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Economic evaluation of environmental protection activities in the context of sustainable development: the experience of Ukraine

Abstract: This paper explores the challenges of economically evaluating environmental protection measures, emphasizing their role in shaping sustainable national economic development. These measures contribute to ecological safety, quality of life, and economic growth while conserving natural resources. Effective economic evaluation ensures long-term benefits from ecosystem preservation and sustainable resource use.

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The study proposes evaluating efficiency using indicators like service payment costs, current expenses, and the volume of services rendered. Using the coefficient method, the analysis focuses on Ukraine and calculates ratios of payment and current expenses to service volume. Findings show that only the water supply, sewage, and waste management sectors fully offset their costs through services rendered. In other sectors (construction, finance, public administration, defense), only partial cost recovery occurs.

An environmental functional analysis method was also applied, assessing efficiency by comparing service volume to costs. A total efficiency coefficient was calculated against inefficiency metrics, revealing sector-specific trends and cost-related drivers. The paper highlights the importance of adjusting costs when higher service volumes are unattainable, ensuring more accurate efficiency assessments.

While grounded in Ukraine's context, the findings are relevant to EU countries prioritizing sustainable development. Applying these methods across the EU could support more effective, adaptable strategies for economic evaluation of environmental protection and advance the implementation of ecologically sustainable economies.

Keywords: sustainability, environmental protection activities, service provision inefficiency, service payment costs, current expenses

Introduction

Environmental protection activities are among those that have a direct impact on all sectors of the national economy. The need for such activities arises from the worsening ecological situation, the depletion of natural resources, and the necessity of ensuring economic growth. As a result, environmental protection has become not a voluntary initiative of individual organizations, but a deliberate state policy aimed at improving societal well-being and fostering sustainable development.

Over the past two decades, Ukraine has experienced significant environmental stress due to intensive industrial activity, outdated infrastructure, and the consequences of armed conflict, which have exacerbated pollution and biodiversity loss. According to the Ministry of Environmental Protection and Natural Resources of Ukraine (2023), over 35% of the country's territory is affected by moderate to high levels of ecological degradation. This highlights the urgent need to optimize the allocation of environmental protection expenditures and integrate sustainable practices into economic planning.

In the context of global challenges, such as climate change and resource depletion, these activities are crucial for achieving the sustainable goals set by international agreements, including those within the European Union (European Commission 2020). In particular, Ukraine's integration efforts with the EU have led to a growing alignment with European environmental standards, including the adoption of circular economy principles and sustainable public procurement mechanisms.

However, one of the most problematic aspects remains the economic evaluation of the effectiveness of environmental protection activities, as there is no unified criterion for determining the feasibility of various ecological improvement measures. The conducted research is based, on the one hand, on purely economic indicators of activity – revenues from service provision and associated costs. On the other hand, it considers all types of economic activities in the context of the specifics of the costs involved in ensuring environmental protection efforts.

Given the European Union's commitment to sustainable development and its ambitious environmental goals, this paper also highlights the importance of applying these evaluation methods within the EU context. In the EU, substantial investments in environmental protection are mandated by various legislative frameworks, and it is essential to track the cost-effectiveness of these investments to ensure long-term sustainability (Eurostat 2021). For example, the EU's Green Deal and the goal of achieving carbon neutrality by 2050 require a clear understanding of the economic implications of environmental measures across member states (European Commission 2020).

To achieve the set goal, mathematical modeling of economic processes related to environmental protection activities is necessary. Correlation-regression methods will help identify the trends in service provision, considering the impact of service payment costs and current expenses. The environmental functional analysis method allows the calculation of the effectiveness of environmental protection measures based on the construction of a marginal line according to the economic activity types (Bocken et al. 2019).

1. Literature review

Several frameworks have been developed to assess the economic efficiency of environmental protection activities. These frameworks often focus on revenues from services provided, associated costs, and overall sustainability (Costanza et al. 1997; Pearce et al. 2006). Bocken et al. (2019) discuss how businesses in the EU are integrating sustainability through economic evaluation models. The importance of these models in ensuring that environmental protection contributes positively to economic growth is emphasized by the OECD (2020).

The EU's commitment to sustainability is reflected in policies such as the European Green Deal, aiming for carbon neutrality by 2050 (European Commission 2020). Eurostat (2021) reports on the EU's significant financial investments in environmental protection, illustrating the relationship between economic growth and environmental sustainability. Various studies (e.g., Johansson et al. 2013) show that countries like Sweden and Denmark, which prioritize environmental policies, also exhibit strong economic growth, supporting the idea that environmental protection can be economically beneficial.

Ukraine's environmental protection efforts are still evolving, and its economic evaluation of such activities lags behind that of the EU. Frolova (2020) highlights the challenges Ukraine faces in integrating environmental policies into its economic development strategy, particularly in sectors with high environmental impact, such as coal and steel production. The State Statistics Service of Ukraine (2020) reports increasing environmental expenditures, though they remain insufficient compared to EU standards.

Recent research underscores the importance of biofuels and waste reuse in enhancing Ukraine's environmental and energy security. For instance, Pryshliak et al. (2021) provide insights into Ukraine's positioning on the international stage through the development of biofuels, emphasizing their socio-economic and environmental significance. Berezyuk et al. (2019) analyze the resource potential of waste usage as a tool for improving environmental and energy safety.

Organizational and marketing strategies are also vital. Lohosha et al. (2023) examine the value chain approach to biodiesel production, providing practical tools for internal and international marketing in agricultural enterprises. Lutkovska et al. (2024) and Biletskyi et al. (2024) explore the roles of innovatively oriented clusters and integrated business structures in Ukraine's post-war economic recovery, highlighting the alignment of environmental initiatives with broader strategic and financial planning.

Sustainability is central to the discussion of economic evaluation in environmental protection. The UN Sustainable Development Goals (SDGs) emphasize the need for policies that promote both economic growth and environmental conservation (United Nations 2021). Models based on sustainability have been proposed by scholars like Daly (1990), who stresses that sustainable economic models require a balance between economic development and ecological integrity. Correlation-regression methods, such as those used by Heikkinen et al. (2012), have proven effective in assessing the relationship between environmental investments and economic performance.

Mathematical modeling and correlation-regression analysis are widely used to assess environmental protection effectiveness. These methods help track trends in service provision, revenues, and expenses, as demonstrated by Bocken et al. (2019) and Heikkinen et al. (2012). The OECD (2020) recommends using these models to evaluate the economic outcomes of environmental policies in the EU countries and Ukraine. Moreover, recent research by Pysarenko et al. (2024) expands the conversation by addressing marketing management of bioeconomic potential in enterprises. Their findings emphasize the role of innovation and strategic planning in post-war recovery, tying economic performance closely to environmental and bioeconomic initiatives.

Despite significant progress, challenges remain in measuring long-term environmental benefits in economic terms. Researchers like Barbier (2011) and Pearce et al. (2006) note that non-monetary indicators, such as quality of life and biodiversity, must be incorporated into evaluations to better reflect the true value of environmental protection. Furthermore, the lack of a unified approach to economic evaluation hinders the effectiveness of policies in countries like Ukraine, as noted by Frolova (2020).

The economic evaluation of environmental protection is essential for ensuring the sustainability of national economies. While the EU has made significant strides in integrating environmental protection into its economic policies, Ukraine faces challenges in aligning its strategies with international sustainability goals. By applying advanced economic evaluation models, both the EU and Ukraine can optimize their environmental policies and contribute to achieving global sustainability goals.

2. Objective of the study

The study aims to perform a comprehensive economic evaluation of the effectiveness of environmental protection measures, enabling an assessment of the current state of this domain in Ukraine and a justification of the patterns of income and expenditure formation across various sectors of economic activity. Emphasis is placed on the integration of sustainability principles, recognizing that effective environmental management constitutes a critical component of long-term development policy. This approach seeks to balance economic performance with ecological preservation, ensuring the rational use of natural resources, minimization of environmental degradation, and the safeguarding of intergenerational equity.

3. Methods and models

The research applies both parametric and non-parametric methods for modeling environmental protection measures. Parametric methods are based on correlation-regression analysis, which evaluates the dependence of the volume of services rendered on expenditures related to environmental protection. Non-parametric methods are employed through the implementation of environmental operating environment analysis, using the coefficient method (coverage ratios) and graphical methods (distance-based evaluation) to assess efficiency levels. The efficiency assessment is carried out by determining the adequacy of the volume of provided services in covering labor and operational costs.

4. Main body

In assessing the effectiveness of environmental protection measures, it is essential to determine the extent to which service-related and operational expenditures influence the volume of services provided, and to construct an operating environment based on the principles of economic efficiency. We propose using correlation-regression analysis to quantify this influence, enabling the development of regression equations and the identification of the strength of relationships for evaluating trends in environmental protection activities. This approach not only reveals the economic rationale behind environmental expenditures but also incorporates sustainability principles into decision-making processes, ensuring a balance between ecological responsibility, economic efficiency, and social relevance in the long term.

The operating environment is considered not at the level of individual enterprises, but rather by types of economic activity. This approach enables the assessment of environmental protection activities based on the justification of input and output indicators across all sectors of Ukraine's national economy, emphasizing their systemic significance.

Correlation-regression analysis is applied to evaluate the influence of expenditures on service provision and operational costs on the volume of environmental services rendered. The strength of this relationship is reflected in a coefficient of determination of 0.5147 (Fig. 1), with a corresponding correlation coefficient of 0.7174. While this indicates a moderate positive relationship, the inability to achieve a stronger correlation suggests the absence of an effective market for environmental services. The incurred costs are not adequately offset by the revenues generated from the provision of these services.

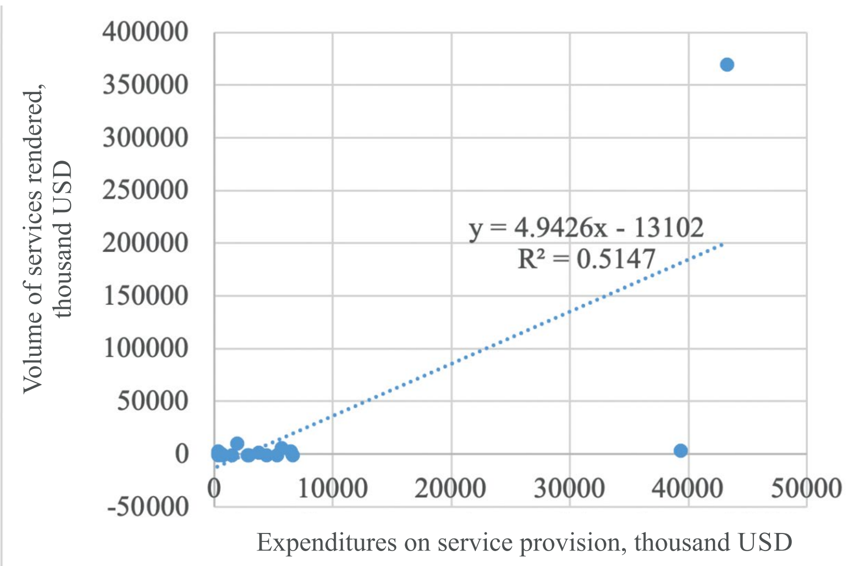

Fig. 1. Correlation-regression relationship between the volume of services rendered and expenditures on service provision by types of economic activity in 2023
Source: compiled by the authors based on data from the State Statistics Service of Ukraine

Rys. 1. Zależność korelacyjno-regresyjna między wolumenem świadczonych usług a wydatkami na świadczenie usług według rodzajów działalności gospodarczej w 2023 r.

In the absence of expenditures on environmental service provision ($x = 0$), the projected loss amounts to 13,102 thousand USD. Thus, the condition for achieving zero (break-even) revenue from environmental services requires a minimum expenditure of at least 2,651 thousand USD.

Current expenditures include costs related to air protection and climate change mitigation, wastewater treatment, waste management, protection and rehabilitation of soil, groundwater, and surface water, as well as other environmental measures.

The correlation-regression relationship between the volume of services rendered and current expenditures (Fig. 2) is characterized by a strong association, with a coefficient of determination of 0.8123 and a corresponding correlation coefficient of 0.9013.

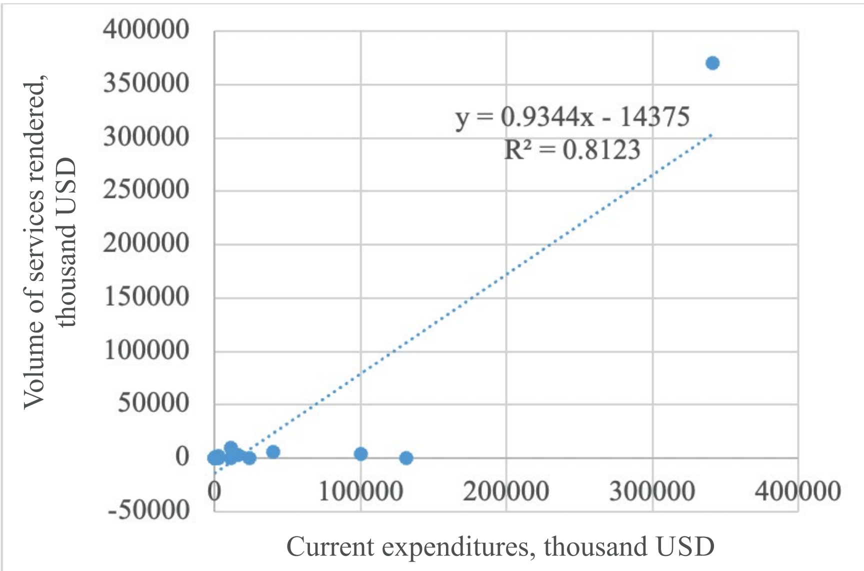

Fig. 2. Correlation-regression relationship between the volume of services rendered and current expenditures by types of economic activity in 2023
Source: compiled by the authors based on data from the State Statistics Service of Ukraine

Rys. 2. Zależność korelacyjno-regresyjna między wolumenem świadczonych usług a bieżącymi wydatkami według rodzajów działalności gospodarczej w 2023 r.

If no current expenditures on environmental protection activities are made ($x = 0$), the resulting loss from service provision will amount to 14,375 thousand USD. Accordingly, to ensure break-even operation, current expenditures must reach at least 15,385 thousand USD.

Thus, the correlation-regression analysis allows us to conclude that current expenditures have a greater influence on the volume of services rendered than expenditures on service provision. This is attributed to the fact that current expenditures are directed toward addressing specific environmental challenges.

However, correlation-regression analysis alone does not permit the assessment of operational efficiency across different types of economic activity, as the results merely reflect trends and the potential for achieving break-even outcomes based on 2023 data.

To assess the effectiveness of environmental protection measures, the study employs the method of operational environment analysis. The essence of this approach lies in constructing a frontier line that enables the evaluation of the efficiency of environmental measures throughout the analyzed period.

Therefore, the operational environment analysis method is classified as a non-parametric frontier approach, which allows its application in evaluating the efficiency of natural monopolies and justifying fair tariffs for the population. The model is based on three indicators: one output variable (revenue from service provision) and two input variables characterizing resource expenditures. In his foundational work, Farrell (1957) proposed using labor costs and capital expenditures as input indicators:

An advantage of the operational environment analysis method is that it is not tied to classical approaches to efficiency evaluation based on financial indicators, such as profit, which merely reflects the presence of a positive financial outcome. In practice, especially in the context of environmental management, there may be instances where profit is not generated, yet this does not necessarily imply inefficiency. By calculating coverage ratios – i.e., the ratio of output to input indicators – this method allows for the equal comparison of different types of economic activity regardless of their influence within the functional environment.

Based on the frontier positions of economic activities (those closest to the *x*- and *y*-axes), an efficiency frontier is constructed. Positions are then classified as conditionally efficient (efficiency coefficient equals one) or conditionally inefficient (efficiency coefficient falls between zero and one). The closer a position is to the efficiency frontier, the higher the effectiveness of that type of economic activity in the field of environmental management.

At present, the operational environment analysis method is applied not only to analyze the activities of natural monopolies but also to assess the functioning of enterprises in competitive markets, financial institutions, educational and healthcare establishments, and more. Furthermore, it serves as a useful tool in evaluating the performance of public administrative bodies, the use of financial resources in the national economy, investment attraction, sectoral development, and other resource-dependent phenomena.

Environmental protection is one of the areas in which the operational environment analysis method has been applied to evaluate land resources of agricultural enterprises in the context of the efficient use of mineral and organic fertilizers (Sakhno and Zaremba 2024). This method has also been used for addressing broader environmental challenges. In the course of research, it has been employed to solve a range of specific tasks, such as assessing state funding of scientific and technical activities by main budget holders, evaluating the effectiveness of technology use in the context of enterprise economic security, and analyzing the performance of economic entities in Ukraine engaged in knowledge-intensive activities and services.

Honcharuk and Vovk (2024) applied elements of non-parametric modeling to analyze the environmental efficiency of crop production in Ukraine, specifically in the context of managing primary waste based on sustainable development principles.

The operational environment analysis method enables the evaluation of environmental protection performance using one output indicator (volume of services rendered) and two input (resource-based) indicators – namely, expenditures on service provision and current expenditures (see Table 1).

Table 1. Environmental protection indicators in Ukraine for 2023

Tabela 1. Wskaźniki ochrony środowiska w Ukrainie na rok 2023

Code	Type of economic activity	Costs of service payments, X_1 [thousand USD]	Current expenses, X_2 [thousand USD]	Volume of services rendered, Y [thousand USD]
A	Agriculture, forestry, and fishing	1,396.0	23,870.4	13.2
B	Mining and quarrying	5,287.5	131,445.2	78.2
C	Processing industry	39,329.3	100,244.0	3,939.9
D	Electricity, gas, steam, and air conditioning supply	5,637.7	39,926.8	5,726.9
E	Water supply; sewerage, waste management	43,235.9	341,223.0	369,762.7
F	Construction	302.3	3,144.8	2,378.9
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	6,557.7	1,776.4	73.3
H	Transportation, warehousing, postal and courier activities	6,362.7	16,371.9	3,252.5
I	Accommodation and food service activities	642.1	47.9	11.1
K	Financial and insurance activities	259.2	908.1	689.7
L	Real estate operations	3,731.9	2,157.3	1,488.2
M	Professional, scientific, and technical activities	577.7	11,281.6	232.4
N	Administrative and support service activities	1,923.1	10,953.7	9,860.9
O	Public administration and defense; compulsory social security	2,825.3	2,561.3	52.7
P	Education	2,758.1	384.6	0.855
Q	Health care and social assistance	4,382.7	352.9	22.7
S	Provision of other services	308.8	448.3	69.9

Source: compiled by the authors based on data from the State Statistics Service of Ukraine.

An analysis of Table 1 reveals that the highest expenditures on service provision are observed in the sectors of water supply, sewerage, waste management, and manufacturing. The highest current expenditures are recorded in water supply, sewerage, waste management, mining and quarrying, and manufacturing industries.

In terms of the volume of services rendered, the most significant type of economic activity is water supply, sewerage, and waste management. Conversely, there are economic activities with relatively low service output, namely education, accommodation and food services, and agriculture, forestry, and fisheries.

Given the values of input and output indicators of environmental protection activities in Ukraine for 2023, we propose calculating the coverage ratios of the volume of services rendered in relation to service provision expenditures (X_1/Y) and current expenditures (X_2/Y), as shown in Table 2.

Table 2. Coverage ratios of service provision expenditures (X_1/Y) and current expenditures (X_2/Y) by the volume of services rendered for environmental protection measures in Ukraine in 2023

Tabela 2. Wskaźniki pokrycia wydatków na świadczenie usług (X_1/Y) i wydatków bieżących (X_2/Y) według wolumenu świadczonych usług w zakresie środków ochrony środowiska w Ukrainie w 2023 r.

Code	Type of economic activity	X_1/Y	X_2/Y
A	Agriculture, forestry, and fishing	105.98	1,812.07
B	Mining and quarrying	67.58	1,680.14
C	Processing industry	9.98	25.44
D	Electricity, gas, steam, and air conditioning supply	0.98	6.97
E	Water supply; sewerage, waste management	0.12	0.92
F	Construction	0.13	1.32
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	8.95	24.24
H	Transportation, warehousing, postal and courier activities	1.96	5.03
I	Accommodation and food service activities	57.91	4.32
K	Financial and insurance activities	0.38	1.32
L	Real estate operations	2.51	1.45
M	Professional, scientific, and technical activities	2.49	48.53
N	Administrative and support service activities	0.19	1.11
O	Public administration and defense; compulsory social security	53.60	48.59
P	Eductaion	3,224.21	449.61
Q	Health care and social assistance	192.96	15.54
S	Provision of other services	4.42	6.42

Source: calculated by the authors based on data from Table 1.

Given the uneven allocation of funding for environmental protection activities in Ukraine, particularly with regard to service provision, significant disparities are observed in the coverage ratios for both service provision expenditures and current expenditures by the volume of services rendered. The most optimal situation occurs when the volume of services rendered exceeds the expenditures (Group 1).

In this case, such an optimal scenario is observed for only a few types of economic activity:

Coverage of service provision expenditures (X_1/Y): water supply, sewerage, waste management; construction; administrative and support service activities; financial and insurance activities; electricity, gas, steam, and air conditioning supply.

Coverage of current expenditures (X_2/Y): water supply, sewerage, waste management.

Thus, under current conditions, it is practically impossible to provide environmental protection services based on full cost recovery.

Group 2 includes types of economic activity where the coverage ratio falls within the range 1 < Coverage Ratio < 10: manufacturing; electricity, gas, steam, and air conditioning supply; construction; wholesale and retail trade; repair of motor vehicles and motorcycles; transportation, storage, postal and courier services; accommodation and food service activities; financial and insurance activities; real estate activities; professional, scientific and technical activities; administrative and support service activities; other service activities.

Group 3 encompasses types of activity with a coverage ratio between 10 < Coverage Ratio < 100: mining and quarrying; manufacturing; wholesale and retail trade; repair of motor vehicles and motorcycles; accommodation and food service activities; professional, scientific and technical activities; public administration and defense; compulsory social security; healthcare and social assistance.

Group 4 includes activities with a coverage ratio exceeding 100: agriculture, forestry, and fishing; mining and quarrying; education; healthcare and social assistance.

An analysis of these four groups indicates that a single type of economic activity may belong to multiple groups. We suggest examining all possible combinations of optimal variations based on the coverage ratio values. Figure 3 presents the assessment of the efficiency of environmental protection measures by type of economic activity (under the conditions 0 < Coverage Ratio < 1 and 1 < Coverage Ratio < 10).

The efficiency frontier consists of two positions: E (Water supply; sewerage, waste management) and K (Financial and insurance activities). Based on this frontier, efficiency coefficients are determined for F (Construction) and N (Administrative and support service activities), as shown in Table 3.

The efficiency coefficient is determined (using position F – Construction as an example) as the ratio of the distance OF_1 to the distance OF. The efficiency coefficient of environmental protection activities in the construction sector in 2023 was 0.66. Accordingly, the inefficiency coefficient equals 0.34 (1 – 0.66). Administrative and support service activities demonstrate even higher efficiency, with a coefficient of 0.89. As a result, the total value of the efficiency coefficients exceeds the total value of the inefficiency coefficients by a factor of 3.4. Figure 4

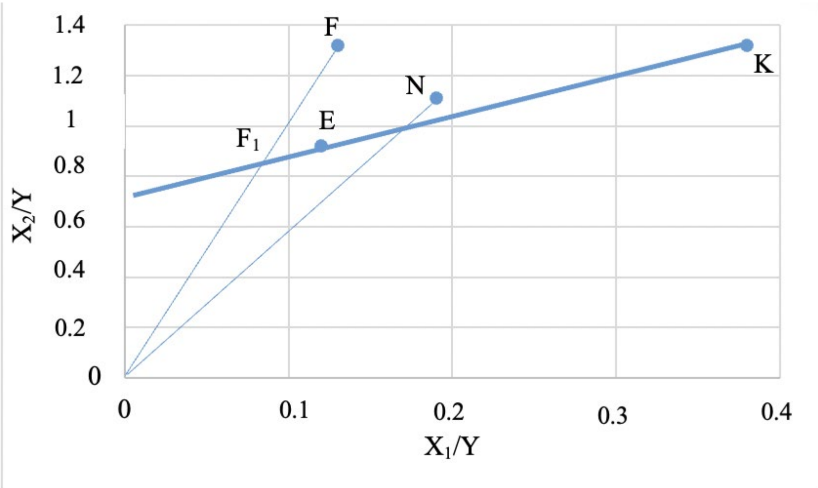

Fig. 3. Efficiency assessment of environmental protection measures by type of economic activity (conditions 0 < Coverage Ratio < 1 and 1 < Coverage Ratio < 10)
Source: compiled by the authors based on data from Table 2

Rys. 3. Ocena efektywności środków ochrony środowiska według rodzaju działalności gospodarczej (warunki 0 < wskaźnik pokrycia < 1 oraz 1 < wskaźnik pokrycia < 10)

Table 3. Efficiency (inefficiency) coefficients of environmental protection measures by type of economic activity (conditions: 0 < Coverage Ratio < 1 and 1 < Coverage Ratio < 10)

Tabela 3. Współczynniki efektywności (nieefektywności) środków ochrony środowiska według rodzaju działalności gospodarczej (warunki: 0 < wskaźnik pokrycia < 1 oraz 1 < wskaźnik pokrycia < 10)

Code	Type of economic activity	Efficiency coefficient	Inefficiency coefficient
F	Construction	0.66	0.34
N	Administrative and support service activities	0.89	0.11
Total		1.55	0.45

Source: compiled by the authors based on Fig. 3.

presents the efficiency assessment of environmental protection measures by type of economic activity (under the conditions 1 < Coverage Ratio < 10 and 10 < Coverage Ratio < 100).

The efficiency line consists of two positions: H (Transportation, warehousing, postal, and courier activities) and L (Real estate operations). Based on the efficiency line, we will determine the efficiency coefficients for manufacturing (C), wholesale and retail trade, repair of motor vehicles and motorcycles (G), professional, scientific, and technical activities (M), and provision of other services (S) (Table 4).

Table 4. Efficiency (inefficiency) coefficients of environmental protection measures by types of economic activity (conditions: 1 < Coverage Ratio < 10 and 10 < Coverage Ratio < 100)

Tabela 4. Współczynniki efektywności (nieefektywności) środków ochrony środowiska według rodzajów działalności gospodarczej (warunki: 1 < wskaźnik pokrycia < 10 oraz 10 < wskaźnik pokrycia < 100)

Code	Type of economic activity	Efficiency coefficient	Inefficiency coefficient
C	Processing industry	0.20	0.80
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	0.23	0.77
M	Professional, scientific, and technical activities	0.30	0.70
S	Provision of other services	0.50	0.50
Total		1.23	2.77

Source: compiled by the authors based on Fig. 4.

Analyzing Table 4, it can be concluded that under the given conditions, the efficiency coefficients of environmental protection measures across different types of economic activity show generally low values, except for "other service activities" (0.5). Accordingly, the total inefficiency coefficient is 2.25 times higher than the total efficiency coefficient.

The efficiency line consists of two points: B (Mining and quarrying) – P (Education). Based on this efficiency line, the efficiency coefficients for agriculture, forestry, and fishing (A) are determined (see Table 5).

Table 5. Efficiency (inefficiency) coefficients of environmental protection measures by types of economic activity (conditions: 10 < Coverage Ratio < 100 and Coverage Ratio > 100)

Tabela 5. Współczynniki efektywności (nieefektywności) środków ochrony środowiska według rodzajów działalności gospodarczej (warunki: 10 < wskaźnik pokrycia < 100 i wskaźnik pokrycia > 100)

Code	Type of economic activity	Efficiency coefficient	Inefficiency coefficient
A	Agriculture, forestry, and fishing	0.92	0.08
Total		0.92	0.08

Source: compiled by the authors based on Fig. 5.

Analyzing Table 5, it can be concluded that under the given conditions, the efficiency coefficient of environmental protection activities in agriculture, forestry, and fishing has a very high value (approaching one), due to the significant excess of resources spent over revenues across all types of economic activity. Figure 6 presents the evaluation of the effectiveness of environmental protection measures by types of economic activity (conditions: 0 < Coverage Ratio < 1, 1 < Coverage Ratio < 10, 10 < Coverage Ratio < 100, and Coverage Ratio > 100).

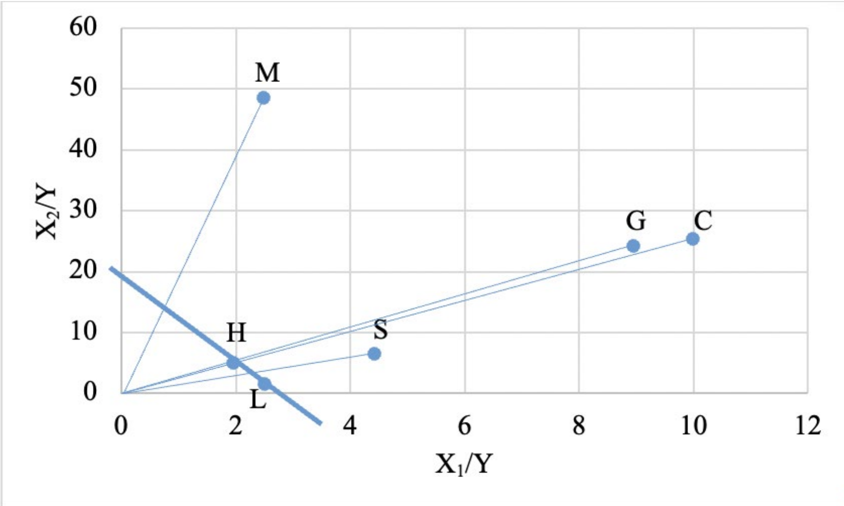

Fig. 4. Evaluation of the effectiveness of environmental protection measures by types of economic activity (conditions: 1 < Coverage Ratio < 10 and 10 < Coverage Ratio < 100)
Source: compiled by the authors based on data from Table 2

Rys. 4. Ocena skuteczności środków ochrony środowiska według rodzajów działalności gospodarczej (warunki: 1 < wskaźnik pokrycia < 10 oraz 10 < wskaźnik pokrycia < 100)

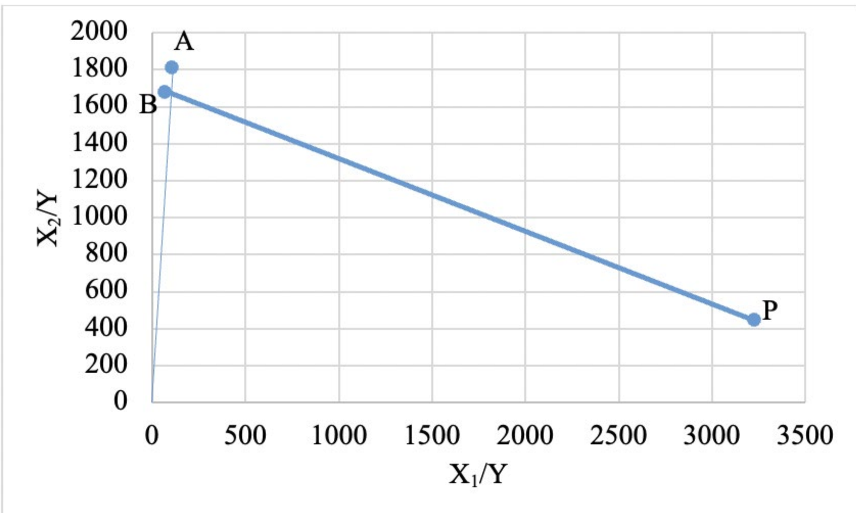

Fig. 5. Evaluation of the effectiveness of environmental protection measures by types of economic activity (conditions: 10 < Coverage Ratio < 100 and Coverage Ratio > 100)
Source: compiled by the authors based on data from Table 2

Rys. 5. Ocena skuteczności środków ochrony środowiska według rodzajów działalności gospodarczej (warunki: 10 < wskaźnik pokrycia < 100 i wskaźnik pokrycia > 100)

The efficiency line consists of two points: D (Electricity, gas, steam, and air conditioning supply) and I (Accommodation and food service activities). Based on this efficiency line, the efficiency coefficients for O (Public administration and defence; compulsory social security) and Q (Human health and social work activities) are determined (see Table 6).

Table 6. Efficiency (inefficiency) coefficients of environmental protection measures by types of economic activity (conditions: 0 < Coverage Ratio < 1, 1 < Coverage Ratio < 10, 10 < Coverage Ratio < 100, and Coverage Ratio> 100)

Tabela 6. Współczynniki efektywności (nieefektywności) środków ochrony środowiska według rodzajów działalności gospodarczej (warunki: 0 < wskaźnik pokrycia < 1, 1 < wskaźnik pokrycia < 10, 10 < wskaźnik pokrycia < 100 oraz wskaźnik pokrycia > 100)

Code	Type of economic activity	Efficiency coefficient	Inefficiency coefficient
O	Public administration and defense; compulsory social security	0.16	0.84
Q	Health care and social assistance	0.29	0.71
Total		0.45	1.55

Source: compiled by the authors based on Fig. 6.

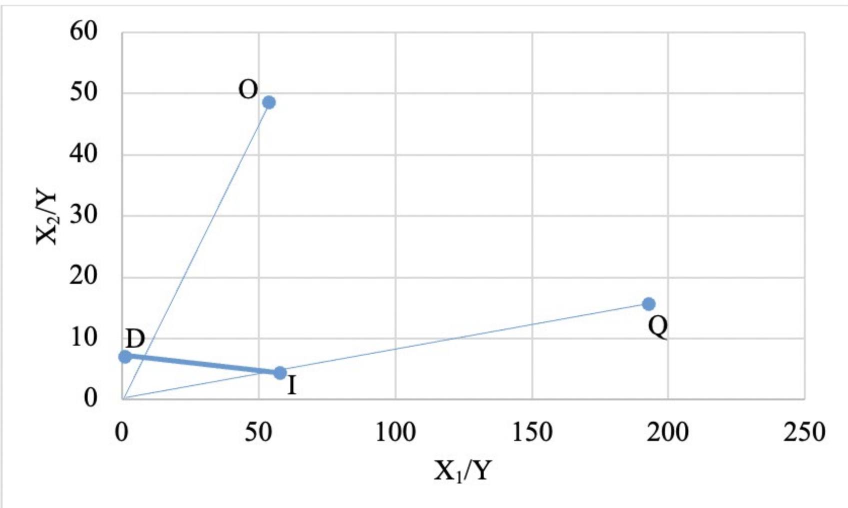

Fig. 6. Evaluation of the effectiveness of environmental protection measures by types of economic activity (conditions: 0 < Coverage Ratio < 1, 1 < Coverage Ratio < 10, 10 < Coverage Ratio < 100, and Coverage Ratio > 100)
Source: compiled by the authors based on data from Table 2

Rys. 6. Ocena skuteczności środków ochrony środowiska według rodzajów działalności gospodarczej (warunki: 0 < wskaźnik pokrycia < 1, 1 < wskaźnik pokrycia < 10, 10 < wskaźnik pokrycia < 100 oraz wskaźnik pokrycia > 100)

An analysis of the data in the table reveals that efficiency coefficients in the environmental protection sector across all types of economic activity are generally low. Accordingly, the total value of the inefficiency coefficients is 3.44 times higher than the total value of the efficiency coefficients.

Based on the conducted research, it can be concluded that the most favorable scenario occurs when the volume of services rendered is sufficient to cover both service provision and current expenditures for environmental protection measures. The following types of economic activity fall under this category (see Fig. 3 and Table 3):

- water supply; sewerage, waste management,
- construction,
- financial and insurance activities,
- administrative and support service activities.

Even in cases where current expenditures slightly exceed the volume of services rendered in the implementation of environmental measures, these types of economic activity may still be considered effective. Therefore, the development of these economic activities should be prioritized in subsequent periods in an integrated manner, as they offer opportunities to expand the volume of environmental services and rationalize cost-reduction strategies.

Another case of near-complete efficiency is observed in the following economic activities (see Fig. 5 and Table 5):

- agriculture, forestry, and fishing,
- mining and quarrying,
- education.

Agriculture, forestry, fishing, and education are characterized by the lowest volumes of services rendered among all economic sectors. In mining and quarrying, current expenditures are among the highest – second only to water supply, sewerage, and waste management – but expenditures on service provision and the volume of services rendered remain relatively low compared to other sectors. This indicates a form of efficiency within a broader context of overall inefficiency in environmental resource use.

All other types of economic activity are marked by a significant excess of cumulative inefficiency over efficiency. This suggests that when any type of expenditure exceeds the volume of environmental services rendered by more than 1.32 times, achieving efficiency becomes practically impossible.

As of 2023, environmental protection activities in Ukraine demonstrate low efficiency. Moreover, the issue extends beyond sector-specific inefficiencies to the formation of inherently inefficient environments, where expenditures on service provision and current costs exceed the volume of services rendered by several orders of magnitude.

Conclusions

The study has demonstrated a clear dependence between the volume of services rendered and the expenditures on service payments and current costs. This allows us to conclude that there is a tendency toward increasing investments in environmental protection activities in order to maximize overall outcomes.

Environmental protection indicators in Ukraine were analyzed, including service payment expenditures, current costs, and the volume of services rendered. This enabled the calculation of coverage ratios, representing the extent to which the volume of services rendered covers service payment and current environmental protection expenditures.

It was revealed that among all types of economic activity, only water supply; sewerage, and waste management are characterized by full cost recovery through the volume of services rendered.

A functional environment analysis method was applied to assess the efficiency of economic activities in implementing environmental protection measures. This allowed for the classification of activities into four groups based on the coverage ratio: 0 to 1; 1 to 10; 10 to 100; and Greater than 100.

For each group, efficiency coefficients were calculated based on the coverage ratios by type of economic activity, allowing for the determination of the overall efficiency coefficient.

The results showed that the total efficiency coefficient exceeded inefficiency in the groups where the coverage ratio ranged from 0 to 1 and from 1 to 10. In all other cases, there was a significant predominance of inefficiency, or at best, efficiency was observed only within an overall inefficient context.

The main challenge in the development of environmental protection activities lies in a conceptual deficiency – the need to increase expenditures to a certain threshold level, beyond which service delivery becomes efficient. Ukrainian practice demonstrates that a positive outcome is achievable in only a few types of economic activity.

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Ocena ekonomiczna działań związanych z ochroną środowiska w kontekście zrównoważonego rozwoju: doświadczenia Ukrainy

Streszczenie

W niniejszym artykule omówiono wyzwania związane z ekonomiczną oceną środków ochrony środowiska, podkreślając ich rolę w kształtowaniu zrównoważonego rozwoju gospodarczego kraju. Środki te przyczyniają się do bezpieczeństwa ekologicznego, jakości życia i wzrostu gospodarczego, jednocześnie chroniąc zasoby naturalne. Skuteczna ocena ekonomiczna zapewnia długoterminowe korzyści wynikające z ochrony ekosystemów i zrównoważonego wykorzystania zasobów.

W badaniu zaproponowano ocenę efektywności przy użyciu wskaźników takich jak koszty płatności za usługi, bieżące wydatki i wolumen świadczonych usług. Wykorzystując metodę współczynników, analiza koncentruje się na Ukrainie i oblicza stosunek płatności i bieżących wydatków do wolumenu usług. Wyniki pokazują, że tylko sektory zaopatrzenia w wodę, kanalizacji i gospodarki odpadami w pełni pokrywają swoje koszty poprzez świadczone usługi. W innych sektorach (budownictwo, finanse, administracja publiczna, obrona) następuje tylko częściowe pokrycie kosztów.

Zastosowano również metodę analizy funkcjonalnej środowiska, oceniając efektywność poprzez porównanie wolumenu usług z kosztami. Obliczono całkowity współczynnik efektywności w odniesieniu do wskaźników nieefektywności, ujawniając trendy charakterystyczne dla poszczególnych sektorów i czynniki związane z kosztami. W artykule podkreślono znaczenie dostosowania kosztów w przypadku, gdy nie można osiągnąć wyższego wolumenu usług, co zapewnia dokładniejszą ocenę efektywności.

Chociaż wyniki badań odnoszą się do sytuacji Ukrainy, mają one znaczenie dla krajów UE, które priorytetowo traktują zrównoważony rozwój. Zastosowanie tych metod w całej UE mogłoby wspierać skuteczniejsze i bardziej elastyczne strategie oceny ekonomicznej ochrony środowiska oraz przyspieszyć wdrażanie ekologicznie zrównoważonych gospodarek.

Słowa kluczowe: zrównoważony rozwój, działania na rzecz ochrony środowiska, nieefektywność świadczenia usług, koszty płatności za usługi, bieżące wydatki