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Impact of forestry on ecosystems and the economy: Regional case studies

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Abstract. In modern conditions, environmental protection, and forests in particular, is becoming one of the main components of effective public policy, given their importance in the context of the state's welfare. Hence, it is essential to consider the impact of forestry on the development of the country's economy and its ecological systems. The study aims to conduct a comprehensive analysis of all aspects of the development of the forestry sector in Ukraine, paying attention to the problems existing in this area. The main methods used in the study were analysis, forecasting, and abstraction. The study described the role of forestry and its impact on the economy in different regions of Ukraine and the environment. The study analysed statistical data describing the current rate of logging according to open statistical sources and forest restoration in Ukraine. The study found

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that the current state of forestry and use of forest resources in Ukraine is insufficient to promote the economic and environmental development of the country and that Russia's full-scale invasion significantly affects the prospects for solving existing problems. Therefore, recommendations were made to improve the current state of affairs in forestry, including expanding the responsibility of forest users and wood products producers, increasing the efficiency of forest management, promoting innovation in forestry. The work brings new knowledge in the context of the study of the state of environmental development in Ukraine, and in particular the state of its forest resources. Its conclusions may be important in the context of formulating public policy and creating their development directions for forestry enterprises: woodworking, logging, tourism

Keywords: environment; sustainable regional development; forest sector of the economy; state forestry and environmental policy; law enforcement

Introduction

The role of forestry in terms of economic and environmental impact is significant. Wood-based products are an important component of certain sectors and industries, including construction, furniture, paper, packaging. Forests create places for recreation, attract tourists and improve the health of residents. The environmental impact of forest management can be significant and has both positive and negative consequences. Responsible forest management helps to preserve the diversity of plant and animal species, allows for the rational use of water resources, and reduces carbon emissions. At the same time, negative impacts can lead to loss of biodiversity, reduced soil fertility, water pollution, and large-scale environmental losses associated with deforestation. Unbalanced forest use and ineffective forest management lead to resource depletion, forest degradation and negative environmental impacts. Therefore, sustainable development of forest use and management is becoming an important task to ensure the long-term well-being of both the economy and the environment, and research into the development of this area in different countries remains relevant.

Many scientists and researchers have been studying the state of forestry in Ukraine and its impact on the country's socio-economic

development and ecology in recent years. G. Poiasnyk (2023) studied the peculiarities of Ukrainian nature management and its prospects in the context of global instability. He described in some detail all the peculiarities associated with the use of natural resources in Ukraine during the war, paying attention to the problems of forestry. He proposed several measures to improve the current situation for both forestry enterprises and government officials. M.A. Khvesyk & O.V. Sakal (2019), investigated what instruments of financial and economic regulation of environmental management exist and how they can be used in Ukraine. V. Kovalyshyn (2023) conducted a detailed analysis of the reform of the forestry system in Ukraine, which took place in 2022-2023, pointing out its strengths and weaknesses and potential threats to sustainable forest management.

S. Kovalchuk (2023) also considered the possibilities of the country's transition to sustainable forestry recovery in the post-war period. The scientist noted that this requires reforming the forestry sector with the implementation of environmental and economic instruments. O.P. Yaremko (2021) focused on the study of forestry development, in particular in the Podilskyi economic region. The scientist noted that the forestry of this region has

significant prospects for development, provided that forestry processes are coordinated. N.I. Tsehelnik (2021) studied the economic state of the forestry industry in Ukraine and its impact on the sustainable development of forestry enterprises. T.V. Kobylinska & N.Yu. Husseva (2020). She noted the increasing role of forestry in the economic and environmental situation of the country, identifying key areas for improving forestry accounting. Among the above-mentioned works of scientists, rather little attention is paid to the component of regional development, which, among other things, makes this study relevant. The issues of addressing socio-economic and environmental problems in the forestry sector, in particular, optimising the ratio of deforestation, restoration, and meeting the needs of the market and local communities for forest resources, also require additional attention. Thus, the purpose of this study is to assess the impact of forestry on ecosystems and the economy in Ukraine.

Materials and Methods

The study used certain statistics taken from the website of the State Statistics Service of Ukraine, which characterised open data on deforestation and reforestation in Ukraine (Environment of Ukraine, 2023). However, it should be noted that this source provides rather limited data: for example, in terms of reforestation, information was available only from 2018 to 2022, while data on deforestation was provided for 2000-2020. Thus, data on the reduction of forest area was calculated for the period from 2018 to 2020, with their gradual restoration in the following period. The calculation was performed using the formula:

$$X = D - R, \quad (1)$$

where: D – deforestation in thousand ha (D – deforestation); R – restoration (forest restoration in thousand ha); X – real volumes of forest

restoration/deforestation in thousand ha as of a certain year (if the value of X is positive, then there was a “net deforestation”, i.e. a decrease in the volume of forest resources in real current terms; if the indicator was negative in a given year, then forest regeneration was present).

The analysis also used data from the State Agency of Forest Resources of Ukraine on the country’s forest area by region to further determine the share of regeneration/deforestation. This made it possible to calculate the percentage growth rates of logging in individual regions and oblasts of Ukraine, which is very important for concluding the future effective development of forestry in the country. All calculations and plots were made using the Microsoft Excel spreadsheet processor and recorded in tables.

The main approach used in the study was systematic. It was used to build a unified system within which various factors affecting both the development of certain regions of the country (from an economic and environmental point of view), in particular Polissia and the Carpathian region, and the state of its forestry interact with each other, which makes it possible to increase the efficiency of such a model and, consequently, the conclusions. This analysis considered both quantitative and qualitative data used in the study to understand the state of forestry in Ukraine. The historical method was used to evaluate trends from the past that have a significant impact on the current state of development of this component, and thus to gain a more accurate understanding of the reasons for current trends in it. Forecasting was used to conclude the future development of the forestry sector in the country and, in particular, its impact on the economic and environmental components. Abstraction was used to increase the effectiveness of the conclusions drawn by reducing the number of factors considered during the study. This method was used to consider only those factors that had a

sufficiently high impact on the object of study and, therefore, were important in the analysis. The tabular method was used to present the information collected during the study on the state of the forest fund in Ukraine in a simpler way. This study complies with ethical standards and considers the requirements set out in international conventions such as the Convention on Biological Diversity (1992) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973).

Results

Forestry in general is a branch of agriculture that includes forest management, maintaining and preserving the conservation functions of forests, and exploiting forest resources to meet various needs, including economic, environmental, and social. Its main goal is the conservation and responsible use of forests, ensuring the rational use of timber and other forest resources. Forestry includes planning as a primary management function (development of forest management plans related to logging, reforestation and maintenance, control of forest fires and pests, as well as assessing the sanitary condition and structure of forests), organising forestry activities (harvesting timber, forest products, mushrooms and berries that can be used for industry, construction, energy and food), environmental monitoring (monitoring the impact of forestry on the environment and the sanitary condition of forests and developing measures to preserve biodiversity and protect natural ecosystems).

Forestry in Ukraine is an important component of the agricultural and natural resource management sectors. In general, Ukraine is a forest-deficient country, with only 15.9% of its territory covered by forests. A significant number of Ukrainian forests also perform important public (environmental, protective, social) functions and have limited commercial value. At the same time, Ukraine has highly productive commercial forests, concentrated mainly in the Carpathians and Polissia, which are subject to large-scale industrial exploitation. Forests in Ukraine also serve as a place for recreation and tourism, which is particularly important for the Carpathian region, where local people and businesses are heavily involved in providing these services. Accordingly, attention should be paid to the significant role of forests in maintaining ecosystem services, which is important for sustainable development and environmental protection in the country (Reim *et al.*, 2019; Parks & Abatzoglou, 2020). Forestry in Ukraine is controlled by authorised state bodies in the forestry and environmental sphere (Kobetska *et al.*, 2019), including the State Ecological Inspectorate of Ukraine, departments of ecology and natural resources operating under regional state (military) administrations.

Table 1 below shows some key indicators of the use of forest wood resources obtained from the website of the State Statistics Service of Ukraine, which characterise the development of forestry and forest resource endowment in certain regions of Ukraine.

Table 1. Indicators characterising deforestation in the forestry sector of Ukraine in the period from 2000 to 2020

Indicator	Area covered by logging from 2000 to 2020, thousand ha	The area on which logging was carried out on average per year in this period, thousand ha	Average area of logging from 2000 to 2004, thousand ha	Average area of logging from 2016 to 2020, thousand ha
1	2	3	4	5
Ukraine	8957.7	447.9	451.5	414

Table 1, Continued

1	2	3	4	5
Autonomous Republic of Crimea	54.6	2.7	4.5	-
Vinnitsia region	417.5	20.9	24.4	16.4
Volyn region	708	35.4	37	28.9
Dnipropetrovsk region	57.8	2.9	3.3	3.2
Donetsk	78.7	3.9	3.1	3.8
Zhytomyr region	1132.2	56.6	44.5	63.2
Zakarpattia region	510.7	25.5	23.9	23
Zaporizhzhia region	36.9	1.8	1.6	1.6
Ivano-Frankivsk region	497.4	24.9	24.1	24
Kyiv region	598.4	29.9	29.6	31.9
Kirovohrad region	99.3	5	6.2	4.4
Luhansk	228.1	11.4	10.1	9.4
Lviv region	502.8	25.1	24	24
Mykolaiv region	64.6	3.2	5.6	2.1
Odessa region	118.5	5.9	9	3.9
Poltava region	179.6	9	10.2	7.9
Rivne region	879.7	44	45.9	38
Sumy region	455.2	22.8	21.7	21.9
Ternopil region	189.3	9.5	10.8	7.2
Kharkiv region	291.4	14.6	12.9	16.6
Kherson region	72.8	3.6	3.2	1.7
Khmelnitskyi region	341.4	17.1	20.2	15.3
Cherkasy region	392.9	19.6	20.4	18.8
Chernivtsi region	279.9	14	13.4	11.7
Chernihiv region	650.6	32.5	37.5	27.7

Note: data within the State Statistics Service of Ukraine are available only as of 2020

Source: compiled by the authors based on data from the State Statistics Service of Ukraine (Environment of Ukraine, 2023) and General characteristics of the forests of Ukraine (2023)

As can be seen from the data in Table 1, in the period from 2000 to 2020, the largest volumes of logging in Ukraine were in Zhytomyr, Rivne, Volyn and Chernihiv oblasts, which are located in the Polissia region and have significant reserves of exploitable forest resources. An important indicator is the change in the volume of logging in the country over a certain period. For this purpose, the average logging volumes for the first and last 5 years of the selected period was calculated.

As can be seen from the table, the volume of logging in general tended to decrease in Ukraine. The highest relative growth rate of this indicator is observed in the Zhytomyr region, while the largest decrease is observed in Mykolaiv, Odesa, and Kherson regions. It is also necessary to understand how quickly forest regeneration is taking place in Ukraine in deforested areas. Data on the volume of forest regeneration by region are presented in Table 2.

Table 2. Volumes of forest restoration in Ukraine in the period from 2018 to 2022, thousand ha

Region	2018	2019	2020	2021	2022
Ukraine	51.52	48.84	44.8	49.36	36.85
Vynnytsia region	1.79	1.63	1.51	1.34	1.2
Volyn region	5.67	7.11	5.89	5.63	3.01
Dnipropetrovsk region	0.16	0.33	0.4	0.42	0.39
Donetsk	0.34	0.3	0.23	0.23	-
Zhytomyr region	8.46	8.17	8.01	10.66	9.72
Zakarpattia region	2.67	2.46	2.18	2.17	1.47
Zaporizhzhia region	0.62	0.52	0.45	0.76	-
Ivano-Frankivsk region	3.04	2.33	2.27	2.21	1.72
Kyiv region	4.34	3.71	3.09	2.94	1.61
Kirovohrad region	0.54	0.56	0.41	0.45	0.31
Luhansk	1.02	1.45	0.89	1.6	-
Lviv region	3.15	2.53	2.44	2.47	2.4
Mykolaiv region	0.1	0.25	0.25	0.23	0.22
Odessa region	0.21	0.06	0.07	0.14	0.05
Poltava region	1.38	1.2	1.04	1.43	1.38
Rivne region	6.27	5.13	5.33	5.44	4.65
Sumy region	1.7	1.69	1.62	1.93	1.64
Ternopil region	0.77	0.71	0.68	0.78	0.42
Kharkiv region	0.58	0.55	0.49	0.25	0.2
Kherson region	0.19	0.14	0.22	0.62	-
Khmelnyskiy region	1.54	1.62	1.38	1.33	0.98
Cherkasy region	1.49	1.4	1.31	1.39	0.96
Chernivtsi region	1.59	1.46	1.47	1.64	1.5
Chernihiv region	3.69	3.4	3.06	3.27	3.02

Note: data is available only for the period from 2018 to 2022

Source: compiled by the authors based on data from the State Statistics Service of Ukraine (Environment of Ukraine, 2023)

Table 2 shows that the volume of reforestation in Ukraine is also significant and varies significantly from oblast to oblast. For example, the Zhytomyr and Rivne regions have the highest rates, which is predictable given that these regions have the largest

amount of clear-cut logging that requires further reforestation. However, it is important to understand how the pace of reforestation in Ukraine differs from the pace of logging. This can be analysed using the example of Table 3.

Table 3. The value of reforestation and deforestation in the period from 2018 to 2020, thousand ha

Region	Logging			Restoration			The difference in area between logging and restoration		
	2018	2019	2020	2018	2019	2020	2018	2019	2020
Ukraine	445.5	436.8	382	51.52	48.84	44.8	393.98	387.96	337.2
Vynnytsia region	17.6	18.4	13.7	1.79	1.63	1.51	15.81	16.77	12.19
Volyn region	31.3	33.4	23.9	5.67	7.11	5.89	25.63	26.29	18.01
Dnipropetrovsk region	2.9	2.7	2.8	0.16	0.33	0.4	2.74	2.37	2.4

Table 3, Continued

Region	Logging			Restoration			The difference in area between logging and restoration		
	2018	2019	2020	2018	2019	2020	2018	2019	2020
Donetsk	3.8	4.5	3.8	0.34	0.3	0.23	3.47	4.21	3.57
Zhytomyr region	68.1	68	63.8	8.46	8.17	8.01	59.64	59.83	55.79
Zakarpattia region	24.4	22.7	20.7	2.67	2.46	2.18	21.73	20.24	18.52
Zaporizhzhia region	1.3	1.4	1.4	0.62	0.52	0.45	0.68	0.88	0.95
Ivano-Frankivsk region	28.3	21.8	18.6	3.04	2.33	2.27	25.26	19.47	16.33
Kyiv region	29.9	35.6	36.9	4.34	3.71	3.09	25.56	31.89	33.81
Kirovohrad region	4.7	4.7	4.2	0.54	0.56	0.41	4.17	4.14	3.79
Luhansk	10	8.2	9.2	1.02	1.45	0.89	8.99	6.76	8.31
Lviv region	27.8	23.3	19.9	3.15	2.53	2.44	24.65	20.77	17.46
Mykolaiv region	1.8	2.1	1.8	0.1	0.25	0.25	1.7	1.85	1.55
Odessa region	4.3	4.1	2.2	0.21	0.06	0.07	4.09	4.04	2.14
Poltava region	8	8.6	7.7	1.38	1.2	1.04	6.63	7.4	6.66
Rivne region	42	42.8	39.4	6.27	5.13	5.33	35.73	37.67	34.07
Sumy region	24.1	23	19.9	1.7	1.69	1.62	22.4	21.31	18.29
Ternopil region	7.5	7.6	5.7	0.77	0.71	0.68	6.73	6.89	5.02
Kharkiv region	18.4	18.9	15.6	0.58	0.55	0.49	17.82	18.35	15.11
Kherson region	1.3	1.2	2	0.19	0.14	0.22	1.11	1.07	1.78
Khmelnyskyi region	17.1	15.5	14.4	1.54	1.62	1.38	15.56	13.89	13.02
Cherkasy region	20.2	17.7	19.9	1.49	1.4	1.31	18.72	16.3	18.59
Chernivtsi region	12.6	11.2	8.4	1.59	1.46	1.47	11.01	9.74	6.94
Chernihiv region	29.2	30.5	26.1	3.69	3.4	3.06	25.51	27.1	23.04

Note: the values are only for the period from 2018 to 2020, given that more data on restoration is available from 2018 to 2022, while deforestation is available until 2020

Source: compiled by the author based on the report of the State Statistics Service of Ukraine (Environment of Ukraine, 2023)

Although the data in Table 3 is not sufficient to show the full picture (it is only available for the period from 2018 to 2020), it indicates that the pace of forest regeneration in Ukraine is currently low. It is also important to note that a direct comparison of logged areas and reforestation areas is not always correct, as logging is often carried out selectively and, therefore, does not require further reforestation. Only clear cut sites are further restored by artificial (forest planting) or natural way. Therefore, a direct comparison is only appropriate for areas covered by clear-cutting and areas of reforestation. In general, the highest logging rates are observed in Zhytomyr, Rivne,

and Kyiv regions. This suggests that forest exploitation in these regions is significant. Although data for 2021 and 2022 are not fully available, which can be attributed to the outbreak of hostilities on the territory of Ukraine, the closure of certain databases, and the difficulty of collecting information, especially in the temporarily occupied territories, it can be assumed that this trend in logging continues, including due to the outbreak of war and the need to use wood resources to maintain the country's defence capability. Table 4 shows the ratio of the so-called "net" deforestation (resulted of clearcuts) to the total area of forests in the regions.

Table 4. Indicators of logging rates in Ukraine in the period from 2018 to 2020

Region	Forest covered area, thousand ha	Percentage of forest covered area, thousand ha	The volume of “net” felling, thousand ha			Share of deforestation, %		
			2018	2019	2020	2018	2019	2020
Vinnitsia region	346.5	13.1	15.81	16.77	12.19	4.6	4.8	3.5
Volyn region	624.6	31	25.63	26.29	18.01	4.1	4.2	2.9
Dnipropetrovsk region	179.2	5.6	2.74	2.37	2.4	1.5	1.3	1.3
Donetsk	184.1	6.9	3.47	4.21	3.57	1.9	2.3	1.9
Zhytomyr region	1001.6	33.6	59.64	59.83	55.79	6	6	5.6
Zakarpattia region	656.7	51.4	21.73	20.24	18.52	3.3	3.1	2.8
Zaporizhzhia region	101	3.7	0.68	0.88	0.95	0.7	0.9	0.9
Ivano-Frankivsk region	571	41	25.26	19.47	16.33	4.4	3.4	2.9
Kyiv region	624.1	22.2	25.56	31.89	33.81	4.1	5.1	5.4
Kirovohrad region	164.5	6.7	4.17	4.14	3.79	2.5	2.5	2.3
Luhansk	292.4	11	8.99	6.76	8.31	3.1	2.3	2.8
Lviv region	621.2	28.5	24.65	20.77	17.46	4	3.3	2.8
Mykolaiv region	98.2	4	1.7	1.85	1.55	1.7	1.9	1.6
Odessa region	203.9	6.1	4.09	4.04	2.14	2	2	1
Poltava region	247.4	8.6	6.63	7.4	6.66	2.7	3	2.7
Rivne region	729.3	36.4	35.73	37.67	34.07	4.9	5.2	4.7
Sumy region	425	17.8	22.4	21.31	18.29	5.3	5	4.3
Ternopil region	183.2	13.3	6.73	6.89	5.02	3.7	3.8	2.7
Kharkiv region	378.3	12	17.82	18.35	15.11	4.7	4.9	4
Kherson region	116.3	4.1	1.11	1.07	1.78	1	0.9	1.5
Khmelnyskyi region	265.1	12.8	15.56	13.89	13.02	5.9	5.2	4.9
Cherkasy region	315.1	15.1	18.72	16.3	18.59	5.9	5.2	5.9
Chernivtsi region	236.7	29.2	11.01	9.74	6.94	4.7	4.1	2.9
Chernihiv region	665.7	20.9	25.51	27.1	23.04	3.8	4.1	3.5
Kyiv	31.3	37.2	8.66	8.75	-	27.7	27.9	-
Ukraine	9573.9	15.9	393.98	387.96	337.2	4.1	4.1	3.5

Source: compiled by the authors based on data from the State Statistics Service of Ukraine (Environment of Ukraine, 2023)

However, when analysing the statistical data have to be taken into account that many clear cutting areas, as a rule, are restored by forest planting during the next year after cutting was done. This also impacts on statistics of deforestation and reforestation for one year, and does not provide us with “clear picture” in forest cover change. As can be seen from Table 4 above, the largest volumes of logging are observed in Zhytomyr, Cherkasy, Khmelnytsky and Rivne oblasts. Accordingly, the pace of restoration should be higher in these oblasts, given that forests are restored over a long period.

Therefore, local authorities and state-authorised bodies should pay attention to this component to promote forest restoration and reduce the area of clear-cutting that potentially can lead to deforestation. It is possible to conclude that there are certain problems associated with amount of clear cuttings in some regions, in particular in Zhytomyr and Rivne oblasts, as shown in the Tables above. Some researchers warn that if this trend continues, the entire area of forests in these regions could decline significantly within 30-38 years (Favero *et al.*, 2020; Tkachuk, 2020). At the same

time, the environmental risks associated with deforestation will increase significantly, including erosion, water pollution, increased number, and scale of floods, especially in the mountainous region of the Carpathians, and reduced biodiversity.

Large-scale logging is still a problem in the Carpathians, affecting local ecosystems, biodiversity, and local communities. The Carpathian Mountains, which span several countries including Ukraine, Slovakia, Romania, Poland, and others, are facing increasing environmental challenges due to human activities, including intensive logging, urban development increasing human impact, and intensified agriculture, which is not always organic. In particular, Romania, home to the largest part of the Carpathian Mountains, has also experienced significant changes in forest due to intensive forest exploitation, driven by strong demand for timber from leading European timber companies, as well as an increase in agricultural land. Forest changes caused by clearcuts in the Carpathian Mountains have far-reaching consequences, including loss of biodiversity, erosion, and a negative impact on climate change. The forested mountains play a crucial role in regulating water flows, protecting against natural disasters, and sequestering carbon, which negatively affects the country's ecological status. Addressing these changes in the Carpathians requires a multifaceted approach, including effective law enforcement and enforcement measures, increased fines for illegal logging, sustainable forestry practices, and socially oriented initiatives to support local communities. Ecotourism and agroforestry can provide alternative sources of income for local communities and reduce pressure on forests, while reforestation and afforestation projects can increase forest cover and conserve biodiversity and ecological functions (Nayha, 2019; Guimaraes *et al.*, 2020).

From a socio-economic perspective, poor forest management can lead to loss of profits and jobs in the long term, reduced tax revenues, and reduced export opportunities for value-added products. This will result in losses for the state budget, as well as for communities and the population as a whole. The current state of use of Ukraine's forest resources does not meet the needs of economic development. At the same time, the set of environmental and economic problems described above has become more acute. Their solution is quite difficult to implement in a time of war (Raihan *et al.*, 2023). Thus, it is expected that real effective actions in this area will be taken only after the end of hostilities. After the war is over, the country will face serious environmental problems, including the destruction of ecosystems, soil and water pollution, and loss of biodiversity, especially in the territory of environmental institutions that are directly located in the war zone. The problem of mining a large part of the forested area, especially in Chernihiv, Kyiv, and Sumy regions, is extremely urgent. This makes traditional forest management, including logging operations, and the development of forest ecosystem services impossible.

Increased intensity of forest exploitation will have both regional and transboundary consequences, affecting neighbouring European countries through pollution of aquatic ecosystems and groundwater, and climate change. With this in mind, several recommendations can already be made to improve the environmental and economic situation in the forestry sector. Thus, it is necessary to implement actions aimed at increasing the responsibility of forest users and logging companies, promoting the creation of local wood processing industries for in-depth processing of wood and its reuse, creating jobs in forestry-related sectors, attracting investment. It should be remembered that forests have a very important social

value, so effective forest management should also be aimed at maintaining and enhancing the social functions of forests. In addition, it is advisable to implement measures to improve the efficiency of forest management in the country and to increase the powers of administrations responsible for environmental safety. Overall, further trends in innovation and digitalisation of the economy should help improve the efficiency of forest management at the regional level in Ukraine.

Discussion

The paper describes the existing problems and difficulties in the forestry sector of Ukraine's economy. The current approaches to forest management are not always effective in the current realities of Ukraine and may lead to an aggravation of negative environmental and economic consequences over time. Therefore, some recommendations can be made (in terms of public policy) that can help avoid undesirable results in the long term in the Ukrainian context. For example, it is important to improve the system of monitoring and supervision of forestry and forest resource use, especially in regions with significant volumes of forest wood resources (Polissia and the Carpathian region). In addition, sustainable forest management practices should be promoted, including responsible logging, reforestation and conservation of forest ecosystems, and forest certification should be encouraged to ensure compliance with international standards of sustainable forest management. Where possible, efforts should be made to raise awareness of these issues among local communities, not only among local authorities but also among ordinary citizens. It is effective to support public initiatives aimed at developing agroforestry on the lands of legal entities and individuals, developing forest ecosystem services, including the introduction of ecotourism, to provide

alternative sources of income and reduce pressure on forests caused by excessive logging. It is important to attract investment in forestry, including for the development of local infrastructure, transport, and logistics links, including the construction of forest roads, and the development of recreational facilities and public recreation areas. In forest management, it is advisable to use financial and economic regulation tools: economic incentives and guarantees, market, credit and mortgage, fiscal and budgetary, and innovative tools.

Previously, the forest management system in Ukraine was characterised by significant shortcomings, primarily related to the combination of economic functions and regulatory powers in the relevant state bodies (Tate *et al.*, 2019; Santoro *et al.*, 2020). This caused state interference in economic activity, corruption risks, and inadequate control over the use of forest resources. This issue was partially resolved in 2022-2023 by reforming the forestry system and establishing a single-state forest management enterprise in Ukraine based on the corporate principle. Many methods can improve the condition of forests (Zada *et al.*, 2019). However, it is necessary to understand that all of them should be applied only in a complex way, as this is the only way to achieve maximum results in improving the environmental and economic efficiency of forest resources use.

The global experience of scientific research in the field of effective forest management aimed at ensuring various functions of forests and regional development is worthy of attention. Y. Wang *et al.* (2021) studied the latest advances in the impact of research and continuous learning on improving forest management. The authors also noted that in the future, the development of in-depth training on the effectiveness of forest management will be on par and in synergy with other new-generation information technologies, such as the use of

the cloud environment, the ability to work with large databases used for data analysis in forestry. The use of such technologies can indeed help solve certain problems related to forest management, including in Ukraine. However, under current conditions, their application is still unlikely due to the ongoing military conflict and the country's overall limited capacity (it is likely that even after the war is over, the country will lack the investment to implement such projects).

J. Iglhaut *et al.* (2019) substantiated the importance of data collection tools and software parameterisation to address specific research questions in the field of forest management in a transformed environment. Among the advanced tools for collecting and updating data in Ukraine, the use of drones for forest monitoring, detection of logging areas and reforestation is considered to be particularly effective. However, their use under martial law is virtually impossible due to the existing restrictions on the use of this tool for civilian purposes at present. A. Raihan & M.N. Said (2022) assessed the cost-effectiveness of climate change mitigation measures in the forestry sector, including forest conservation, afforestation, and natural regeneration, through a benefit-cost analysis. The findings confirm the importance of the forestry sector in mitigating climate change. In the context of Ukraine, as mentioned above, this is also relevant: forests as such bring many benefits to the country, including climate change mitigation.

The impact of forestry on economic development was studied by Y. Li *et al.* (2019). The authors showed that the forestry sector has a significant direct, indirect, and induced impact, creating more jobs in other related sectors of the economy than in the forestry industry itself. After reviewing and analysing the situation in terms of individual industries, the researchers showed that the woodworking industry

received the greatest economic effect and benefit (it had the largest multiplier). Such conclusions suggest that, after logging, it is worth monitoring how wood is used, as it can bring different benefits in different areas.

Conclusions

The study assessed the impact of logging activities on both the environment and the economy of Ukraine. The study describes the role of the forestry sector in addressing various development needs of the country and its important role, in particular, in conserving biodiversity, providing economic opportunities, and maintaining ecological functions. The study presents a comprehensive analysis of deforestation and reforestation trends in different regions of Ukraine, highlighting the challenges and problems associated with them.

The data presented in the article shows that the problem of effective forest management is a pressing issue, as intensive logging is observed: in particular, this is evidenced by the fact that in the period from 2018 to 2020, according to the State Statistics Service of Ukraine, about 4% of the forest was cut down annually. Although the volume of clear cutting leading to potential deforestation in the country is gradually decreasing (according to available statistics from open sources, from 445.5 thousand ha in 2018 to 382 thousand ha in 2020), and there is a gradual transition to gradual and selective logging methods, the issues of responsible forest management and proper reforestation remain relevant. The data also suggests that it is important to accelerate the pace of forest regeneration to offset the impact of deforestation. Another important issue is the problem of illegal logging, which, although reduced compared to previous years, is still a pressing concern for Ukraine. It is important to address the problem of illegal logging because it poses an environmental and economic threat to the country. Although

efforts have been made to combat illegal logging, more substantial actions are needed to effectively address the problem.

Further research should be devoted to assessing the state of other regional systems important for economic development and environmental well-being. For example, it remains important to analyse the impact of economic activity on water resources, as well as on carbon storage capacity and global climate change.

Regular assessment of international experience in this area should be conducted to understand global trends in forest management and environmental protection.

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Conflict of Interest

None.

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Вплив лісового господарства на стан екосистем та економіку: аналіз регіональних прикладів

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Анотація. В сучасних умовах захист навколишнього середовища, та зокрема лісів, стає однією із основних складових формування ефективної державної політики, зважаючи на їхню важливість у контексті добробуту держави. Це робить актуальним розгляд впливу лісового господарства на розвиток економіки країни та її екологічних систем. Метою даного дослідження було провести комплексний аналіз усіх аспектів розвитку лісового господарства України, звертаючи увагу на наявні в даній сфері проблеми. Основними методами, що були використані під час дослідження, стали аналіз, прогнозування та абстрагування. В рамках роботи було описано роль лісового господарства та його вплив на економіку в різних регіонах України та навколишнє середовище. В рамках дослідження аналізувалися статистичні дані, що описували існуючі темпи лісозаготівель за даними відкритих статистичних джерел та відновлення лісів в Україні. Під час проведення дослідження встановлено, що сучасний стан ведення лісового господарства та використання лісових ресурсів України є недостатнім для сприяння економічному та екологічному розвитку країни, а повномасштабне вторгнення Росії значно погіршує перспективи вирішення існуючих проблем. Зважаючи на це, були надані рекомендації для покращення ситуації існуючого стану справ в лісовому господарстві, що включають в себе розширення відповідальності лісокористувачів та виробників деревної продукції, підвищення ефективності управління лісовими ресурсами, сприяння розвитку інновацій в сфері лісового господарства. Робота приносить нові знання в розрізі дослідження стану розвитку навколишнього середовища в Україні, та зокрема стану її лісових ресурсів. Її висновки можуть стати важливими у контексті формування державної політики, та створенні власних напрямів розвитку для підприємств в сфері лісового господарства: деревообробних, лісозаготівельних, туристичних

Ключові слова: навколишнє середовище; сталий регіональний розвиток; лісовий сектор економіки; державна лісова та екологічна політика; правозастосування