Organizational and economic problems of ecological safety in construction

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Abstract. Nowadays it is necessary to make the environmental impact assessment (EIA) in order to identify, analyze and take into account the direct and indirect effects of environmental impact during the planning of design consideration for construction projects. The results of this assessment determine the aftereffects of a certain construction project’s implementation. These results are the objective information about the future state of the environment of the territory for making decisions on the implementation of the planned project.

The economic component of this assessment is the determination of the cost of implementing measures to protect the environment of a given territory. Current design trends have a tendency to change the criteria for planning the construction projects. It is important to make the managerial, technical and commercial decisions during the project development in favor of the environmental safety of the construction industry. During the criteria of the assessment development, it is necessary to take into account the prevention measures. It is important to prevent the pollution but not to monitor and eliminate the negative effects.

This article considers an example of the calculation of the criterion for choosing the environmental pollution control measures which can reduce the construction cost. These calculations make it possible to determine the environmentally and economically suitable area for the construction of an object in the populated area.

Introduction

Nowadays it is necessary to make the environmental impact assessment (EIA) in order to identify, analyze and take into account the direct and indirect effects of environmental impact during the planning of design consideration for construction projects. The results of this assessment determine the aftereffects of the implementation of a certain construction project. These aftereffects are the potentially possible changes that can take place in the environment, including in the lives of people after the implementation of construction as well. The results of this assessment are objective information about the future state of the environment of the territory for making decisions on the planned project’s implementation. The economic component of this assessment is the determination of the costs of implementing measures to protect the environment of a given territory.

The conditions for the long-term environmental management of territories at the moment are the necessity for the introduction of environmental aspects into the urban area development plans and into the development construction projects. The important conditions are also predictive calculations of the
environmental and economic impacts that need to be carried out at all stages of investment and construction activities. [1, 2]

Practically the environmental safety issues at the planning and design stages are performed in the projects as the environmental protection measures which are focused on the reduction of the negative impact, but not on its prevention. [3] The development of the technical and technological concepts, criteria for the location of construction sites, the selection and the comparison of materials and structures are analyzed for environmental safety. [4] Thus, the strategy of economic calculation of liquidation of consequences dominates now, but the prevention of possible negative economic consequences is profitable in practice.

Ecological and economic criteria for assessing the environmental impact of construction activities
The system of environmental impact assessment should include the social, environmental and economic factors. These factors combine ecology and economy. This process helps to avoid the separation of the costs for construction operations and environmental protection, commercial and public benefits and losses, criteria for assessing the effectiveness of environmental and socio-economic costs.

Current design trends have a tendency to change the criteria for planning the construction projects. It is important to make the managerial, technical and commercial decisions during the project development in favor of the environmental safety of the construction industry. Nowadays the criteria for growth of construction production, capacity extension to meet the needs are no longer the main goals of the economy. The economic assessments of construction projects get better and change with dominating environmental factors.

The current criteria for environmental impact assessment of the project are the implementation of various environmental solutions in the design of the construction project. These solutions are focused on preventing the environmental problems, improving the quality of design, and preserving the environment in its original form.

The problem of integrating environmental and economic performance indicators should include two main tasks:
1. Assessment of socio-economic aftereffects caused by the impact on the environment.
2. The overall economic assessment of the planned design decisions of the object, taking into account the impact on the environment during their implementation.

These calculations must be carried out at all stages of the development of project documents.

The procedure of conducting the environmental impact assessment should consist of several stages:
1. Definition of the objectives of the proposed construction activity, the validity of its results, environmental requirements and restrictions, public and economic preferences for the implementation. All this information should be the source data for environmental and economic calculations.
2. Formation of socially necessary, potentially feasible, technically feasible alternatives of the construction in order to satisfy the goals. The sources and types of environmental impacts and the consequences of those impacts are determined for all the alternatives. Then the alternatives that do not meet the environmental requirements and restrictions are excluded.
3. Definition and assessment of socio-economic consequences after the implementation of the alternatives under consideration. The calculation of the total alternatives’ implementation costs. The comparative analysis of the alternatives’ cost-effectiveness according to the criteria of the assessment. The analysis should include a comparison of alternatives by determining the total cost of each alternative implementation according to the identified level of environmental impact. Comparison of the impact and consequences degrees of the alternatives’ implementation will allow to determine the more effective alternative correctly [7].

Calculation of the criterion for determining the environmentally and economically suitable area for the construction site of an object
Let’s consider an example of the calculation of the criterion for choosing the environmental pollution control measures which can reduce the construction cost. These calculations make it possible to
determine an environmentally and economically suitable area for the construction of an object in a populated area.

The reduction of the costs associated with environmental safety organization is provided with the mathematical model adaptation. It can identify a number of possible actions that assess the harm done to the environment and reduce the cost for its restoration.

This model is associated with the economic costs of restoring the environment polluted by emissions. Together with the previously reviewed facts, this functional gives a fairly complete picture of the possible consequences of environmental pollution and the economic costs of its restoration [8].

Since, the emissions from the construction operations tend to oppress the environment, including population and other environmental components, it is important to give an integral, over the entire region $\Sigma_o$, estimate of loss due to constructional emissions.

According to this, let us consider differential characteristics that describe the number of people in a given territory $l$ done harm due to dust pollution $j$ referred to a unit area per time unit of unit dust concentration. Let us denote it by $n_i b_{jl} \ (j=1,2...,m; l=1,...,s)$, where $n_i (x,y)$ is the density of the $l$ population in $\Sigma_o$ and $b_{jl}$ is data of sick people calculated per unit density. Then the total annual number of people of a given territory $l$ due to dust pollution at concentration $\phi_j$ in $\Sigma_o$ is defined by the formula:

$$\beta_j = \int_0^T \int_0^1 \sum_{i=0}^s n_i b_{jl} \phi_j d\Sigma$$

(1)

Let $\beta_j$ be the costs of medical care. The total costs of medical care due to pollution in such case will be equal to

$$c_j = \int_0^T \int_0^1 \sum_{i=0}^s \beta_j n_i b_{jl} \phi_j d\Sigma$$

(2)

If we sum up $c_j$ the overall population of a given territory $l$, we obtain

$$c_j = \int_0^T \int_0^1 \sum_{i=0}^s p_{jl} \phi_j d\Sigma$$

(3)

where

$$p_{jl} = \sum_{i=1}^s n_i \beta_j b_{jl}$$

(4)

The values $b_{jl}$ showing the level of physiological oppression of a population with dust of a given type are obtained on the basis of experimental studies. It may be noted that at large concentrations of pollutants, $b_{jl}$ ceases to be linear functions. Now, if we sum up the results of the overall components of the dust discharged by construction production, we obtain the total number of the people with diseases caused by the pollution in the region:

$$c = \sum_{j=1}^m \int_0^T \int_0^1 \sum_{i=0}^s p_{jl} \phi_j d\Sigma$$

(5)

Let us now formulate the optimization problem. Here we consider $m$ problems corresponding to the basic emissions components:
\[
\frac{\partial \phi_j}{\partial t} + \text{div} \, \mathbf{u} \cdot \mathbf{\phi}_j + \sigma_j \phi_j = \frac{\partial}{\partial z} \left( \frac{\partial \phi_j}{\partial z} \right) + \mu \Delta \phi_j + Q_j \delta \left( r - r_0 \right) \quad (6)
\]

\[
\phi_j = 0 \quad \text{on} \quad \Sigma, \quad \frac{\partial \phi_j}{\partial z} = \alpha \phi_j \quad \text{on} \quad \Sigma 0, \quad \frac{\partial \phi_j}{\partial z} = 0 \quad \text{on} \quad \Sigma H, \quad \phi_j \left( r, T \right) = \phi_j \left( r, 0 \right), \quad j = 1, 2, \ldots, m,
\]

and \( m \) adjoins problems:

\[
-\frac{\partial \phi}{\partial t} - \text{div} \, \mathbf{u} \cdot \phi + \sigma \phi = \frac{\partial}{\partial z} \left( \frac{\partial \phi}{\partial z} \right) + \mu \Delta \phi + p_{0j} \delta (z) \quad (7)
\]

\[
\phi = 0 \quad \text{on} \quad \Sigma, \quad \frac{\partial \phi}{\partial z} = \alpha \phi \quad \text{on} \quad \Sigma 0, \quad \frac{\partial \phi}{\partial z} = 0 \quad \text{on} \quad \Sigma H, \quad \phi \left( r, T \right) = \phi \left( r, 0 \right), \quad j = 1, 2, \ldots, m,
\]

We assume that the problems (6) and (7) are solved. Let us now consider the functional:

\[
I_j = \int_0^T \sum_0 p_{0j} \phi_j \, dt \quad (8)
\]

Its dual form is written by solving an adjoin equation and takes the form:

\[
I_j = Q_j \int_0^T \phi \left( r, \tau \right) \, dt. \quad (9)
\]

It is important to note that in case of the functional in question problem (7) is solved only once for a fine dust. Further we compute the function \( \phi \left( r, t \right) \) and find the region \( \omega_B \) where the cases of diseases due to polluted environment will be minimum. Thus, along with the region \( \omega_C \) introduced for ensuring satisfaction of sanitary requirements for ecologically important objects, there appears a region \( \omega_B \) where conditions of permissible environmental effects for the region \( \Sigma_0 \) are fulfilled. The intersection of these regions, see in Fig. 1, gives the most suitable area for locating a new construction site. [6]
The calculating of the area suitable for placing a new construction site

**Figure 1.** The calculating of the area suitable for placing a new construction site

**The economic costs determination during the environmental assessment**

The important factor in determining the total cost for implementation of the considered alternative is the indirect costs consideration. The ecological and economic assessment of a curtain project for the construction production should include only indirect costs, related to the environment. These indirect costs are the resource extraction, the development of the energy and construction base, transport infrastructure, etc. The methods of calculation and the number of estimated factors depend on the stages of investment and construction activities (investment, pre-project, project).

During the feasibility study for the construction, reconstruction or technical re-equipment development, it is necessary to calculate the full costs throughout the entire building’s life cycle; i.e. the construction cost should include not only the costs for the development of the project documentation and the implementation of the construction production, but also such costs as liquidation, technical means ensuring environmental protection during the operation of the building, standby funds for contingencies etc. [5]

It is necessary to calculate the expenses associated with this construction work in detail. It is necessary to avoid uneven expansion of cost indicators in environmental and economic calculations. For example, if the cost of natural resources is not uniquely determined and does not find reflection in real financial flows, then its special calculations in one project are no more useful than the natural indicators of their use degree. Such calculations can only distort the estimate. In this case, it is much better to use a part of the indicators in kind for total costs when justifying one or another version of the project.

If the calculation of environmental and economic indicators is carried out at the stage of preplanned development of a regional or construction industry-specific level, the results of such calculations should show the share of industrial investment in the implementation of the planned business decisions with unconditional implementation of the environmental constraints and requirements laid down in the target installations. Thus, the future environmental tasks must be solved with the help of the production investments without limiting the many ways to solve them.

The environmental investment must keep in the special environmental protection funds. These funds will supply construction production with money expended on the restoration of ecosystems, natural resources, on compensation for losses due to the expropriation of land from agricultural use as a result of the diminishing of fertility, on social decisions, caused by ecological consequences. These ecological consequences are temporary the local pollution of atmospheric air due to the construction work, resettlement of people from the environmentally hazardous living areas, arrangement of new places of settlement and workplaces, standby funds for emergency situations that may entail serious environmental consequences.

The environmental and economic calculations in the environmental impact assessment are the regulators of the search for optimal rates, proportions, structures, principles of spatial location of construction sites at the initiatory stages of strategic planning. The alternatives of electricity equipment and electrical source at a construction site for the analyzed construction period must be chosen according to both the cost estimating of energy facilities and environment safety.
It is necessary to take into account all the elements of production and infrastructure providing those construction operations (materials and its transportation, waste disposal, methods of energy transfer and use, the period of operation of facilities etc.), and regional features when placing the construction sites [9].

These factors can complete the complex ecological assessments of the construction site location territory selection or the actual construction project for realization selection. When the impacts of the additional productions associated with this project outside the site are be taken into account, the construction methods and places for construction sites location in the region at an earlier stage of planning will be chosen. This data should be added to the new EIA methodology for decision-making and the creation of a subordinate system of environmental-economic assessments for analyzing the data from all stages of an object life cycle.

EIA is not a separate appraisal report of the selected decision, but a research process that is an integral part of the preparation of the proposed solution for implementation. It describes various aspects of the project. The ecological component is very important, but environmental and economic aspects of this assessment are also important. The assessment is not only a report; it is a system of study which proves a judicious choice of construction project implementation. The results of EIA are the assessment of many environmental-economic aspects of the alternative projects.

The ecological and economic calculations at all the stages of investment and construction activities should give a comprehensive socio-environmental-economic assessment, summarizing all the projected consequences of the implementation of the planned construction operations in the integral indicators of social costs. The distorted idea of the ecological effectiveness of construction, which is created by formal indicators will be improved.

The environmental impact assessment conducted during the construction of the new facilities planning should include a number of socially oriented values. The main role is given to solving environmental problems. Current trends in the development of environmental safety in construction are already beyond the scope of a single condition for assessing the effects. It is necessary to develop a system of criteria that are primarily needed to assess the impact on human health.

The principles of the criteria assessment development are general, independent of the stage of preparation of the decision and the public sentiment. They should reflect the strategy of rational nature management, taking into account the long-term prospects and consequences of the activity being carried out [10].

Summary
During the criteria of the assessment development, some preventive measures should be taken into account. It is important to prevent the pollution but not to monitor and eliminate the negative effects. The modern EIA realization is conformed to the following principles:

1. The substantiation of the construction operations expediency, taking into account its load on the environment. It is necessary to conduct the environmental assessments at the earliest stages of the project preparation, making decisions about the area socio-economic development.
2. The search for ways to reduce the load on the environment expansion.
3. The assessment must be multivariate.
4. The enhancement of research to improve the methods for predicting the effects and calculating the environmental-economic indicators adequately reflecting those effects.
5. The complexity of assessments that integrate technological, material and other aspects of the proposed activity.

This complexity is realized in:
- considering the related activities and processes connected to the proposed construction operations;
- identifying cause-effect relationships between environmental consequences, that seem to be out of touch with changes in the environment;
- conducting a secondary EIA which should correct the assessment and determine the economic indicators.
6. The criteria of the assessment should include not only territorial attributes of biological and geographical aspects, but also the regional interests of the population: living conditions, employment, cultural, ethical, historic and other aspects.

The environmental and economic project performance figures should comprehensively reflect the identified effects without unreasonable expansion of the role of cost indicators.

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