The Impact of environmental management on the sustainable development of territorial communities

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Abstract

Environmental management of territorial communities is important for preserving natural resources and mitigating environmental risks, which contributes to achieving sustainable development goals (SDGs). The aim of the study is to assess the effectiveness and impact of environmental protection expenditure (EPE) as an important tool of environmental management on the sustainable development of territorial communities. The study employs regression analysis, correlation analysis, and comparison methods. The study identified the most effective areas of EPE by territorial communities. These include: other activities in the field of ecology and protection of natural resources, environmental protection measures at the expense of special-purpose funds, protection and rational use of natural resources. The effectiveness of such areas was determined through a regression analysis of the impact of EPE on the environmental indicators of the relevant regions. The volume of pollutant emissions into the atmosphere is most affected by expenditures on other activities in the field of ecology and protection of natural resources with a regression coefficient of -0.542787. Environmental protection measures at the expense of special funds have a significant impact on total waste generation (-0.782511) and on

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the volume of polluted wastewater (-0.443516). Regression analysis did not reveal a statistically significant impact of any of the variables on the I-III hazard class waste generation and the number of cases of malignant neoplasms. The environmental policy of territorial communities should focus on the identified effective areas of expenditure and revise expenditures that do not contribute to improving environmental indicators. It should be noted that the volume of expenditures is not the most important factor in efficiency – the quality of planning and management is of key importance. The findings may be useful for territorial communities to improve the environmental management system in terms of managing the effectiveness of expenditures on environmental protection.
Keywords: environmental management, territorial communities, sustainable development, environmental protection expenditure, protection of natural resources, targeted measures.

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Introduction

Adaptive Sustainable development of territorial communities is an important component of the global strategy for sustainable development of society. It balances the social, economic, and environmental aspects of life at the local level, fostering sustainable development of the state as a whole. At the global level, this contributes to achieving SDGs – poverty reduction, providing access to quality education, combating climate change, etc.

The sustainable development of territorial communities in Ukraine faces a number of problems, one of the most difficult being the ongoing hostilities in the country (Savina et al., 2024). In addition to the complete devastation of territories and significant losses among the civilian population, the war leads to a catastrophic deterioration of the environmental situation (Pereira et al., 2022; Rawtani et al., 2022). The environmental component of sustainable development of communities requires special attention because of the aggravation of environmental problems.

Effective implementation of environmental conservation approaches is ensured by a proper environmental management system. The correct setting and achievement of environmental goals depends on the environmental management of territorial communities (Chen & Huang, 2020; Latysheva et al., 2020). Such goals include the rational use of natural resources, mitigation of environmental risks, and preservation of the natural environment.

One of the key tools of environmental management is the EPE, which is aimed at the implementation of environmental programmes and plans. Given limited financial resources of territorial communities, the rational use of such

expenditures is an important factor for achieving environmental goals (Borisova et al., 2020). Accordingly, the aim of the research is to assess the effectiveness and impact of EPE as an important tool of environmental management on the sustainable development of territorial communities. The aim involves the fulfilment of the following research objectives:

- Conduct a regression analysis of the impact of EPE on the environmental indicators of territorial communities;
- Identify the most effective measures to support the natural environment and minimize negative impacts;
- Compare the effectiveness of expenditures by region.

Literature review

Sustainable development of territorial communities is relevant given the significant contribution of these territorial units to the overall socio-economic development of states. Moallemi et al. (2020) are confident that transformational changes at the local level can provide a promising approach to increasing sustainability, adapted to the unique conditions of each territorial unit. Erbaugh et al. (2020) and Imperiale and Vanclay (2021) noted the need to prioritize the sustainable development of territorial communities and their significant role in increasing resilience to risks. Toledo (2020) emphasized that until recently, rural modernization was associated with the forced replacement of peasant small-scale production by large collective or entrepreneurial farms. In contrast to this approach, the new strategy for sustainable development of territorial communities is based on evolutionary development and involves the modernization of the village. Such an approach has significant advantages in terms of preserving local traditions and supporting the development of local economies. At the macroeconomic level, it contributes to long-term economic stability, mitigating the negative consequences of industrialization.

Despite the great importance of territorial communities in sustainable development, their role in this process remains limited. Haji et al. (2020) noted that an obstacle to achieving environmental goals is the existing gap between the goals of the government and the local population or communities. Adamowicz and Zwolińska-Ligaj (2020), and Budziewicz-Guźlecka and Drożdż (2022) noted that rural areas are often left out of the main processes of innovative development. According to the researchers, the idea of growth with the involvement of territorial communities can be based on the concept of “smart village”. Zhang and Zhang (2020) defined this concept as a model of rural development based on the use of the advantages

of information and communication technologies. Agreeing with the importance of introducing new technologies, Renukappa et al. (2024) and Zavratnik et al. (2020) noted that the implementation of the concept of "smart village" is difficult without the active involvement of the local population.

Along with comprehensive approaches, one of which is the development of a "smart village", the researchers consider narrow areas of ensuring sustainable development of communities. Khomiuk et al. (2020) proved that one of the most effective tools is diversification, which allows strengthening the competitive advantages of territorial units, increasing their income and productivity. A number of studies have noted the advantages of developing sustainable tourism in territorial communities, which provides profit for the agricultural, tourism and cultural economic sectors (Iannucci et al., 2022; Maldonado-Erazo et al., 2022).

In the context of globalization, environmental issues of sustainable development of territorial communities are of particular importance (Rahman, 2022). For Ukraine, which suffers from the devastating consequences of war, supporting and restoring the environment are priority tasks that determine the strategic importance of environmental management (Flamm & Kroll, 2024). The importance of proper management of natural resources and environmental protection is emphasized in the research of Pye-Smith and Borrini-Feyerabend (2021). The researchers gave examples of successful initiatives in the field of environmental management of territorial communities, which contributed to the implementation of sustainable practices and the growth of community incomes. Hrynchuk et al. (2023) concluded that the mechanism of environmental management of territorial communities enables the implementation of a balanced environmental policy, balancing the interaction of local residents and nature.

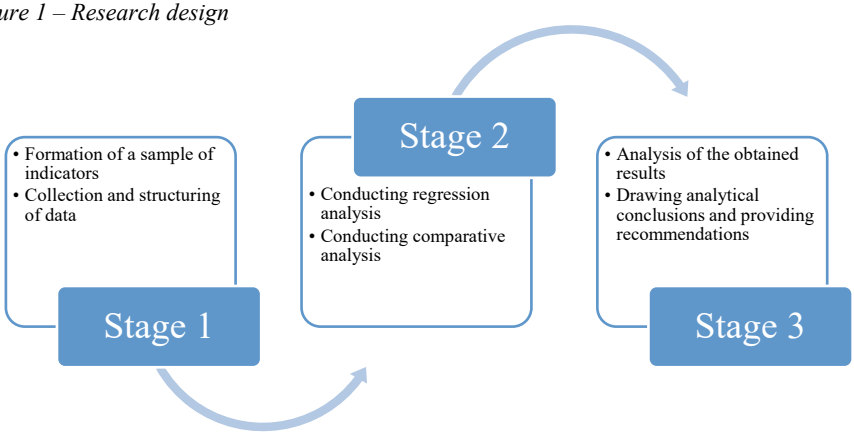
At the same time, the issue of the impact of environmental management on the sustainable development of communities remains poorly studied. This is determined by the lack of a unified clearly defined approach to the composition and content of indicators for such an assessment. The studies of Alaimo and Maggino (2020), and Panchyshyn and Vdovyn (2023) propose different approaches to the formation of a system of indicators for the sustainable development of territorial communities. However, indicators for assessing the effectiveness of environmental management and its impact on sustainable development are not taken into account in the studies. This study seeks to fill this gap by proposing its own method of assessing the impact and effectiveness of environmental management on the sustainable development of territorial communities. This involves the use of a system of environmental indicators and indicators of the volume of EPE.

Methodology

Research design

The research procedure includes three main stages. The first stage involved the formation of a sample of environmental indicators of the regions of Ukraine and indicators of expenditures of territorial communities on environmental protection. The second stage involved the collection of data on the specified indicators and their structuring for the purposes of regression and comparative analyses. The third stage involved the analysis of the results, drawing conclusions, and providing recommendations (Figure 1).

Figure 1 – Research design



Source: developed by the authors

Sample

The sample is formed by two groups of indicators: indicators of the ecological state of the regions and indicators of the total expenditures of territorial communities on environmental protection. The first group included: emissions of pollutants into the atmosphere, increase/decrease in mobile source emissions per person, generation of waste of I-III hazard classes, generation of waste in general (I-IV hazard classes), volume of contaminated wastewater, number of cases of malignant neoplasms. The second group included indicators of the volume of expenditures on: protection and rational use of natural resources, waste disposal, elimination of other environmental pollution, preservation of the nature reserve fund, other activities in the field of ecology and protection of natural resources, environmental protection measures at the expense of special funds. The

sample was formed based on data on the assessment of the ecological state of the regions and data on the total budget expenditures of territorial communities for each region, respectively (Lviv Portal, 2022; Open Budget, 2024). The observed indicators reflect the main aspects of the ecological state of the regions, as well as the level of financing of environmental measures. This enables assessing the relationship between the incurred costs and environmental results. The indicators relate to key aspects of environmental management, in particular, pollution control, conservation of natural resources, waste disposal, etc. The formed sample is sufficient to achieve the objectives of the study, in particular, to identify the most effective environmental measures to improve the environmental situation.

Methods

The main method of the study is regression analysis using the linear regression method. This method was used to assess the impact of territorial communities' EPE on the environmental indicators of the regions of Ukraine. Additionally, comparative analysis was applied, which allowed us to identify indicators with the greatest impact on the dependent variables. Correlation analysis using the k-means was applied to assess the relationship between these indicators. These methods made it possible to describe the effectiveness of the expenditures and make assumptions about the impact of the amount of expenditures on the effectiveness of the results.

Results

Regression analysis of territorial communities' expenditures on ecology as a tool of environmental management was aimed at assessing their impact on the environmental indicators of the regions. This indicated the effectiveness of environmental management of territorial communities from the perspective of the used models of financing environmental measures, as well as priorities and strategies within the framework of environmental policy. Accordingly, the environmental indicators of the regions were dependent variables in the analysis, and territorial communities' EPE were independent ones (Tables 1-4).

Table 1 – Regression results for the dependent variable Pollutant Emissions into the Atmosphere

	Regression coefficient	Standard error	t(5)	p-value
Regression results for the dependent variable: Pollutant Emissions into the Atmosphere R = .73182769, R2 = .53557176, Adjusted R2 = .37165592, F(6.17) =3.2674, p < .02527. Standard error of estimate: 2.2427				
Intercept	3.636425	0.680706	5.34214	0.000054
Protection and rational use of natural resources	-0.240800	0.178014	-1.35270	0.193871
Waste disposal	0.008490	0.168453	0.05040	0.960392
Elimination of other environmental pollution	0.018427	0.184918	0.09965	0.921788
Preservation of the nature reserve fund	0.169313	0.178130	0.95050	0.355176
Other activities in the field of ecology and protection of natural resources	-0.542787	0.168270	-3.22569	0.004965
Environmental protection measures at the expense of special-purpose funds	-0.463399	0.167932	-2.75944	0.013400

Source: developed by the author based on (Lviv Portal, 2022; Open Budget, 2024)

Two variables have a strong negative impact on the dependent indicator – other activities in the field of ecology and protection of natural resources and environmental protection measures at the expense of trust funds. The first of them may include non-standard measures, for example, monitoring the environmental state, conducting educational campaigns, supporting public initiatives. Environmental protection measures at the expense of special-purpose funds are aimed at solving specific environmental problems. The costs of the noted measures are the most effective for reducing the volume of pollutant emissions into the atmosphere. The Intercept has a direct effect with a high correlation coefficient on the dependent variable. Accordingly, the growth of pollution can be significantly affected by factors not taken into account in the model. However, this is not a drawback of the model, as it is aimed, first of all, at identifying measures to minimize pollution.

Table 2 – Regression results for the dependent variable Increase/Decrease in Mobile Source Emissions per Person

	Regression coefficient	Standard error	t(5)	p-value
Regression results for the dependent variable Increase/Decrease in Mobile Source Emissions per Person R = .61940521, R2 = .38366281, Adjusted R2 = .16613204, F(6.17) = 1.7637, p < .16682. Standard error of estimate: 1,0700				
Intercept	-0.412146	0.324775	-1.26902	0.221534
Protection and rational use of natural resources	0.221976	0.205071	1.08243	0.294175
Waste disposal	0.268529	0.194057	1.38376	0.184332
Elimination of other environmental pollution	-0.164017	0.213025	-0.76994	0.451900
Preservation of the nature reserve fund	0.521182	0.205204	2.53982	0.021148
Other activities in the field of ecology and protection of natural resources	0.030649	0.193846	0.15811	0.876231
Environmental protection measures at the expense of special-purpose funds	0.305162	0.193457	1.57742	0.133125

Source: developed by the author based on (Lviv Portal, 2022; Open Budget, 2024)

The dependent variable is most influenced by the amount of spending on preserving the natural reserve fund. This influence is direct, that is, preserving the natural reserve fund is accompanied by an increase in mobile source emissions. This can be explained by an indirect influence of tourist activity and, for example, the arrangement of recreation areas in the relevant territories. These factors contribute to an increase in traffic flow, which leads to an increase in emissions from mobile sources.

According to the regression results for the dependent variable "waste generation of hazard classes I-III", the corresponding model had low explanatory power and none of the variables was statistically significant. This situation indicates inefficient or insufficient spending on reducing the I-III hazard class waste generation. The problem may be the difficulties associated with the management and control of such waste, technical limitations, high cost of disposal.

Table 3 – Regression results for the dependent variable Total Waste Generation (I-IV hazard classes)

	Regression coefficient	Standard error	t(5)	p-value
Regression results for the dependent variable: Total Waste Generation (I-IV hazard classes) R = .92351413, R2 = .85287834, Adjusted R2 = .80095305, F(6,17) = 16.425, p < .00000. Standard error of estimate: .55014				
Intercept	2.608134	0.166982	15.61930	0.000000
Protection and rational use of natural resources	-0.477700	0.100192	-4.76784	0.000179
Waste disposal	0.159942	0.094811	1.68696	0.109872
Elimination of other environmental pollution	0.269354	0.104078	2.58801	0.019149
Preservation of the nature reserve fund	-0.051895	0.100257	-0.51762	0.611394
Other activities in the field of ecology and protection of natural resources	-0.378219	0.094708	-3.99353	0.000940
Environmental protection measures at the expense of special-purpose funds	-0.782511	0.094518	-8.27900	0.000000

Source: developed by the author based on (Lviv Portal, 2022; Open Budget, 2024)

Environmental protection measures at the expense of special-purpose funds show the strongest negative impact on waste generation in general. This indicates the high effectiveness of target measures, which may be associated with the introduction of new technologies that contribute to reducing waste volumes. The same is applicable to the expenditures on the protection and rational use of natural resources, which contribute to reducing waste generation by improving resource management and rational use of nature. Other measures that are not included in standard programmes can also be effective in reducing waste generation. This is evidenced by the negative impact from other activities in the field of ecology and protection of natural resources. Only the variable Elimination of Other Environmental Pollution has a direct impact on the waste generation volume. Pollution elimination measures may involve active collection, accumulation and accounting of waste, which affects statistical data. If the waste processing process has certain shortcomings, it may lead to the accumulation of a large amount of secondary waste, which also affects the waste generation indicator. The statistically insignificant effect of waste disposal expenditures can be explained by the fact that the relevant measures are aimed at recycling existing waste, but do not affect the volume of its generation. In general, the

resulting model is able to explain about 80% of the variation in the dependent variable given the adjusted coefficient of determination.

Table 4 – Regression results for the dependent variable Polluted Wastewater Volume

Regression coefficient		Standard error	t(5)	p-value
Regression results for the dependent variable: Polluted Wastewater Volume R = .58497628, R2 = .34219725, Adjusted R2 = .11003158, F(6,17) = 1.4739, p < .24556. Standard error of estimate: 2.6845				
Intercept	2.347810	0.814823	2.88138	0.010363
Protection and rational use of natural resources	0.147575	0.211857	0.69658	0.495483
Waste disposal	0.042198	0.200478	0.21049	0.835790
Elimination of other environmental pollution	0.246830	0.220074	1.12158	0.277634
Preservation of the nature reserve fund	0.131058	0.211995	0.61822	0.544628
Other activities in the field of ecology and protection of natural resources	-0.153608	0.200261	-0.76704	0.453579
Environmental protection measures at the expense of special-purpose funds	-0.443516	0.199858	-2.21915	0.040372

Source: developed by the author based on (Lviv Portal, 2022; Open Budget, 2024)

The greatest negative impact on the polluted wastewater volume is caused by spending on environmental protection measures at the expense of target funds. Targeted environmental protection measures financed by the budgets of territorial communities are effective in improving the quality of water resources. Intercept shows that the increase in the wastewater pollution volume may be influenced by factors not taken into account in the model.

The model of the influence of environmental indicators on the number of cases of malignant neoplasms did not reveal a statistically significant effect on the dependent variable. Such diseases may be the result of a complex of factors, not only environmental, but also social, economic and other. Accordingly, spending on environmental measures may be only part of an overall strategy to minimize this problem.

Discussion

The conducted analysis proves the effectiveness of EPE as an environmental management tool. At the same time, the amount of EPE is not

a determining factor of effectiveness, so the quality of planning and management of expenditures plays an important role. Additional factors of effectiveness may be cooperation with local residents, the introduction of new technologies, etc.

The obtained results are consistent with the conclusions of Pye-Smith and Borrini-Feyerabend (2021), who noted that the most important role in the implementation of environmental management of territorial communities is played by cooperation, community participation, and innovation. Haji et al. (2020) proved the crucial role of the local community in sustainable land and forest management. Regarding the leading role of cost management, the author's conclusions are also supported by a number of studies. In particular, Hrynchuk et al. (2023) mentioned environmental spending among the key tools of environmental management of territorial communities. The importance of environmental costs and their assessment is also emphasized in the studies of Bilokinna (2023) and Diachuk et al. (2024). However, unlike the author's study, the authors did not analyse the impact of such costs on sustainability.

Regarding the assessment of sustainable development of territorial communities, many researchers emphasized the lack of effective approaches to its implementation and proposed their own systems of evaluation indicators. Panchyshyn and Vdovyn (2023) proposed a comprehensive approach using an integral indicator. The Alaimo and Maggino (2020) method consists in focusing on the first three sustainable development of and identifying indicators useful for analysing specific regions. Roldan et al. (2023) identified a set of variables related to the sustainable development of rural areas using methods of analysing academic literature. However, studies lack approaches to creating a system of indicators that determine the effectiveness of environmental management, as well as approaches to assessing its impact on sustainable development. The author's study partially compensates for this gap by proposing an approach to assessing the effectiveness of environmental management taking into account the environmental indicators of communities and their environmental costs.

Environmental management of territorial communities is closely related to the smart village concept. This concept also includes the use of new technologies and management approaches for the sustainable development of territorial communities (Zhang & Zhang, 2020). The works of Adamowicz and Zwolińska-Ligaj (2020), and Budziewicz-Guźlecka and Drożdż (2022) prove that the implementation of smart village is beneficial for the sustainable development of rural areas. The key difference between the author's study and the noted works is a narrower focus directly on the environmental aspect of sustainable development.

A number of studies considered other tools for ensuring the sustainable development of territorial communities. For example, Khomiuk et al. (2020) noted that attracting investment and diversifying economic activities can be important tools for ensuring sustainable development. Unlike the author's study, their research focuses more on economic strategies for ensuring sustainable development. In turn, environmental management is aimed, first of all, at the rational use of natural resource potential.

Tourism development plays an important role in achieving sustainable development of territorial communities. This direction is related to environmental management, because tourism, as Iannucci et al. (2022) noted, can have both positive and negative effects on the natural environment. According to Maldonado-Erazo et al. (2022), sustainable tourism allows preserving natural resources and minimizing harmful impacts on the environment, contributing to the development of communities. However, this direction was not considered in the author's study, as the costs in the tourism industry defined in the article Implementation of Programmes and Activities in the Field of Tourism and Resorts, are not directly related to EPE. The practical value of the study is the substantiated approach to assessing the impact of environmental management on the sustainable development of communities using a system of environmental indicators and environmental cost indicators.

The research limitations concern the difficulties in determining the ecological state of regions of Ukraine during wartime and revealing the real damage to the environment from military operations.

Recommendations

- Optimize EPE focusing on the most effective areas: financing through trust funds, protection and rational use of natural resources;
- Strengthen control and efficiency of resource use in the field of waste disposal;
- Improve management and infrastructure in the transport sector, for example, implement initiatives to create a network of environmentally friendly public transport to tourist destinations;
- Implement innovative solutions for hazardous waste management, strengthen control and treatment requirements.

Conclusions

The environmental component is particularly important in the context of sustainable development of territorial communities, as significant reserves for natural regeneration have been preserved in rural areas. This makes it urgent to implement environmental management of territorial communities, identify effective environmental management tools, and evaluate results.

The results of the analysis conducted in the study gave grounds to identify the most effective areas of environmental spending as an important tool of environmental management. The reduction of pollutant emissions into the atmosphere is affected by spending on other activities in the field of ecology and protection of natural resources and environmental protection measures at the expense of special-purpose funds. Expenditures on environmental protection measures at the expense of special-purpose funds shows a strong negative impact on waste generation in general. This also applies to spending on protection and rational use of natural resources and other measures that are not included in standard programmes. Expenditures on environmental protection measures at the expense of special-purpose funds has a significant negative impact on the polluted wastewater volume.

The environmental policy of territorial communities should be based on identified effective areas of expenditure and revision of areas that have not demonstrated a significant impact on improving environmental indicators. At the same time, the volume of expenditure is not a determining factor in their effectiveness, therefore, sound planning and management are of great importance. Further research may focus on analysing the impact of tourism expenditure on the sustainable development of territorial communities.

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