Environmental Impact Assessment Procedure as the Implementation of the Value Approach in Environmental Projects

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Abstract

Strategic planning sets goals in three key areas: goals to maximize value for owners and shareholders, goals to harmonize stakeholder interests, and goals for social and environmental responsibility. In particular, the lack of a high level of environmental awareness is expressed in the insufficient level of attention to the problems of environmental pollution. At the same time, the introduction of value-oriented management is becoming more diverse at all levels of business. The concept of "value" is the basis of a modern understanding of the strategic management of the organization. Sustainability focuses on solving social and environmental problems, as well as creating long-term competitiveness is what distinguishes a modern company. The article considers the approaches to environmental impact assessment available in national and world practice. The presented methodological aspects of impact assessment are based on the definition of three parameters: the spatial scale of the impact; the temporary scale of influence; the intensity of influence. Each of the parameters is evaluated on a certain scale, using the appropriate criteria developed and submitted for each gradation of the scale. This methodology is aimed at generalizing the Ukrainian and international experience in EIA and specifying the evaluation criteria. The developed methodology of impact assessment allows: to assess the impact on the environment under the influence of various sources and determine the significance of the 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 review.

Keywords 1

Project, value approach, environmental expertise, assessment criteria, environmental impact, Harrington function.

1. Introduction

The value-based approach to company management, which originated in the late twentieth century, was a response to the demand for building a connection between the goals of the organization and social goals. The company cannot be viewed outside the context of its social, environmental, and cultural environment. Value management as a tool for integrating a company into the global social order is extremely relevant in the modern socio-economic structure. The complexity and multifactorial nature of the problem, a fundamentally new view of the company management process in the context of creating social value require a modern company to intensify the search for the optimal combination of classical tools and the introduction of new management models [1-3].

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2. Problem

In the era of information technology and globalization, companies cannot remain in the old paradigm, focusing only on cost indicators. Realities demand from companies a different approach to doing business, which would correlate with the values of the whole society. Companies must be managed in a way that creates value not only for the owners but for the whole society.

Heightened attention to environmental issues, social justice, a significant income gap entered the global social order, going beyond national and regional boundaries. For any company, this means that the problem of creating value for society must become part of the strategic planning of any company.

The main areas of business that exist in the concept of sustainable development are 4 key areas [4-7]:

1. firms can increase their value by reducing resource consumption and environmental pollution;
2. increasing the level of transparency and interaction with civil society;
3. firms can create new technologies and methods of production, reduce the force of human impact on the planet;
4. value creation can be linked to meeting the needs of the world's poorest people and creating a system of equitable distribution of wealth. Figure 1 shows the strategy of forming a sustainable value.

The ecological aspect of sustainable development is associated with the impact of a portfolio, program, and project on living and non-living natural systems: land, air, water, ecosystems, as well as flora, fauna, and those who inhabit the ecosystem.

The environment is also where people live, and it can consist of streets, cities, small towns, or regions.

The legal framework for environmental protection includes international laws and regulations, treaties and agreements, conventions, and declarations, as well as other instruments, such as [7]:

- UNESCO Convention for the Protection of the World Cultural and Natural Heritage;
- UN Convention on Climate Change;

State acts and regulations for the preservation of the environment against air pollution, water bodies, etc., in support of materials that are biodegradable.

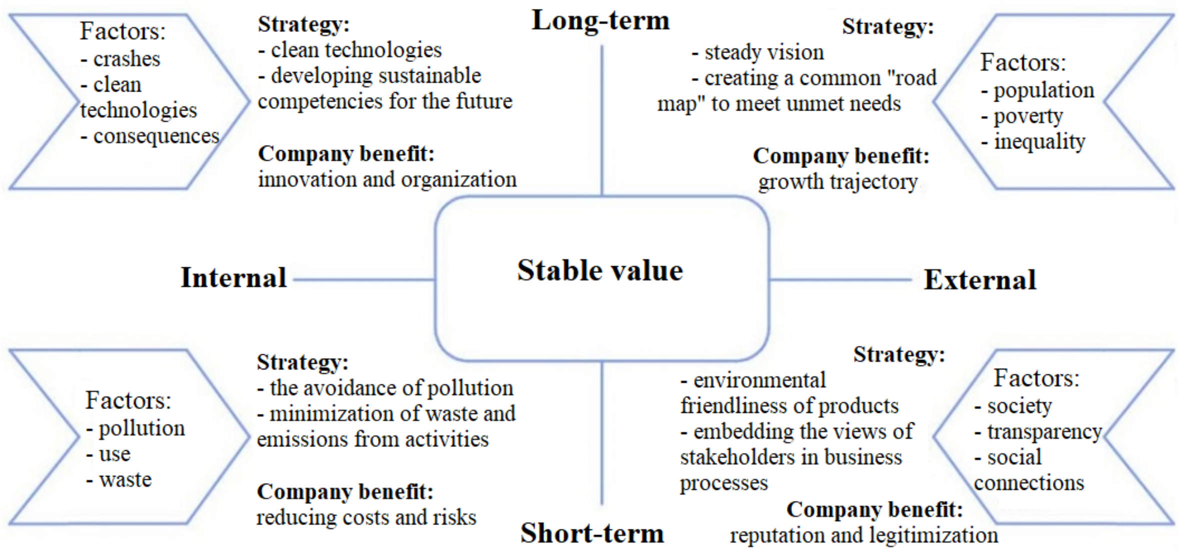

Figure 1: The strategy of forming a sustainable value

The environmental criterion includes elements of sustainability, which can be attributed to the following subcategories Transport, Energy, Water, Consumption [9] (Table 1).

From the concepts discussed above, the so-called Triple bottom line concept was formed - the concept of building a business, according to which entrepreneurs and managers should take into account not only financial indicators but also the social and environmental performance of the company. According to the concept, business is built on the “three pillars of sustainable development” - the planet, people, and profit.

Strategic planning sets goals in three key areas: goals for maximizing value for owners and shareholders, goals for harmonizing interests of stakeholders, and goals for social and environmental responsibility.

Table 1
Elements of sustainability of the environmental criterion [8]

Transport	Energy	Water	Consumption
Purchasing from local suppliers	Power consumption	Water quality	Processing
Digital communications	Carbon emissions	Water consumption	Recycling
Business trips and travel	The return of clean energy	Sanitary moving water	Pollution and contamination
Logistics	Renewable energy		Waste

Currently, value management has received insignificant distribution in our reality, both in the practical field and in the scientific environment. This fact is due to the peculiarities of the structure of the Ukrainian market and values of social attitudes as such.

In particular, the lack of a high level of environmental awareness is expressed at an insufficient level of attention to the problems of environmental pollution. Problems exist both in the field of legislation and the lack of proper regulation of industrial enterprises and in everyday consciousness.

At the same time, the implementation of value-based management is becoming more diversified at all levels of the business [9-11].

Firstly, recently more and more companies are joining international social reporting standards by entering international markets or on a voluntary initiative. Conferences and forums dealing with sustainable development issues are held.

Secondly, a policy is being implemented to reduce emissions into the atmosphere, and local laws are adopted that regulate the activities of companies that are hazardous to the environment. The use of innovative solutions to reduce emissions and other pollution is becoming more and more justified from the point of view of company management.

Thirdly, the open market continues to develop and more and more companies become open joint-stock companies. And as noted earlier, companies' shareholder value activities have a positive impact on the overall value that the organization creates.

The concept of "value" is the basis of the modern understanding of the strategic management of an organization. Sustainability, focus on solving social and environmental problems, and building long-term competitiveness is what distinguishes a modern company. The main components of value today are: creating value for stakeholders; the embodiment of the company's mission by decomposing strategic goals into operational tasks; compliance with the global principles of sustainable development.

Application of the methodological tools available in each of the described approaches, which allow companies to build a value management system and control the process of its creation

3. Model development and use of modelling method

The aim of the work is to develop a unified integrated method for assessing the impact of project activities on the environment in the process of implementing a value-based approach. The method is based on the determination of three parameters of the impact: the spatial scale of the impact; time scale of impact; intensity of exposure. Each of the parameters is assessed according to a certain scale, using special criteria. The procedure for assessing the impact on the environment, which is considered in the work, is determined in accordance with the requirements of the Law of Ukraine "On Environmental Expertise" [12].

Consider the methodological approaches to assessing the impact on the environment, considers the structure, content, and procedure of "Assessment of the impact of the planned activity on the environment" in a standard situation.

The Environmental Impact Assessment (EIA) section is a necessary component of a full environmental assessment. Assessment of the impact of the planned activity on the environment is carried out using available materials and statistical data provided by the territorial departments of the Ministry of Ecology and Natural Resources of Ukraine, as well as various scientific and research organizations.

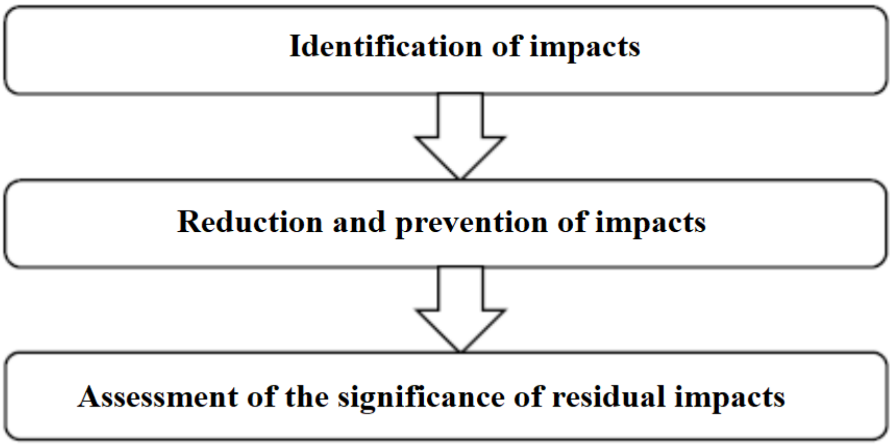

Figure 2: Generalized scheme of environmental impact

Assessment of potential environmental impacts resulting from the implementation of the project is an important stage in the EIA process. The purpose of the assessment is to determine the environmental changes that may arise as a result of the proposed activity and to assess the significance of these changes (Fig. 2). This assessment is based on the following:

- technical description of the project;
- identification of the environmental components affected;
- experience gained from other projects.

Impact assessment is carried out for individual components of the natural environment.

In the practice of performing a conventional EIA, as the most important ecosystems and components of the natural environment, the impact on:

- soil and bowels;
- surface and sea waters;
- the groundwater;
- marine sediments;
- air quality;
- biological resources;
- landscapes and visual impact;
- physical factors of influence (noise and electromagnetic influence, vibration, etc.).

Basically, the measures taken to mitigate the impact are established during project development in accordance with the scale presented in Table 2.

Table 2
Impact Mitigation Scale for Project Planned Activities

Scale gradation	Structure of measures to reduce and prevent impacts
Prevention at source	Prevention or reduction of impacts to its sources presuppose design decisions in which the causes of impact are excluded or modified. The term "minimization" is also used.
Decrease at the source	It is envisaged to apply modifications to the original design development, for example, measures to control environmental pollution. Often referred to as in-place cleaning technology.

Reduction in place	If the impact cannot be mitigated at the point of discharge, then these measures can be carried out outside the site of the facility.
Weakening outside	Some impacts lead to inevitable damage to resources. Recovery involves measures to return the resource to its original state.
Recovery or correction	If other mitigation measures are not possible or are not effective enough, compensation for losses, damages and general intrusion is an acceptable solution. Compensation can be "in-kind", which is expressed, for example, in planting new plantings to replace the lost ones.

3.1. Impact assessment

The impact study of this EIA covers the mitigation measures already foreseen by the project based on the work included in the preliminary design. The impact assessment examines the significance of residual impacts, that is, those impacts that remain after the application of mitigation measures [13-15].

The EIA reflects the state of the project based on available preliminary design information. A detailed design will be undertaken to further detail many of the mitigation activities. However, the characteristics of the environmental conditions were established during the preliminary design stage.

For many impacts, the assessment of the significance of the residual impact is based on characteristics that were previously obtained from existing documents, regulations and reports. This data is provided to the contractor for detailing and further use as a starting point in the process of project implementation. This will ensure that mitigation measures applied at least once will cause impacts that are not environmentally stronger than the impacts foreseen in the EIA.

The significance or degree of residual impacts in this EIA will not necessarily be the same as those already described during the project, as further mitigation of impacts will be studied for many impacts during the detailed design phase. It is expected that the actual actions from the final draft will be no larger than those already described.

3.2. Significance criteria

The significance of residual impacts is assessed based on opportunities for influence and the consequences of exposure.

The assessment is based on local, limited, local, and regional impact levels. In assessing impacts, special attention is paid to local and limited impact levels. Attention is also paid to vulnerable resources (for example, species listed in the Red Book).

In most environmental impact assessments, it is difficult to quantify environmental changes. The proposed methodology is a fluffy assessment based on the so-called "desirability curve" as well as interval scales [16].

The significance of anthropogenic disturbances to the natural environment at all levels is assessed by the following parameters: spatial scale; time scale; intensity.

Let us examine these parameters using one of Harrington's logistic functions – the so-called "desirability curve". It is defined by the function: $d=exp(-exp(-Y))$. This function is deduced by an empirical method. The construction of the generalized Harrington function is based on the idea of converting the obtained values of the negative impact (in various units of measurement, including qualitative and quantitative) into a dimensionless scale of desirability. The specific parameters of the compared systems are distributed on a scale corresponding to the requirements imposed on them, over the range of effective values of the scale of private indicators. Here is the Y coordinate called the scale of private indicators and measured in some conventional balls. The d – desirability scale. The interval of effective values on the scale of private indicators – [-2; 5]. The desirability scale is divided in the range from 0 to 1 into five intervals, each of which is determined by experts in a fuzzy expression:

- [0; 0.2] – "very bad";
- [0.2; 0.37] – "bad";
- [0.37; 0.63] – "satisfactory";

- [0.63; 0.8] – "good";
- [0.8; 1] – "very good".

For the convenience of calculations, let us combine the last two intervals into one and give it a fuzzy expression [0.63; 1] – "good".

The choice of marks on the desirability scale – 0.63 and 0.37, is explained by the convenience of calculations: $1 - {}^{1}/_{e} \approx 0.63, {}^{1}/_{e} \approx 0.37$. We will replace the linguistic scale with the opposite one, proceeding from the condition that the project will be safer for a lesser impact on the environment:

- [0; 0.2] – "very good";
- [0.2; 0.37] – "good";
- [0.37; 0.63] – "satisfactory";
- [0.63; 1] – "bad"

Specific parameters are distributed on a scale corresponding to the conditions of standardization, over the range of effective values of the scale of private indicators. Then the corresponding indicators on the desirability scale are listed in the value of the domain of the Harrington function (Fig. 3).

Further, already specific values are listed in numerical marks in the range from -2 to +5 (Fig. 3). The choice of this interval on the scale of particular indicators is due to the fact that it is at these points that the values of the desirability scale are already practically close to the limiting ones, but they can still change significantly depending on the values of the corresponding parameters. This interval can be called the effective range of practical values of the comparison parameters. In addition, if from all the values of this parameter of the considered systems "assign" the "worst" mark "5", and "the best" - "2", then all the rest will be located between them, forming a scalable sequence of values. Converting them into particular indicators, we obtain the coefficient of desirability for this parameter.

For this technique, the interval [1;10]. Compliance intervals determined from the standardization condition. Comparison of the values of the degree of impact for each parameter is assessed by the Harrington function according to the developed criteria. Each criterion is based on the practical experience of specialists and experts obtained in the implementation of similar projects.

For the natural environment, we will accept a 4-interval scale. This is due to the fact that in contrast to the social sphere, in any of which the activity will be provided with an impact on the natural environment [9, 16, 17].

Zero impact will be present only in the absence of technical activities or impact associated with natural variability. Therefore, in the future, for a comprehensive assessment of the impact on the natural environment, a multiplicative (multiplication) calculation methodology is used.

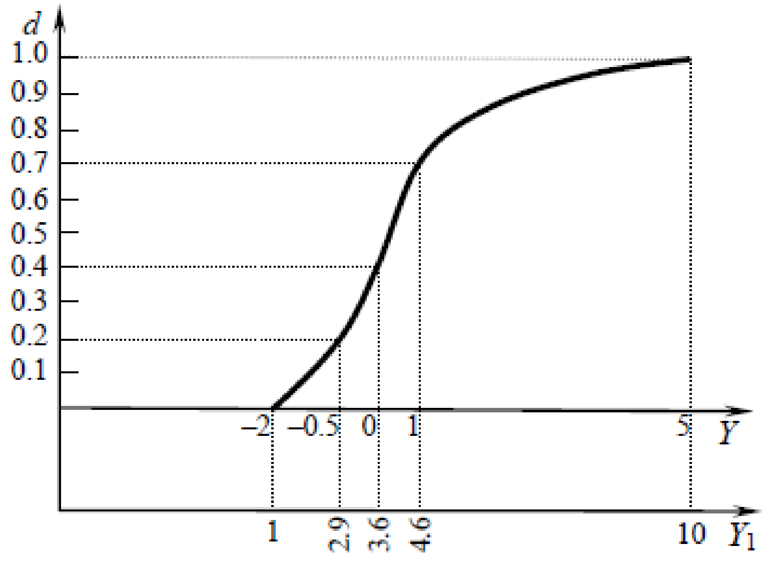

Figure 3: Harrington function graph

3.3. Determination of the spatial scale of impact

Determination of the spatial scale of impacts is carried out on the analysis of technical solutions, mathematical modeling, or on the basis of expert assessments and are presented in Table 4.

Local impact – impacts acting on the components of the natural environment, limited by the territory (water area) of the direct location of the object or slightly exceed it in the area (up to 1 sq.km). (Influence on elementary natural-territorial complexes on land at the level of natural boundaries).

Table 3

Table of correspondence of intervals of the domain of definition of the Harrington function

Desirability scale (d)	Scale of private indicators ("old") (Y)	Scale of private indicators ("new") (Y1)	Qualitative assessment
[0; 0,2]	[-2, -0,5]	[1, 2,9]	"Very good"
[0.2; 0,37]	[0,5, 0]	[2,9; 3,6]	"Good"
[0,37; 0,63]	[0; 0,8]	[3,6; 4,6]	"Satisfactorily"
[0,63; 1]	[0,8, 5]	[4,6, 10]	"Bad"

Limited influence – influences acting on the components of the natural environment in the territory (water area) up to 10 sq.km. (Influence of natural-territorial complexes on land at the level of groups of natural boundaries or terrain).

Local (territorial) impact – impacts acting on the components of the natural environment in the territory (water area) until 100 sq.km. (Influence of natural-territorial complexes on land at the landscape level).

Regional influence – influences acting on the components of the natural environment on a regional scale in the territory (water area) for more than 100 sq. km. (Influence of natural-territorial complexes on land at the level of landscape districts or regions).

Table 4

Scale for assessing the spatial scale (area) of impact

Gradations	Spatial boundaries of influence (in km or sq. km)		Point intervals
Local impact	Square	Influence at a distance of up to 100 m from a linear object	1÷2,9
Limited impact	Impact up to 1 sq. km	Influence at a distance of up to 1 km from a linear object	2,9÷3,6
Local (territorial) impact	Square	Influence at a distance from 1 to 10 km from the line object	3,6÷4,6
Regional impact	Impacts up to 10 sq. km	Influence at a distance of more than 10 km	4,6÷10

3.4. Determination of the time scale of the impact

The time scale of the impact on individual components of the natural environment is determined on the basis of technical analysis, analytical (model), or expert assessments, and is presented in Table 5.

Short Term Impact - Impact observed for a limited period of time (for example, during construction, drilling, or decommissioning), but usually ceases after completion of the operation, duration does not exceed one season (3 months allowed).

The medium-impact is an impact that occurs over a period of one season (3 months) to 1 year.

Long-term impact - impact, observed for a long period of time (more than 1 year, but less than 3 years) and usually covers the period of construction of the designed object.

Long-term (permanent) exposure – exposure that has been observed for 3 to 5 years or more (for example, noise from the operation), and which may be rather periodic or repetitive (for example, impacts from annual maintenance work). Basically refers to the period when the design capacity is reached.

Table 5

Scale for assessing temporary exposure

Gradations	Time scale of influence	Point intervals
Short-term exposure	The effect is observed up to 3 months	1÷2,9
Influence of average duration	The effect is observed from 3 months to 1 year	2,9÷3,6
Long stay under the influence	Impact observed for 1 to 3 years	3,6÷4,6
Long-term (permanent) exposure	Impacts observed for 3 to 5 years or more	4,6÷10

3.5. Determination of the magnitude of the impact intensity

The intensity scale is determined based on a number of environmental assessments as well as expert judgment and is discussed in Table 6. The involvement of expert assessments is usually required in cases where there are no criteria for assessing the intensity of the impact, for example, for assessing individual emergency situations.

Table 6

Scale of the magnitude of the intensity of exposure

Gradation	Description of exposure intensity	Point intervals
Negligible impact	Changes in the environment do not exceed the existing limits of natural variability	1÷2,9
Weak influence	Changes in the natural environment exceed the limits of natural variability, the environment is completely self-healing.	2,9 ÷3,6
Moderate influence	Changes in the natural environment that exceed the limits of natural variability lead to a violation of individual components of the natural environment. The natural environment retains the ability to heal itself.	3,6÷4,6
Strong influence	Changes in the natural environment lead to significant disruptions to components of the natural environment and / or ecosystem. Individual components of the natural environment lose their ability to heal themselves (this statement does not apply to atmospheric air).	4,6÷10

For the air environment, the criteria were selected based on the experience of calculating greenhouse gas emissions during the preparation of the EIA.

For the aquatic environment, hydrodynamic modeling, reference books, expert methods are used.

The geological environment is considered based on maps of hazardous processes and expert assessments.

For groundwater, the criteria are determined on the basis of modeling the spread of pollutants, expertly, or on the basis of analogs.

Criteria for soil and land resources are considered on the basis of technical solutions; special studies or peer review.

Assessment components required for this project can be summarized in a summary table and attached to the main project documentation.

Comprehensive (integral) assessment of the impact on individual components of the natural environment from various sources of impact

Impact significance is essentially a complex (integral) assessment. The comprehensive assessment is a multi-step process. Determining the significance of the impact is carried out in several stages.

Stage 1. To determine the complex impact on individual components of the natural environment, use tables with impact criteria (tables 4 -6).

The complex score is determined by the formula:

$$Q_{complex}=Q_i^t * Q_i^s * Q_i^f \quad (1)$$

where:

$Q_{complex}$ – a complex assessment score for the considered impact;

Q_i^t – point of temporary impact on the i-th component of the natural environment;

Q_i^s – point of spatial influence on the i-th component of the natural environment;

Q_i^f – the score of the intensity of impact on the i-th component of the natural environment.

Stage 2. The category of significance is determined by the range of values depending on the score obtained when calculating the integrated assessment, as shown in Table 7.

The significance categories are the same for different components of the natural environment and may already be comparable to determine the component of the natural environment that will feel the strongest impacts.

For the presentation of the results in this EIA, three categories of impact significance are adopted - minor, moderate, and significant.

Impact of low significance occurs when the impact is experienced, but the magnitude of the impact is sufficiently low and within acceptable standards.

Impacts of moderate significance can have a wide range, ranging from a threshold below which the impact is low to a level that almost violates the legal limit. Whenever possible, it should be shown that the impact is of moderate significance.

Impacts of high significance occur when tolerance limits are exceeded or when large scale impacts are noted, especially for valuable/sensitive resources.

Significance categories are defined for the following environmental components:

- impact on soil and subsoil;
- impact on the surface, ground, and ground waters;
- impact on the quality of atmospheric air;
- influence on various physical processes (flooding, erosion, etc.)
- impact on biological objects of the sea and land, as well as endangered species;
- impacts on wildlife, agriculture, and forestry;
- impacts on landscapes, landscapes, and reserves.

And also for the assessment of physical factors of influence: noise and electromagnetic influences, vibration and force fields, and background radiation.

To obtain a category of impact significance, first, for each environmental component, we determine the average score of a comprehensive impact assessment (using the example of the project "Project for the reclamation of lakes in the area of the Odessa-Sortirovochnaya railway station").

In this project, the resulting signs can be defined as "low", since two types of impact received a low impact significance, one had an average impact, and the complex assessment by the source of impact "Formation and precipitation of suspensions" was equal to 27.6. The lower limit of the interval of the average significance of 25÷100 is equal to 25. When some components change, the estimate will decrease to a low significance of the influence.

If the significance of the influence determined for a specific component of the environment (atmospheric air, wildlife, etc.) is the only one, then it is used directly to assess the resulting significance of the impact.

Table 7
Impact Significance Categories

Impact categories, scoring intervals			Significance categories	
Spatial scale	Temporary scale	Intensity impact	Interval	Significance
Local 1÷2,9	Short-temporary 1÷2,9	Minor 1÷2,9	1÷25	The impact of low significance
Limited	Medium duration	Weak		
Provincial 3,6÷4,6	Long 3,6÷4,6	Mild 3,6÷4,6	25÷100	The impact of average significance
Regional 4,6÷10	Perennial 4,6÷10	Strong 4,6÷10	100÷1000	The impact of high significance

In practice, various impacts of many sources can be provided to one component of the natural environment, therefore, to determine the significance of the impact, the resulting assessment of the significance for a specific component of the natural environment is used. Based on the results of the identified levels of impact significance, the expert can give an integral assessment of the impact on a specific component of the natural environment. An example of determining the resulting impact significance and integral assessment is presented in Table 8.

Table 8
Example of calculating the significance of the environmental impact

Environ-mental components	Source and type of influence	Spatial scale	Temporary scale	Significance of impact	Compre-hensive assess-ment	Categories of signifycance of impact
Activity of karst suffusion processes	Violation of the bottom and bottom sediments when cleaning the bottom of lakes	Local 1÷2,9 (2)	Long 3,6÷4,6 (4,4)	Mild 3,6÷4,6 (4,4)	38,8	Average significance
	Burial of vegetation when dumping construction rock	Local 1÷2,9 (1,3)	Short 1÷2,9 (1,3)	Weak 2,9÷3,6 (3,2)	5,4	Low significance
	Formation and sedimentation of suspensions	Local 1÷2,9 (2,2)	Medium duration 2,9÷3,6 (3,3)	Mild 3,6÷4,6 (3,8)	27,6	Average significance
	Elimination of the buffer lake	Local 1÷2,9 (1,1)	Medium duration 2,9÷3,6 (3,2)	Weak 2,9÷3,6 (3,0)	10,6	Low significance
The resulting significance of the impact					Low significance	

4. Conclusions

The method developed in this work is aimed at generalizing the Ukrainian and international experience in EIA and concretizing the criteria for assessing the impact of adverse factors on the environment. When developing the method, the approaches used by both Ukrainian specialists and those shown in international normative documents were considered. The combined use of these two approaches has made it possible to create a new, comprehensive method for assessing the impact of project activities on any components of the environment. Also, the method allows you to oppose the significance of the impact, and move on to assessing alternative options for project implementation. The resulting impact significance values for each component of the environment can be compiled to obtain the final impact significance value for several options for project implementation.

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