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ENVIRONMENTAL IMPACT ASSESSMENT AS PART OF THE FEASIBILITY STUDY OF PROJECTS

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ABSTRACT

The tasks of environmental assessment of projects are to determine quantitative criteria for decision-making on the admissibility or inadmissibility of the project, to ensure the choice of options and types of planned economic activities with the lowest environmental and social costs, to obtain quantitative criteria for assessing the effectiveness of environmental measures. project implementation. Environmental assessment accompanies all stages of the project-investment cycle. One of the main principles of evaluating the effectiveness of projects is the inclusion of environmental results and costs in the cash flows that are taken into account in the analysis of the project. According to the traditional cost-benefit economic analysis, a project is considered effective and feasible if the benefits outweigh the costs. The paper presents modified methods of expert and environmental assessment that accompany all stages of the project-investment cycle of the project. The authors propose harmonization of approaches to environmental impact assessment, which are used in national and world practice. The methodology is shown, which is aimed at generalizing the Ukrainian and international experience in EIA and specifying the evaluation criteria. Developed and proposed methodological aspects of environmental impact assessment can be used to develop a final EIA. The study describes a comprehensive impact assessment for any components of the environment. The proposed criteria allow us to draw specific conclusions on the assessment of the impact on each environment, which is a priority in the environmental assessment.

Keywords: Project; Environmental Project Assessment; Environmental Impact Assessment; Comprehensive Environmental Assessment; Methodological Aspects of Environmental Assessment

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INTRODUCTION

The tasks of environmental assessment (EA) of projects are to determine quantitative criteria for decision-making on the admissibility or inadmissibility of the project, to ensure the choice of options and types of planned economic activities with the lowest environmental and social costs, to obtain quantitative criteria for assessing the effectiveness of environmental measures. rates of return during project implementation [1, 2].

EA accompanies all stages of the project investment cycle. One of the main principles of evaluating the effectiveness of projects is the inclusion of environmental results and costs in the cash flows that are taken into account in the analysis of the project. According to the traditional economic analysis "cost – benefits" the project is considered effective and suitable for implementation if the benefits (B) exceed the costs (C): B-C> 0.

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Complex EA includes: assessment of project effectiveness from the standpoint of the environmental component; assessment of the effectiveness of environmental measures implemented under the project (calculation of the cost-effectiveness indicator of an environmental nature). Thus, in both cases, the economic and environmental components are very closely interrelated and inseparable from each other.

The Environmental Impact Assessment (EIA) method is needed to make decisions on the rationality of project implementation taking into account environmental issues identified at the project initiation stage, to include in projects processes and measures aimed at improving environmental quality and preventing, reducing and compensating for environmental damage [3].

In the project-investment stage, the most informative is a detailed assessment of the project, the essence of which is to provide complete and reliable information about the project.

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Currently, assessing the environmental performance of a project is the most difficult. It is possible to conduct EA and identify compliance of the project with environmental requirements only if its preparation was accompanied by an EIA.

FORMULATION OF THE PROBLEM

The purpose of EA is to ensure that projects, development plans, programs are acceptable in terms of environment and sustainability. EO is a planning process used to predict, analyze, and interpret significant environmental impacts of planned activities, as well as to provide information that can be used in decision-making [4, 5].

EA can be used to prevent or minimize adverse impacts, while helping project-oriented organizations assess the real potential of their resources, maximizing the benefits of planned activities [6, 7]. This is a process that can: change and improve the project of the planned activity; ensure efficient use of resources; to improve the social aspects of the planned activity; identify monitoring and impact management measures; to promote the adoption of sound decisions.

Successful practice of EA plays an effective role in the implementation of planned activities. When facilities are built and commissioned, or projects are completed, adverse environmental impacts can be further reduced through appropriate mitigation and monitoring measures [8].

In the EA project we get three main values of EIA: sustainability – the result of the EA process will be environmental safety; integrity – the EA process will meet agreed standards; usefulness – the EA process will provide balanced, reliable information for decision making.

The result of the EA project will be [9, 10]: accurate and relevant information on the nature, probable magnitude and significance of the potential impact, risks and consequences of the planned activity and alternatives to its implementation; an impact statement or report presenting this information in a clear, understandable and appropriate form for decision-making, including information on the assumptions made and the limits of reliability in the impact forecasts; resolution of emerging problems and conflicts within the limits of the process.

RESEARCH METHODOLOGY

The development of the section "Environmental Impact Assessment" in the projects should be considered as a single process of consistent detailing and refinement of quantitative and qualitative assessment of the impact of the project solution on the quality of the environment [11].

In order to identify and take the necessary and sufficient measures to prevent possible unacceptable consequences in the process of analysis and assessment of the impact of the planned activities on the environment, the developer shall substantiate the following documentation [12, 13]:

1) the purposes of realization of the plan or the supposed project;

2) reasonable alternatives to the planned activity;

3) information on the state of the environment on the territory of the intended implementation of the planned activity in the relevant spatial and temporal framework;

4) characteristics of project and other proposals in the context of the existing environmental situation in a particular area, taking into account previously adopted decisions on its socio-economic development;

5) possible consequences of the implementation of the planned activity and its alternatives;

6) measures to prevent unacceptable for society consequences of the implementation of decisions;

7) proposals for the development of a program for monitoring the implementation of the prepared decisions and the plan after the project environmental analysis.

In the process of developing the EIA section as part of the feasibility study should be performed: analysis of natural, climatic conditions and technogenic situation of the construction area; comprehensive assessment of the existing and expected state of the environment (based on the proposed methodology); development and implementation in the design solution of a set of tools aimed at preserving, reclamation or transformation of the natural landscape, protection of the population from industrial and transport pollution; control and management of changes in the existing environment that will occur during the implementation of the project solution at the end of the calculation period; preparation and submission of data on the forecast quality of the living environment on the territory of the projected construction.

In the process of approvals and approval of the project, if necessary, assessments of the impact of the results of the adjustment of the project solution on the quality of the environment, which is designed for the period of construction and operation.

Sources of initial information in substantiating the site location may be materials of specially authorized state bodies in the field of environmental protection and their territorial subdivisions, published and stock materials of scientific organizations and departments, data of statistical reporting and environmental monitoring, engineering surveys and environmental data on analogous objects, calculations and forecast models [15].

As source information you can use:

– cadastral maps of natural resources, maps and maps-schemes of components of the natural environment (soil, geobotanical, fauna, etc.), maps of groundwater protection, etc;

– data banks on production and consumption waste;

– scheme of the natural complex;

– map of engineering-geological zoning of the district according to the activity of karst-suffusion processes;

– scheme of hydrogeoecological zoning;

– computer database on stationary sources of air pollution;

– hydrological and water management materials;

– sanitary and hygienic information.

The EIA section should consist of the text of the report, graphic and text appendices.

The introduction covers the following issues: geographical and administrative location of the work area, characteristics of the topography used, purpose and exact task, profile and characteristics of the designed object, planned and actually performed volumes of all types of works in the form of tables, terms of works. At the end of the chapter, the main executors of design and survey works, authors of the report, managers and consultants are indicated.

An illustration to this section is an overview map of the work area.

In the section “Current state of the environment” it is necessary to comprehensively reflect:

– the current state of all components of the ecosystem, including the characteristics of the aquatic environment, description of flora and fauna, recreational and other, specially protected areas (forest parks, architectural ensembles, historical monuments) and other ecological characteristics;

– the formed socio-economic structure in the area of the object;

– brief information on current and future use of the territory (according to schemes and development programs);

– restrictions on nature use;

– information on existing sources of impact on various components of the ecosystem.

In this section it is necessary to show the final information on the state of the environment with a sufficient degree of detail to be able to assess all the significant areas of environmental impact inherent in the proposed project. Existing natural conditions should be described in terms of their main characteristics, which will be compared during the operation of the proposed project (if it is implemented).

The role of each element of the environment in the project location and the probability that it will be affected should determine the scope and depth of the main study.

In some cases, the collection of the necessary data may require large-scale analysis and / or long-term monitoring programs.

It is especially worth noting once again that environmental impact assessment is an independent research and production process that often requires special research, which should be conducted by specialists in this field. The decision on the fundamental possibility and expediency of construction of objects depends on the correct interpretation of the received data.

It should be emphasized that there are different research methods. It is necessary to carefully approach the choice of the optimal and implemented in practice method in each specific geoecological situation.

At the beginning of the section “Current state of the environment” it is necessary to briefly describe the functional organization, man-made load of the territory, relief, geomorphology and geological structure of the territory.

Information on the man-made load includes a brief description of its population, the functional organization of the territory, the degree of man-made change, etc.

When describing the relief, its character, degree of intersection, absolute marks, excess of the main forms of relief over river valleys, the general nature of the change of relief in the territory are noted.

Geomorphological characteristics include a brief description of landforms, characteristics of the dependence of landforms on the composition of rocks and geological and structural features of the area. River terraces are covered in more detail, the number and types of terraces, their width, height and nature of the surface are indicated.

The description of the theological structure should indicate the distribution, lithological-facial composition, conditions and depth (in meters from the surface and in absolute terms), as well as the thickness of each horizon, cracking, cavernous.

In the section “Impact on the environment during the construction and operation of structures” should be quantitative (or qualitative) indicators of the degree of impact of the designed structure on all of the above environmental characteristics.

The description of the impact should be given in the form of separate chapters on the components of the environment.

A separate and mandatory part of the consideration of the mechanisms of impact on the environment should be the assessment of the probability and possible consequences of emergencies during the construction and operation of structures.

In the section “Projected state of the environment” it is necessary to provide a conclusion about the degree of impact of the projected structure on the environment.

Forecasts of the state of the environment are given on the basis of the decision of a necessary complex of hydrodynamic, thermodynamic and other problems in deterministic or stochastic statement and on the basis of the following models (matrices, simulation models).

1. Construction of the Leopold matrix [16]

The forecast assessment procedure, which is included in the EIA, is based on solving a variety of problems, the diversity of which is determined by the specifics of the studied processes and interactions, and the levels of their study and mediation. Solving problems is fundamentally impossible for real, measured and quite diverse natural conditions. These conditions are always simplified, generalized, presented in the form of some simplified scheme (model). The simplest and accurate and, at the same time, the most abstract, are deterministic models in which causes and effects are related in a system of unambiguous algebraic, differential or finite-difference equations. More complex and less definite, and often less studied, processes are described by stochastic, probabilistic models, the applicability and correctness of which are far from fully justified in geoecology. Finally, for the most complex interactions in the ecosystem, only conceptual models can exist so far.

As many interactions do not yet have good quantitative models, EIAs inevitably include expert assessment methods that complement and adjust calculation methods.

To compile the model, it is necessary to sketch the characteristics of the environment that are affected and the characteristics of the impact.

The primary, most general approach to EIA is implemented in the compilation of the Leopold matrix, which characterizes the qualitative relationships in the system "cause-effect". In essence, this matrix is just a form that organizes information. The forecast and an estimation is given by means of expert estimations through ranking in rather wide and not strictly defined limits (from 1 to 10 points). In this case, 1 means influence, 0 – no influence.

2. Development of simulation models of influence [17].

The model of the impact of project options on environment is a function of several variables, which are indicators of the state of the environment (table 1). In turn, the indicators of the state are determined from the models of indicators of the state of the environment, which are built for each element of the emergency, which is affected by the project [18].

The described simulation model uses two classes of models of indicators "environmental quality – impact" and "limiting environmental factor" (Battelle method).

Table 1. **"Objects" of the environment**

A. Physical and chemical objects	Land	Soil contamination
		The presence of other negative engineering and geological phenomena (swelling, subsidence)
		Radiometric situation of the territory
	Waters	Conditions of interconnection of underground and surface waters (on horizons)
		Groundwater level (by horizons)
		Groundwater regime (by horizons)
		Groundwater aggressiveness (by horizons)
		Chemical composition of groundwater (horizons)
		Groundwater protection conditions (by horizons)
	Atmosphere	Air quality
		Temperature
	Processes	Flood processes
		Erosion
		Activity of karst-suffusion processes
		Activity of slope processes
B. Biological objects	Flora	Presence of green plantings
		Endangered species
	Fauna	Terrestrial animals
		Endangered species
C. Objects of anthropo-genic impact	Land use	Recreational value of the territory
	Aesthetic needs and inclinations of the person	Presence of the protected territory (parks and forest parks, monuments of architecture, town-planning complexes and ensembles)
		Landscape aesthetics
		Social amenities
	Some environme	Salinization of waters
		Soil salinization

***Source*: compiled by the author**

In fact, such a dependence can be represented by a function that is given graphically. The ordinate axis reflects the quality of the environment, the value of which is determined by the above dependencies.

The quality of the environment varies from 0 to 1. The value 1 corresponds to the worst quality, 0 – the best.

On the abscissa, that is, the argument is taken one or another indicator, such as groundwater mineralization, depth of groundwater level, the degree of activity of karst-suffusion processes, etc.,

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which is decisive for the quality of the environment for this component.

The thus obtained values of environmental quality for each characteristic of the environment are made in the final matrix of impact.

The order of consideration and the choice of environmental characteristics as variables of the simulation model was determined by the significance of the characteristic and the number of influences on it. Consider, as an example, some characteristics.

Soil contamination. The quality of environment for this component is assessed by the total indicator of soil contamination (Table 2). The pollution index is shown on the X axis. The model looks like on Fig. 1.

Table 2. **Categories of pollution and their meanings**

Categories of pollution	Total indicator of soil pollution
Clean	0
Acceptable	≤16
Moderately dangerous	16-32
Dangerous	32-128

***Source*: compiled by the author**

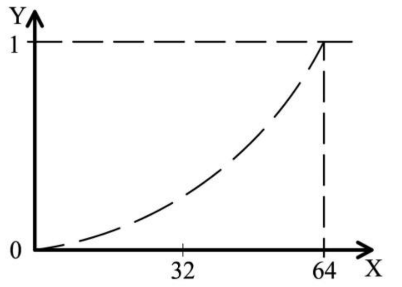

Fig. 1. **Soil contamination**
***Source*: compiled by the author**

The presence of other negative engineering and geological phenomena. The quality of environment for this component is assessed by the number of negative engineering and geological phenomena in the territory. The number is determined on the X axis. The model looks like on Fig. 2.

Quicksand. The presence of soils in the area of work deteriorates the quality of the environment. The quality of the emergency will be determined by the change in the value of internal soil adhesion under the influence of construction. Soil adhesion is measured in kg per cm^2 and is located on the abscissa axis. The model looks like Fig. 3.

The list of factors includes almost 20 characteristics, including groundwater level and their chemical composition, air quality, activity of slope processes, the presence of greenery, recreational value of the territory, etc. This list does not limit the list of environmental characteristics. Under specific conditions, the necessary lines can be added to it. For example, when laying a water supply system, it is important to note and enter in the EIA the characteristic “improvement of living conditions of the population” or “comfort of living”. When building a sewer, it is reasonable to introduce a characteristic that determines the sanitary and hygienic living conditions of the population.

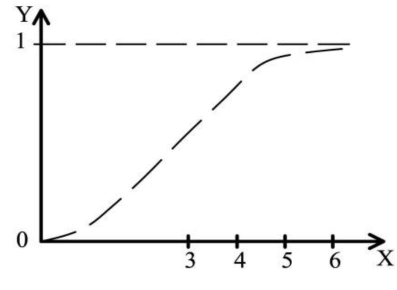

Fig. 2. **The presence of other negative engineering and geological phenomena**
***Source*: compiled by the author**

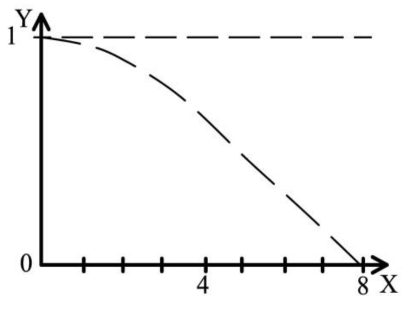

Fig. 3. **Quicksand**
***Source*: compiled by the author**

On the other hand, the listed set of characteristics of influence of environmental characteristics is not strictly obligatory, and has to be made individually for each project, depending on concrete conditions of construction, design decisions, etc.

To ensure the unity of measurements, the possibility of their comparison and comparison, in assessing the impact on the environment should be used units of measurement of environmental characteristics, provided by current regulations and standards.

All the following characteristics of the impact are taken into account in the form of coefficients when calculating the quality index [19, 20].

In assessing the possible impact related to the stages of construction and operation of the proposed project, it is necessary to analyze the potential impact in terms of: exposure (nature of influence); turnover; orientation; cumulative and synergistic effects.

Exposure (impact characteristics).

Each process that leads to the impact on the emergency must be described in terms of limits, intensity and duration of exposure.

The criterion of the limits of influence includes the geographical area (whether the area of influence is a limited area, located near or within the proposed object or it is much wider) and the number of objects of influence (characteristics of the emergency that will be exposed to this type).

The intensity of the impact characterizes the degree of change in the component of the emergency: strong or weak.

The duration of action can be equal to, for example, the construction period, the duration of operation of the structure or be longer if the residual contamination is very stable. It is also necessary to indicate whether the impact is periodic, continuous or due to an emergency situation.

Reversibility of influence. Some effects are not reversible or weakly reversible. Impacts or changes are significant when the ability to weaken or reverse them is limited. The process of weakening or reversibility can be assisted by natural forces, direct cleaning operations and other measures provided for in the design solution.

Orientation of influence. Direct impact is inherent in the characteristics of the production project, ie the process itself, accidents, construction. Indirect effects become significant in different places after the end of time or in other elements of the emergency. Indirect effects include, for example, degeneration of vegetation due to prolonged waterlogging.

Cumulative and synergistic effects. The evaluation process should take into account the cumulative impact of all these indicators, along with the impact of each separately. This is very important, because the influence of individual factors can be insignificant, and the cumulative – much greater.

The reason is that the effects of individual pollutants may change as they accumulate over time.

Particular attention should be paid to synergistic effects, because the reaction to two or more factors acting simultaneously is stronger than simply summing the effects.

In the Table 3, shows the ranges of values of the coefficients of influence, which are taken into account in the future for each component when calculating the quality index.

Table 3. **Values of impact factors [18]**

Characteristics of influence	Values of influence coefficients
Exposition	
The exposition is superficial	0,5-9,8
The exposure is intense	1,5
Temporary characteristic	
Short-term exposure	0,5-1
Long-term exposure	1-3
Spatial characteristics	
Limited exposure	0,5-1,5
Large exhibition	1,5-3
Reversibility	
Irreversible impact	0,5-1,5
Reversible effect	1,5-3
Orientation	
Direct impact	1-2
Indirect influence	0,5-1
Synergy	
Cumulative impact	1,5-2
Synergetic effect	1,5-2

***Source*: [18]**

All the obtained values of the characteristics are entered into the final impact matrix. It is filled as follows. First, the Leopold matrix calculates the number of impact characteristics that affect each characteristic of the environment. It corresponds to the number of filled cells in the column opposite the environmental characteristics divided by the total number of cells. These values are entered into the final matrix of influence in the frequency column by the Leopold matrix for each component of the environment.

After that, for each component in the column evaluation by the simulation model is put the value obtained from the evaluation using the simulation model.

Next, for each component, using the principle of the Liebig minimum, choose the maximum value from the first two columns: the result of the evaluation using a simulation model and the frequency of the Leopold matrix. The obtained value is entered in the column correlation estimation. The highest value is chosen according to what should be calculated as a more significant impact.

In the column "Specific weight of the component" for each component is entered corresponding to the specific conditions of the value, the range of which is given in the Leopold matrix. To simplify the calculations and since the specific weight range of the component belongs to the range from 0 to 10, we will calculate the specific weight of the component by the formula

$$p = \frac{x_{max} + x_{min}}{2} * \frac{1}{10}$$

Then fill in the columns of different "Coefficients of influence", calculated for each component, based on the specific characteristics of the impact. The final calculation of the "Quality Index" is as follows.

For each component, the value "Correlation score" is multiplied by "Specific weight of the component" and by all "Impact factors".

The resulting value is entered in the column "Quality Index".

The final environmental quality index is obtained by summing the quality indices of all components. The higher the quality index, the more the environment is negatively affected by the implementation of the proposed project and the worse will be its condition for the estimated period. The quality indices calculated in this way for different design variants can be compared with each other and with the quality index of the "zero" variant, which is calculated for the conditions "without the designed structure". Differences between quality indices will serve as a criterion for assessing the impact of projected structures on the environment.

It is mandatory to assess the "zero" option, in the situation of abandonment of the project. For the conditions of large cities, it is not uncommon for the "zero" option to be the least preferred, especially when passing the route through wastelands, landfills, as well as when introducing a set of compensatory and rehabilitation measures into the project.

In the section "Measures to minimize environmental damage" should be substantiated proposals for compensation and rehabilitation measures necessary to minimize environmental damage, proposals for environmental monitoring, to conduct special additional hydrogeoecological studies.

At the same time, it is not only acceptable, but also desirable to substantiate such proposals for the protection, preservation and rehabilitation of the environment, which will significantly reduce the damage to nature and man. Such proposals are worthy of self-assessment of the impact along with the above.

In a generalized form, conclusions are given about the degree of impact of different project options on the environment based on a comparison of the obtained estimates and a conclusion is made about the benefits of a particular project option.

In a short form, proposals for minimizing environmental damage in the implementation of the proposed project are summarized.

CONCLUSIONS

An attempt is made to harmonize the approaches to environmental impact assessment available in national and world practice. The methodology is shown, which is aimed at generalizing the Ukrainian and international experience in EIA and specifying the evaluation criteria. The development used methodological approaches that are clear to Ukrainian experts and based on regulatory requirements and international requirements.

Developed and proposed methodological aspects of environmental impact assessment can be used to develop a final EIA. The study describes a comprehensive impact assessment for any components of the environment. A mechanism for determining the significance of the impact is proposed. The developed method of impact assessment allows: to assess the impact on the environment under the influence of various sources; determine the significance of environmental impact. The proposed criteria allow us to draw specific conclusions on the assessment of the impact on each environment, which is a priority in the environmental assessment.

The proposed method of EIA allows the results of the impact assessment, expressed in points, to proceed to the evaluation of alternative project options in points. The obtained impact significance scores for each component of the natural environment can be added to obtain the total significance of the impact of each project variant.

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ОЦІНКА ВПЛИВУ НА ЕКОЛОГІЮ В ЧАСТІ ДОСЛІДЖЕННЯ ТЕХНІЧНОСТІ ПРОЕКТІВ

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АНОТАЦІЯ

Завданнями екологічної оцінки проектів є визначення кількісних критеріїв для прийняття рішень про допустимість або неприпустимість реалізації проекту, забезпечення вибору варіанту і виду запланованої господарської діяльності з найменшими екологічними і соціальними витратами, отримання кількісних критеріїв оцінки ефективності намічених проектом природоохоронних заходів, вибір прийнятної для суспільства норми віддачі при реалізації проекту. Екологічна оцінка супроводжує всі стадії проектно-інвестиційного циклу. Одним з основних принципів оцінки ефективності проектів є включення екологічних результатів і витрат в грошові потоки, що враховуються при аналізі проекту. Відповідно до традиційного економічного аналізу «затрати – вигоди» проект вважається ефективним і придатним для реалізації, якщо вигоди перевищують затрати. У роботі наведено модифіковані методи експертної та екологічної оцінки, які супроводжують всі стадії проектно-інвестиційного циклу проекту. Авторами запропоновано гармонізацію підходів до оцінки впливу на навколишнє середовище, які використовуються в національній та світовій практиці. Показана методика, яка спрямована на узагальнення українського і міжнародного досвіду з ОВНС та конкретизацію критеріїв оцінки. Розроблені та запропоновані методологічні аспекти оцінки впливу на природне середовище можуть бути використані для розробки остаточної ОВНС. У дослідженні описано проведення комплексної оцінки впливу для будь-яких компонентів природного середовища. Запропоновані критерії дозволяють зробити конкретні висновки по оцінці впливу на кожних середах, що є першочерговим при проведенні екологічної експертизи.

Ключові слова: проєкт; екологічна оцінка проєкту; оцінка впливу на навколишнє середовище; комплексна екологічна оцінка; методологічні аспекти екологічної оцінки

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