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THE CONTENT OF THE METHODOLOGY FOR ASSESSING THE ENVIRONMENTAL AND ECONOMIC EFFICIENCY OF INDUSTRIAL ENTERPRISES

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Abstract:

This article discusses the essence and significance of using a methodology for assessing the ecological and economic efficiency of industrial enterprises. Additionally, it presents formulas for evaluating the effectiveness of environmental protection measures and all types of prevented damages. The methodology for assessing ecological and economic efficiency is based on the principles of economically justifying environmental protection activities. Furthermore, the positive outcomes of applying this methodology in industrial enterprises are summarized.

Keywords: industrial enterprises, ecological efficiency, economic efficiency, prevented damage, environment

INTRODUCTION

The main stages of achieving the normative quality of the environment by industrial enterprises are aimed at economically justifying the implementation of environmental measures, calculating the economic efficiency of these measures, and assessing the effectiveness of the actions taken. According to the document of the State Committee for Nature Protection of the Republic of Uzbekistan dated January 1, 2011, titled "Ecological Certification System of the Republic of Uzbekistan. Criteria for Environmental Safety of Products and Waste Subject to Mandatory Ecological Certification. Basic Rules[1]" the methodology for assessing ecological efficiency is currently being applied. Based on this, ecological efficiency assessment is expressed as an internal management process that uses indicators allowing comparison of an organization's past and present ecological efficiency with the established criteria for ecological efficiency for that organization.

The economic efficiency of implementing environmental protection measures reflects the improvement of the methodology for determining the effectiveness of environmental protection work and services performed by industrial enterprises. Environmental protection measures encompass all types of economic activities aimed at reducing and eliminating negative anthropogenic impacts on the environment, as well as preserving, enhancing, and rationally utilizing the country's natural resource potential. These include the construction and operation of purification and neutralization facilities and equipment, low-waste and waste-free technological processes, development of production, placement of enterprises and transport flow systems, as well as taking into account ecological requirements such as melioration, soil erosion control measures, protection and enhancement of flora and fauna, underground protection, and rational use of mineral resources.

At the same time, the methodology should substantiate the following principles for economically justifying environmental protection measures: ensuring that forecasted and planned environmental protection achieves comprehensive goals: a) compliance with normative requirements for environmental quality that respond to health, human, and environmental protection interests, taking into account prospective changes arising from production development; b) maximizing environmental improvement, conserving natural capital, and fully utilizing natural resources.

METHODOLOGY

The degree of achievement of these goals is determined by the indicators of the overall production, economic, ecological, and socio-economic results of environmental protection measures. A comprehensive approach should be adhered to in the economic justification of environmental protection systems, which includes the following proposals:

- to cover as comprehensively as possible all positive (as well as negative, if they arise) socio-

[1] https://lex.uz/docs/-2526084

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economic consequences of implementing various options for environmental protection;

- to fully offset the costs associated with the implementation of the considered environmental protection options;
- to take into account the time factor when assessing the costs and results of environmental protection measures.

The overall economic efficiency of environmental protection measures is determined for the following purposes:

- to establish the results of the costs of preventive and protective measures;
- to identify the characteristics of actual and planned cost efficiency in enterprises;
- to make decisions regarding the priority of environmental protection measures in various sectors.

The overall (absolute) economic efficiency indicator of environmental costs is calculated as the ratio of the annual volume of total economic benefits from environmental protection measures to the costs incurred to achieve them. The effectiveness of environmental protection measures is calculated according to the following formula:

$$A_{total} = \frac{\sum_{i=1}^{N}(S_{econ} + S_{envir} + S_{social})}{\sum_{i=1}^{N} X_{time}} \qquad (1)$$

A_general - The impact of the effectiveness of environmental protection measures (in currency) on costs (in currency);

S_{econ} - the production-economic efficiency (result) of implementing ecological measures, in currency units;

S_{envir} - the ecological and economic result (value) derived from implementing environmental protection measures, in currency;

S_{social} - the social-economic result (value) derived from implementing environmental protection measures, in currency;

X_{time} - the total costs for implementing environmental protection measures for the considered period, in currency.

The ecological-economic efficiency (result) of environmental protection measures consists of reducing negative impacts on the environment and improving its condition. This is manifested in a decrease in the volume of pollution entering the environment and its pollution level (concentration of harmful substances), a reduction in noise levels, radiation, etc., as well as an increase in the quantity and quality of useful lands, forests, and water resources. The ecological impact in the form of maintaining the self-regulation, self-recovery, and self-cleaning capabilities of natural resources, natural objects, and the ecosystem as a whole creates conditions for meeting economic and social needs.

The social-economic effectiveness (result) of environmental protection measures includes improving the standard of living of the population, enhancing physical development, reducing the incidence of diseases, increasing life expectancy and active longevity, improving labor and leisure conditions, preserving aesthetic values, and maintaining natural and anthropogenic landscapes, among others.

When calculating the production-economic efficiency of environmental protection measures, the result of these measures is considered as the sum of the following values:

- prevention of damage from environmental pollution, meaning that due to the decrease in pollution of the environment, material production, non-production sectors, and population costs, etc., there is a reduction in what could have been produced;
- the increase in the economic (monetary) value of natural resources preserved (improved) as a result of implementing environmental protection measures or the increase in the monetary value of sold products obtained from full utilization of resources due to implementing these measures.

$$I = \Delta Oz + \Delta P \qquad (2)$$

I - the production-economic efficiency (result) of implementing environmental protection measures, in currency;

ΔOz - the amount of prevented damage, in currency;

ΔP - the increase in the monetary value of sold products obtained from full utilization of resources as a result of implementing environmental protection measures for a specific period (year), in currency.

The amount of economic damage prevention from environmental pollution (ΔOz) is equal to the difference between the calculated values of the damage that occurred before and after the implementation of environmental protection measures.

$$\Delta Oz = Z_1 - Z_2 \qquad (3)$$

Z_1 - the amount of damage caused to the environment before the implementation of environmental protection measures, in currency;

Z_2 - the amount of damage prevented after the implementation of environmental protection measures, in currency.

In solving the singular targeted task of preventing or reducing the negative impact of an object on the natural environment, the production-economic

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efficiency is equal to the annual amount of damage incurred.

$$\sum_{i=1}^{n} S_i = \sum_{i=1}^{n} \Delta O_i, \qquad (4)$$

$\sum_{i=1}^{n} \Delta \mathbf{O}_i$ - the annual economic damage prevented as a result of reducing or stopping the impact of zero object on the environment (in currency/year).

In the process of implementing environmental protection measures based on new production technologies or waste disposal, the overall production and economic efficiency in solving the multi-objective problem is equal to:

$$\sum_{i=1}^{n}\sum_{j=1}^{m} S_{i,j} = \sum_{i=1}^{n} \Delta O_i + \sum_{j=1}^{m} \Delta P_j \qquad (5)$$

ΔP_j - the annual increase in profit from resource-saving technologies in production or the use of substances collected from wastewater and exhaust gas treatment (in thousands of currency units per year).

It would be advisable to implement the methodology for calculating the amount of damage caused by water pollution. This methodology is based on calculating the damage amount using taxes for assessing the damage caused by the pollution of water bodies with various substances. For example, the assessment of the damage caused to a water body from the discharge of pollutants in wastewater is carried out according to the following formula:

$$Z = K_{water} + K_{index} \cdot \sum_{i=1}^{N} S_i \cdot M_i \cdot K_{ih} \qquad (6)$$

Z - the amount of damage, in thousands of currency units;

K_{water} - a coefficient that takes into account environmental factors (the condition of water bodies);

K_{index} - the indexing coefficient;

M_i - the mass of the i-th pollutant whose discharge was prevented as a result of environmental protection measures, for example, per year, in tons;

S_i - taxes used to calculate the amount of damage caused by the discharge of the i-th pollutant into water bodies;

K_{ih} - a coefficient that accounts for the intensity of the negative impact of harmful (polluting) substances on the water basin.

The amount of damage caused by air pollution from stationary sources is assessed by $Z^{E}_{pol.stat}$ and is determined by generalizing the reduced value of all types of pollutants:

$$Z^{E}_{pol.stat} = \sum_{i=1}^{N} (M_1 - M_2) \times T_i \times K_{econ} \times K_{reg} \times K_{pol.em} \times K_{index}, \qquad (7)$$

M_1, M_2 - the mass of pollutants discharged at the beginning and end of environmental protection measures, respectively, in the enterprise, in the area under consideration, and in the region;

T_i - the basic standards for payment for pollutant emissions into the atmosphere (in currency units per ton). A coefficient that multiplies by five for excess amounts;

K_{econ} - a coefficient that takes into account the ecological factors of the economic regions of the Republic of Uzbekistan (the condition of the atmosphere);

K_{reg} - a coefficient describing the region;

$K_{pol.em}$ - a coefficient for the emission of pollutants into the atmosphere by stationary sources;

K_{index} - an indexing coefficient related to changes in price levels.

In the field of water and air resource protection, the additional income obtained after carrying out environmental protection measures ensures an increase in profit due to:

- prevention (reduction) of dust loss resulting from increased raw materials, fuel, main and auxiliary materials, solid waste, untreated wastewater, exhaust gases, and clean products;
- more effective use of main production equipment under improved environmental conditions (assessed by reduced downtime during repairs, increased machine time availability, decreased overall costs, and increased productivity of workers engaged in maintenance and technical servicing of equipment);
- prevention of premature wear of fixed assets due to increased benefits from using low-quality natural resources or operating equipment in polluted environments (considered as savings on total repair costs);
- savings on nature use costs;
- reduction of payments for pollution by enterprises, compensation for damage, and payment of fines.

To economically assess damage caused to land resources, approaches based on land value standards are used, taking into account correction coefficients. The amount of damage arising from soil and land degradation is assessed according to the following formula:

$$D^{E}_{get.pro} = Y_v \times S \times K_{econ} \times K_a, \qquad (8)$$

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$D^{E}_{get.pro}$ - the amount of damage caused by the degradation of soil and land in the area under consideration due to environmental protection measures (S) over time (years), (thousand soums/year);

Y_v - the value of the land, (thousand soums/hectare);

K_{econ} - coefficient of the ecological condition of the soil;

K_a - coefficient of productivity of the area.

The assessment of the amount of damage arising from the contamination of land with chemical substances due to environmental protection measures is carried out according to the following formula:

$$D^{E}_{pol.per} = \sum_{i=1}^{N}(Y_v \times Y_i \times K_{econ} \times K_a) \times K_{ch.k}, \quad (9)$$

$D^{E}_{pol.per}$ - the amount of damage assessed from the prevention of soil pollution by i-pollutants for the reporting period (i=1, 2, 3, ...N), (thousand soums/year);

Y_i - the area of land where pollution by i-type chemical substances has been prevented in the reporting year, (hectares);

$K_{ch.k}$ - the increasing coefficient for preventing (or eliminating) soil pollution by multiple (n) chemical substances.

$$K_{ch.k} = \begin{cases} 1+0,2(n-1), \text{ here } n \le 10 \\ 3, \text{ here } n > 10 \end{cases}$$

The assessment of the amount of damage caused by unauthorized landfills as a result of environmental protection activities is carried out according to the following formula:

$$D^{E}_{was.per} = \sum_{i=1}^{N}(Y_v \times Y_i \times K_{econ} \times K_a), \quad (10)$$

Here, $D^{E}_{was.per}$ represents the estimated damage caused by the contamination of land due to waste of type i (where i = 1, 2, 3, …, N) during the reporting period (in thousands of soums per year);

Y_i - is the area of land (in hectares) where the accumulation of waste of type i has been prevented during the reporting period.

The total amount of damage caused by the degradation and destruction of soil and land in the considered area over a specific period is determined by $D^{E}_{ap.per}$, which is calculated by summarizing all types of prevented damage.

$$D^{E}_{ap.per} = D^{E}_{get.pro} + D^{E}_{pol.per} + D^{E}_{was.per}, \quad (11)$$

In calculating the economic effectiveness of measures aimed at reducing and preventing land degradation, pollution, and damage, additional revenues can be expressed as follows: a) the potential income from agricultural products obtained after the restoration activities for ecology; b) the possibility of using the restored land plot for other purposes (for example, renting it out for agricultural production), which can be calculated based on rental rates. The additional income is determined by the average annual growth of net production and the average annual growth of profit.

To calculate the amount of damage caused to biological resources as a result of implementing ecological measures that ensure the preservation of the entire biological resource complex in the region, taxes are used as a basis for calculation. In this case, the assessment of damage to biological resources is carried out using the following formula:

$$D^{b}_{get.1} = \sum_{i=1}^{N}(N_{q.i}\, S_i)K_m \times K_{ind}, \quad (12)$$

In this case, $D^{b}_{get.1}$ - prevention of damage to biological resources during the reporting period, in thousands of soums/year;

i = 1,...,N - species of terrestrial vertebrates and plants;

$N_{q.i}$ - total number of individuals of species i living in the entire protected area;

S_i - tax for damage caused to the recorded animals or plants of species i , in soums/n;

K_m - regional coefficient of biological diversity;

K_{ind} - indexation coefficient related to changes in price levels established by law in the "State Budget Law" each year.

The ecological and economic impact of environmental protection can be assessed by the positive outcomes of environmental protection (for example, reduction of pollutant emissions into the atmosphere, reduction of waste discharges into water bodies, and decrease in waste generation) as the environmental impact $E_{env.imp}$ and through a step-by-step assessment of economic and social impacts. This is because maintaining the balance of ecosystems, preventing their degradation, and improving ecosystem characteristics serve as the basis for meeting ecological, economic, and social needs.

The overall ecological impact $\sum E_{ecol}$ results from the combination of direct, indirect, and specific ecological impacts.

$$\sum E_{ecol} = E_{ecol.dir} + E_{ecol.indir} + E_{ecol.spe} \quad (13)$$

Here, E_{ecol} represents the overall ecological impact, in thousands of soums/year.

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$E_{ecol.dir}$ - represents the direct ecological impact, in thousands of soums/year.

$E_{ecol.indir}$ - represents the indirect ecological impact, in thousands of soums/year.

$E_{ecol.spe}$ - represents the specific ecological impact, in thousands of soums/year.

The direct ecological impact $E_{ecol.dir}$ is defined as the changes in ecosystems resulting from the positive outcomes of environmental protection (for example, reduction of pollutant emissions into the atmosphere, discharges into water bodies, and waste generation).

ANALYSIS AND RESULTS

The indirect impact on the environment (additional benefits) can be as follows: an increase in the value of natural objects; restoration of ecosystem services provided by ecosystems (ecological and recreational functions) (either fully or partially); an increase in the value of real estate—land or apartment market values; an increase in payments corresponding to the rise in land value.

The assessment of the specific ecological impact of environmental protection measures is based on evaluating biological resources' ecosystem functions (specifically, environmental protection), for example:

• Sanitary-hygienic function: The absorption (or decomposition) of harmful substances that enter the environment as a result of anthropogenic impact. Economic assessment is carried out considering the damage caused by environmental pollution.

• Deposit function: Carbon sequestration by forest and wetland ecosystems. The economic assessment is determined by the volume of CO_2 deposits and is particularly significant in relation to the formation of the global carbon trading market.

• Water retention function of forest resources: Increasing overall (surface and groundwater) runoff by reducing rainwater evaporation. Economic assessment may be based on revenues obtained from additional water resources.

• Erosion control function of forest resources: Reducing wind and water erosion of soils and increasing the fertility of agricultural lands. The economic value is determined by the income derived from increased soil fertility.

For example, the economic assessment of natural resources performing the sanitary-hygienic function (R_1) is carried out based on the amount of damage caused by environmental pollution:

$$R_1 = \sum_{i=1}^{N} D_1 \times H_1, \qquad (14)$$

In this context: N — the amount of absorbed (or decomposed) harmful substances (1, 2, 3,..., N);

D_1 - damage from pollution of the environment by the i-th substance, in som;

H_1 - the annual volume of the absorbed (or decomposed) i-th harmful substance, in tons.

Due to the existence of the environmental protection functions of natural resources, it can be difficult to determine the amount of damage caused by pollution. In such cases, the average costs for cleaning up such waste can be used instead of this value. The social-economic benefit of environmental protection is represented by the amount of damage prevented, which includes:

• reduction of medical treatment costs;

• increase in budget tax and social payments due to a decrease in temporary or permanent incapacity for work;

• reduction of damage from reproductive dysfunction;

• increase in budget revenues due to a decrease in the mortality rate.

World experience shows that conserving and recycling natural resources used in production is necessary not only for protecting the natural environment but also for ensuring ecological safety in economic activities as a basis for production growth in modern conditions.

Ecological and economic efficiency allows for the assessment of overall economic indicators in the product manufacturing process while considering its impact on the environment. When viewed comprehensively, an organization's ecological-economic system should be characterized not only by high efficiency in the use of material and labor resources but also by the ecological nature of economic activities, including an acceptable level of pollution.

Determining ecological and economic equality plays a significant role in quantitatively assessing the impact of production on the state of the environment. The role of rational use of natural resources is extremely important for sustainable development of production, which necessitates both the improvement of existing mechanisms for environmental protection and the development of new measures.

World experience shows the possibility of utilizing three main types of environmental management:

• administrative regulation — the introduction of relevant regulatory standards and restrictions that producers must comply with, as well as direct control and licensing of environmental management processes;

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• economic incentives related to the development of market mechanisms;

• a mixed type that combines the first two approaches.

In practice, when implementing administrative-legal measures, it is necessary to consider additional costs associated with their implementation and enforcement. Therefore, in our opinion, it is advisable to use mixed mechanisms that include state regulation and market tools to reduce the negative impact of agricultural production on the environment. Such an ecological-economic mechanism can be implemented comprehensively within a single program framework:

• Establishing environmentally safe fertilizer dosages that correspond to specific natural-climatic and production conditions;

• Quotas on the amount of nitrogen fertilizers provided to organizations at subsidized prices, as well as targeted programs aimed at supplying agricultural producers with mineral fertilizers and plant protection agents;

• Selling mineral nitrogen fertilizers at reduced prices beyond the quotas;

• The excess portion of the price is set in the form of a corrective tax that takes into account specific ecological damage;

• Funds collected from the corrective tax should be allocated to regional departments of the state body responsible for environmental protection.

The use of excess nitrogen fertilizers is not restricted; however, in this case, organizations must purchase them at a high price. The excess amount should correspond to the Pigovian corrective tax rate, which is determined based on natural, climatic, and production characteristics.

The introduction of a price threshold makes environmental pollution unprofitable and helps prevent additional ecological costs in the future. A reverse scheme can be considered, which provides for state compensation payments to agricultural organizations that voluntarily reduce the intensity of economic activities leading to negative changes in the state of the environment. In this case, the amount of payments should correspond to the difference in acceptable levels of ecological burden from the perspectives of economic and ecological requirements (see Table 1).

Table-1
Corrective tax rates [2]

When the maximum environmentally safe doses of fertilizers are exceeded, kg d.v. N/ga	The adjusted tax rate is from the average selling price %
<20	6,5
20-40	10,1
40-60	14,8
60-80	18,9
.>80	23,1

Developing a mechanism for regulating soil fertility is also relevant for regional conditions. Calculations show that, particularly due to the cultivation of vegetable crops that have high demands on soil fertility, the reserves of organic matter decrease by 0.5 tons per hectare annually. If this trend continues for ten years, a significant portion of the region's lands may lose more than 8% of their fertility.

CONCLUSIONS AND PROPOSALS

Regulating soil fertility should be anessential component of a set of measures aimed at creating sustainable agricultural production at the regional level. Targeted state subsidies for agricultural organizations should form the basis of this regulation to maintain soil fertility. In our opinion, subsidies should be provided in the form of bonuses for producers who successfully maintain and enhance soil fertility over a specified period. Conversely, full utilization of soil by enterprises, which leads to a decrease in organic matter and degradation of soil cover, should be reflected in punitive measures against them. The amount of monetary fines or bonuses should be calculated based on specific production and climatic conditions. In our case, social costs necessary for maintaining and restoring soil fertility should be taken into account.

Depending on the type of management of agricultural organizations, either bonuses are offered (when measures to improve soil are taken), or the farm is required to pay fines (if environmental efficiency is low). From the perspective of economically incentivizing agricultural organizations, it is more beneficial to encourage careful environmental practices rather than to be a subject of penalties. The implementation of the proposed measures will allow for a reduction in technogenic load on the environment, which, in turn, will contribute to the development of sustainable agricultural production with high ecological and economic efficiency.

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