Methodological principles of forming a mechanism for assessing environmental damage from the functioning and development of industrial real estate within the boundaries of the urban environment

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Abstract. It is not possible to imagine the implementation of investment and construction projects for industrial purposes in isolation from the environment. During the construction and further operation of enterprises, it is necessary to remember the close relationship between nature and man and plan the processes of waste disposal from harmful substances. In pursuit of profit, management often forgets about air and water purification measures, which causes deterioration of the natural environment around the enterprise, complaints from residents, loss of business reputation, and often financial losses due to the need to eliminate the consequences of emissions. Thus, during the construction of industrial facilities, an important task is not only the calculation of profits from operation, but also environmental protection measures, which must necessarily be carried out by enterprises. The growth of the country's economy largely depends on the growth of gross domestic product (GDP). In 1934, when this indicator was first introduced, it was most often used to understand how much the country is ready for hostilities and how many products enterprises can produce to ensure stable functioning. Later, in the 40s, the indicator was associated with the volume of industrial production, since the service sector at that time was poorly developed. And accordingly, the calculation of the GDP indicator was a very necessary mechanism: the growth of GDP per capita from one thousand to 10 thousand dollars meant a rapid leap in the material well-being of the population.

Keywords: industrial projects, environmental damage, problems of industrial enterprises, management of aggregate ecological and economic risk.

1 Introduction

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Today, the industry, consisting of a huge number of industrial productions, occupies a large construction share in the Russian economy. The quality of manufactured industrial products plays an important role in the social climate of the state, determining the economic power and independence of the country [1].

Therefore, the key place is occupied by large investment and construction projects, which are implemented mainly thanks to the state. These projects are characterized by a long implementation period and significant risks. But in the conditions of the current situation in the world, there is a need to develop modern Russian industry and strengthen its positions in the domestic and foreign markets.

To achieve this goal, the industry needs investment from private business. But investors need guarantees that the projects will be reliable, cost-effective and payback.

It follows from the above that increasing the investment attractiveness of large industrial investment and construction projects is an important task both for the economic climate of the country and for the development of the industrial sector [2].

According to the classification provided by Rosstat, the entire industry is divided into three major sectors: mining, manufacturing and electric power. Figure 1 shows the shares of the components of industry [3].

![Fig. 1. Distribution of industries in industrial production in Russia (2023).](image)

Table 1 shows the distribution of industries by specific weights in the total industry of Russia in 2023.

<table>
<thead>
<tr>
<th>Share, %</th>
<th>Mining</th>
<th>Manufacturing</th>
<th>Electricity generation and heating</th>
<th>Water supply, sanitation and waste disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>39</td>
<td>51</td>
<td>7</td>
<td>3</td>
</tr>
</tbody>
</table>

One of the important features that distinguishes industrial construction from civil construction is that industrial facilities are divided into different types, depending on their purpose. These can be industrial buildings, workshops and factories, as well as hangars,
warehouses and specialized technological facilities. Based on this, each type has certain specifics of design, construction and further operation [4].

The basic principles of industrial construction were formed in the second half of the 20th century: the leading scientific and design institutes of the USSR carried out research and experimental work, thanks to which organizations engaged in industrial construction were provided with an advanced scientific and regulatory framework.

It was at that time that standard load-bearing and building structures, engineering networks were developed, which properly provided a comfortable stop inside industrial enterprises, and the basic principles of the construction of industrial facilities were also developed.

In addition, when implementing an investment and construction project of industrial real estate in the structure of the urban environment, it is important to pay attention to the specific features of industrial facilities that must be taken into account at the design stage of buildings and structures[5]:
- use of specific types of transport and equipment;
- release of harmful substances, as a consequence of entailing pollution of the environment and atmosphere;
- availability of engineering networks and structures on the territory of the enterprise;
- continuous improvement of production technologies (updating of the material and technical base, zoning of premises, etc.).

The efficiency of the entire industrial facility, as well as the health and safety of the people working in it, depends on how much the construction organization has approached compliance with all technical requirements [6].

2 Materials and Methods

One of the important stages in the implementation of the ICP of an industrial facility is the selection and preparation of a land plot. When organizing industrial production, it is necessary to focus on Article 8, Article 78 and Article 88 of the Land Code of the Russian Federation, which specifies the conditions for conducting this process legally, not to the detriment of the population and ecology of a certain territory of the city.

Let's consider the main types of negative impact on the urban environment from the functioning of an industrial enterprise [7].

The first type is directly related to the consumption of natural resources entering the production process (minerals extracted from the subsoil, built-up land, etc.); the second is pollution of the water and air oceans by harmful emissions at the output of production processes.

The ecological consequences of both types are extremely diverse in nature. The loss of a natural resource can be complete or partial (deterioration of water and air quality as a result of pollution), final or recoverable (water pollution, death of a forest area). The loss can be felt by the enterprise that caused it (air pollution), or manifest itself outside of it (harmful discharges into rivers). Finally, the consequences of such losses may occur immediately (death of fish during the discharge of pollution) or only in the distant future (flooding of a promising deposit). Thus, many economic and investment measures, seemingly even of a local nature, aimed at saving a single natural resource, can be accompanied by negative consequences outside the enterprise that caused them and after many years, accumulating over time. In all cases, such losses cause damage to the national economy [8].

What should be done to ensure that the company that caused the damage directly felt it on its indicators? How can such damage be economically assessed at all? To successfully
solve the issue, it is necessary to know what monetary value is a unit of any kind of natural resources—a ton of ore in the subsoil, a cubic meter of fresh water, a hectare of agricultural land, a hectare of forest, etc.

In other words, it is necessary to have a unified system of assessments of the most important types of natural resources. The indicators of these assessments should be directly reflected in the composition of the working criteria for justifying the economic efficiency of production and investment decisions [9].

Therefore, the value of the resource estimate inevitably changes over time. In addition, time-dispersed costs are generally known to be economically unequal, which creates a number of additional difficulties. With particularly long periods of evaluation of many natural resources (forests, mineral deposits), a number of specific issues related to the dynamics of the reduction rate, taking into account the growing limitations of a number of natural resources and other aspects of the reflection of the time factor, which here receive peculiar forms [10-12]. From what has been said, it is clear how much more complex and multifaceted the requirements for the national economic assessment of natural resources are compared to those that can be provided in terms of current profits.

3 Results

In order for the estimates of individual resource volumes to be comparable, they should be based on uniform design and value standards, take into account the same level of production organization. The actual costs of enterprises cannot be used as the basis for such estimates, since they are carried out at different levels of production, at different times and according to different standards. Only the design calculation method can provide a uniform degree of rigidity of such estimates.

It is impossible not to agree that as a result of pollution, there is a loss of net production and profit of the enterprise—a shortage of crops, a decrease in forestry, fisheries, etc. The magnitude of this damage according to the first of the concepts under consideration is calculated by multiplying the profit attributable, for example, per unit of agricultural crop, by the volume of its crop shortage. The resulting estimate reflects the self-accounting value of losses, but, apparently, it does not take into account the entire complex of costs arising in the national economy in this case [13-15].

Today, the market of industrial facilities in Russia cannot be called prosperous. For the most part, it presents old premises that require major repairs:
- industrial facilities that are used for their intended purpose, but are not properly equipped with modern technological equipment;
- military and state facilities;
- enterprises of Soviet times.

If we touch on the forecasts of experts about the growth in demand for industrial facilities, we can identify quite optimistic indicators.

If an industrial facility belongs to the category of warehouses, then they will be in regular demand.

However, in order to bring the industrial market to a competitive and in-demand level relative to world analogues, it is necessary to find solutions to eliminate the following problems related to the investment support of industrial enterprises in the urban environment, presented in Figure 2.
Fig. 2. Problems of investment of industrial enterprises in Russia.

To analyze integrated risk based on accounting modeling, it is necessary to simultaneously compare derivative balances of various types of industrial real estate, reflecting as separate factors the structure and situational aspects of various types and types of environmental management and environmental protection.

<table>
<thead>
<tr>
<th>Types of risks</th>
<th>Th e p o w e r of e x p o s u re to r i s k , %</th>
<th>Derivative balance sheet instruments of aggregate environmental and economic risk</th>
<th>Analysis of the reserve system level</th>
<th>Control level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit risk</td>
<td>60-65</td>
<td>Hedged balance sheet, Correspondence on risk operations, Report on aggregate risk, Conditional correspondence, Derivative balance sheet of aggregate risk, Adjustment of coefficients in the system of  $\beta$-coefficients</td>
<td>General assessment, SWOT analysis, Strategic management, Resource management</td>
<td>Reorganization procedures</td>
</tr>
<tr>
<td>Operational risk</td>
<td>20-25</td>
<td>Reflected by the risk environment assets, Calculation of net assets of total risk, Conditional realization of assets and satisfaction of environmental assets of total risk, Derivation of net assets, liabilities and the price coefficient, Adjustment of the difference between environmental net assets and calculations of the size of the minimum allowable value of risk, Strategic derivative balance sheet, Based on derivatives balance sheets, Reorganization accounting</td>
<td>Capital, Decision making, Strategic planning, Reorganization accounting</td>
<td></td>
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Table 2. Accounting and analytical support for the management of aggregate environmental and economic risk.

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Each economic system is more or less affected by the cumulative environmental and economic risk, and internal and external resources are mobilized in the form of the enterprise's reserve system to neutralize its consequences (Table 2).

The author's approach is broader. Since the lost products were a priori recognized as socially necessary and it was assumed that they provided satisfaction of national economic needs, then, obviously, these products should be reproduced. And inevitably, sooner or later, additional economic compensating costs arise — the costs of compensation (compensation) for lost benefits. The damage from product losses according to this concept is estimated by the amount of differential rent. It is assumed that the rental assessment reflects an increase in the economic effect of the exploitation of a natural resource or a decrease in the effect (the occurrence of damage) that occur as a result of the refusal to use it (a decrease in its quality, productivity). The amount of differential rent depends on the marginal (closing) costs, which are understood as the reduced costs of obtaining an additional unit of production from the closing consumer, and the amount of individual costs for the production of this type of product [16-19].

According to this approach, the numerical value of direct losses (for example, shortage of agricultural products as a result of environmental pollution) is determined not so much by the indicators of the object under consideration directly, as by additional economic costs for compensation of losses. This concept can be called reproductive. In our opinion, it more accurately reflects the national economic approach to assessing losses and allows us to take into account the limitations and non-reproducibility of a number of natural resources. However, currently there are no approved standards for closing costs for products of nature-exploiting industries, and therefore the first approach is more applicable in practical calculations [20].

Damage is often suggested to be measured by the costs of preventing environmental pollution. Such a method is possible on the premise that if you refuse to implement the costs of preventive measures, then the national economy will incur costs even greater than the costs of pollution prevention.

It seems to us that, since the damage from pollution is associated with the spread of the concentration of harmful impurities in space and time, direct losses and additional costs should be highlighted in its composition. The total economic damage from pollution consists of a number of components that consistently arise as the concentration of ingredients increases over time and their impact on various objects.

The first of these components is the cost of preventing the effects of the polluted environment on various objects of U1. This type of cost allows you to prevent the negative
impact of harmful substances contained in water and air on other objects. This includes additional costs for cleaning
contaminated water before using it for drinking and technological purposes, costs for air conditioning in the workplace, etc.

The second component includes direct (unremunerated) product losses expressed in monetary form U2. Here there is a direct impact of the polluted environment on the object. These are losses from a decrease in yield, productivity, a decrease in the volume of output, deterioration in the quality of fish stocks, crop crops, etc., calculated on the basis of marginal (closing) costs for the products of nature-exploiting industries.

The third component can be attributed to the costs of eliminating the consequences of pollution at this U3 object. This includes, for example, the costs of clearing the forest that died as a result of pollutants, the costs of cleaning a reservoir affected by pollution, the costs of breeding fish in it, the costs of special treatment of a contaminated agricultural site.

It is impossible not to agree that as a result of pollution, there is a loss of net production and profit of the enterprise – a shortage of crops, a decrease in forestry, fisheries, etc. The magnitude of this damage according to the first of the concepts under consideration is calculated by multiplying the profit attributable, for example, per unit of agricultural crop, by the volume of its crop shortage. The resulting estimate reflects the self-accounting value of losses, but, apparently, it does not take into account the entire complex of costs arising in the national economy in this case.

And finally, the fourth component of economic damage includes the costs of U4 to compensate for the damage caused by connecting other external sources that make it possible to make up for the lost benefits (development of new agricultural plots to replace those that have been retired, obtaining missing volumes of products from external sources, additional costs of rearing young animals on other sites).

The first component of economic damage prevents the influence of the polluted environment on the object, the next three arise from the direct impact of the polluted environment on it. Direct losses of U2 are estimated by the amount of lost rent (or profit in the absence of calculated values of closing costs), the calculation of the remaining components is based on the indicator of reduced costs.

4 Discussion

The definition of damage by the value of U2 can be interpreted as an assessment that allows you to find out what it will cost society to refuse to carry out environmental measures, and calculate the amount of natural losses. When assessing the damage by the values of U3, U4 has the opportunity to decide what is more profitable for society: to prevent the consequences of pollution at the source of their occurrence or to seek funds for their compensation and elimination.

Sometimes the amount of damage is characterized by the amount of costs necessary to achieve a predetermined final result, which makes sense and simplifies the time-consuming procedure for obtaining numerical values of economic damage.

Methods of assessing the totality of social consequences that society and an individual bear as a result of environmental pollution remain relatively poorly developed. A sufficiently detailed analysis of the elements of social damage can be carried out rather at a qualitative level, although some of them can also be given an economic assessment. The social consequences of environmental pollution appear primarily in the following: deterioration of public health; reduction of workers' free time; dissatisfaction with working conditions and place of residence; increased migration of the population from polluted
areas; increased time and costs for recreation; deterioration of the quality of food that were exposed to pollution; decrease in the prestige of the profession; increase in time for household services.

Indirect economic estimates have been found for many of the social consequences of pollution. Thus, the damage from the increased morbidity of the population is proposed to be determined by additional expenses from the public consumption fund for social insurance (including payment of sick leave, disability pensions), expenses from the state budget for medical care. The retirement of an employee from the sphere of material production leads to direct losses, manifested in a decrease in the output of industrial products, the cost assessment of which is part of the damage from increased morbidity associated with environmental pollution. The estimate of one man-hour of labor, which, according to some calculations, is 560-830 rubles, can serve as a basis for communication with the loss of working (as well as free) time. The damage caused by pollution of recreational areas can be represented as the sum of the costs of cleaning them, the costs of developing new territories, and an increase in transport costs.

5 Conclusions

The most difficult thing in the problem of assessing the magnitude of damage is to identify the entire chain of possible negative consequences that arise as a result of industrial emissions, and to take into account the complex of costs that arise. It is still difficult to determine in monetary terms such types of environmental damage as the loss of unique, completely non-recoverable, uncompensated natural resources. It is difficult to estimate in money, for example, the loss of a relict forest, beaches of the sea coast, damage from the cutting down of virgin mountain forests, the destruction of whales, etc. It is equally difficult to calculate the economic significance of the forest as a supplier of wood, mushrooms, a place of rest and recuperation of a person. It is also not easy to find a number of other manifestations of damage, the principal methodological approach to the calculation of which is quite clear in itself.

Thus, we do not yet have sufficiently clear numerical characteristics of the effect of a number of harmful compounds on human health. In such cases, the economic assessment of the effectiveness of environmental protection measures remains incomplete, and it has to be supplemented with indications of the presence of additional environmental and social effects.

Consideration of the environmental consequences caused by the implementation of a particular production or investment decision should be carried out within the framework of a single calculation of its economic efficiency as a whole. The simplest and sufficiently justified method of such accounting is to include additional monetary assessments of environmental consequences in the costs covered by the efficiency criterion. As noted above, such consequences are reflected in the form of indicators of the economic assessment of natural resources or monetary damage caused to the environment. Calculated for the entire volume of the lost (or polluted) natural resource according to the variant, these additional cost components are introduced into the composition of the efficiency criterion. The option that turned out to be optimal in terms of the value of the criterion calculated by this method best combines production and environmental costs and effects. If it is accompanied by a certain environmental damage, then its value is economically justified and compensated by the input of the closing source of the corresponding natural resource.

Thus, when calculating the effectiveness of reconstruction projects, new equipment, etc., the composition of the economic effect they bring should additionally include a monetary
assessment of the $E_{\text{econ}}$ of the environmental effects achieved: $E_{\text{integral}} = E_{\text{econ}} + E_{\text{ecol}}$. Payback periods, the above costs and other criteria for the final effectiveness of the reconstruction projects under consideration, new equipment are calculated with the appropriate inclusion of the $E_{\text{ecol}}$ effect in them.

In cases where pollution of a natural resource in excess of the established standard is considered unacceptable for non-economic reasons, the requirements for not exceeding the level of pollution are formulated in the form of special strict restrictions when setting the task.

Within the framework of the same problem of evaluating the effectiveness of production solutions, the tasks of determining the effectiveness of environmental protection measures themselves are of interest.

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