental factors, and when making investment decisions, it is necessary to assess

the negative impact on the environment, along with a calculation of the prevented damage when implementing environmental investments.

Thus, with the inclusion of the negative environmental impact factor in the assessment of the activities of enterprises, it is necessary to include the decrease in payments for negative impact, which is performed by the method of generalized indirect estimates. The method of specific damages allows to estimate the prevented damage, and the method of direct calculation - to include the factors of negative impact in calculation of the profitability of the business.

REFERENCES

- [1] Foreign trade of Russia was reduced in 2016. February 10th, 2017. Available from: <http://global-finances.ru/vneshnyaya-torgovlya-rossii-2016/>
- [2] The review of a state and environmental pollution in the Russian Federation for 2015. Moscow, 2016.
- [3] Temporary methodology for determining prevented environmental damage, Moscow, 1999.
- [4] Federal Law №7-FZ "On Environmental Protection", 2002.
- [5] Decree of the Government of the Russian Federation №255 "On the calculation and collection of fees for negative environmental impact", 03.03.2017.
- [6] Temporary typical methodology for determining the economic efficiency of implementing environmental measures and assessing economic damage caused to the economy by environmental pollution. M: Economics, 1986.