“Forest resource security in Ukraine: assessment and provision”

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FOREST RESOURCE SECURITY IN UKRAINE: ASSESSMENT AND PROVISION

Abstract

The activities of forestry enterprises suffer from ecological and economic conflicts of interest that are long- and short-term in nature. As a result, productive forest stands are depleted and forest ecosystem sustainability is reduced. Therefore, this article is aimed at justifying recommendations to evaluate and ensure forest resource security. The article also defines the essence of forest resource security as qualitative and quantitative characteristics of the forest fund that ensure the desired level of economic efficiency of the forestry subject to rational use of forest resources, maintaining the quality of the forest ecosystem and performing all other functions of the forest.

Based on the functional and process approach, the methodology of forest-resource safety assessment has been developed, which considers main features of forestry activities and provides for the definition of an integral index of forest resource security as the sum of three groups of indices. The methodology was tested in the context of four forestry enterprises of Volyn and Rivne regions (Ukraine). The results reveal a high level of forest resource security. However, the study identified many problems and, on that basis, the proposals were made to improve forestry practical activities. The results obtained can be considered as the basis for developing environmental policy and taking current and strategic management decisions to ensure the sustainable development of forestry enterprises.

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INTRODUCTION

Environmental crisis phenomena have currently become global, thus having a negative impact on the living standards and leading to degradation of ecosystems. This situation requires a revision of contemporary management principles and transition to the sustainable development principles. This is especially true for forestry enterprises, which are viewed as the complex dynamic ecosystems, the long-term economic efficiency of which is mostly determined by the enterprise's environmental policy and the implementation of principles of sustainable and reproducible forest management. However, forest management of natural resources and use of resource-intensive technologies resulted in the depletion of some of them and the exhaustion of ecosystems. Logging activation leads to negative consequences in the forest ecosystems of the Carpathians; besides, the ecological situation in the Polissia region deteriorates. Under such conditions, assessing and ensuring the forest resource security of forestry enterprises are topical questions, which should be considered as the preconditions for the sustainable development of forestry.

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1. LITERATURE REVIEW

The concept of forest resource security and its evaluation have not been explicitly considered by scientists. However, certain aspects determining the meaningfulness of the concept itself and the evaluation elements were explored in the context of building forest resource capacity.

In particular, Yarova, Mishenina, and Pizniak (2018) substantiated socio-ecological and economic characteristics of forest potential; Antonenko (2008) determined ecological and economic priorities to modernize forest resource complex; Lytsur (2010) studied ecological and economic problems of the spatial organization of the forest complex; Hliebov (2008) considered the features of the formation of optimal forest cover; and Mishenina (2010) analyzed ecological and economic principles of entrepreneurship development in the forest resource sphere.

In the context of environmental and economic security and forest resource security, Koval (2012) focused on reducing the biological sustainability of forest plantations, increasing the influence of natural and climatic factors, and the imbalance of land and territorial systems.

Artyushok (2012) proposed criteria for environmental, economic, and social sustainability in accordance with the forestry enterprise's mission and goals.

Loehle, MacCracken, Runde, and Hicks (2002) considered the problems of justifying approaches to landscape planning based on calculations to identify the forestry's compatibility with environmental functions.

Strange, Jacobsen, and Thorsen (2019), examining the problems of agricultural land afforestation, focus on the uncertain value of ecosystem and public forestry services (co-production of forest products, ecological goods such as biodiversity, hunting, water and soil protection, carbon deposition, recreation, etc.). This causes forest resources to be considered from the perspective of environmental security.

The Ministerial Conference on the Protection of Forests in Europe defines six criteria for sustainable forestry (maintaining and properly increasing forest resources, ensuring the viability of the forest ecosystem, maintaining and stimulating production functions of forests (tree and non-forest), conservation and enhancement of biodiversity in forest ecosystems, keeping and properly enhancing the protective functions of forests, providing other socio-economic functions and conditions); this closely correlates with the authors view of forest security criteria (Holmgren & Persson, 2002; FAO, 2001).

Wolfslehner and Vacik (2008) noted that understanding of sustainable forestry went beyond sustainable logging, since it is necessary to take into account the need for forests to fulfill environmental, economic and social functions without harming ecosystems. It is necessary to consider anthropogenic pressure on the environment and changes in the environmental health parameters. This makes it possible to obtain more information about the network of human impacts on forest ecosystems and oversteps the limits of flat-dimensioned indicators.

The analysis of many research papers has made it possible to identify three main insights in assessing environmental safety of enterprises, including resource security:

1) attention is paid to environmental protection against the negative impact of the eco-destructive activity of enterprises;

2) the main focus is on natural resource availability and efficiency; and

3) combination of the two previous approaches.

The research results show that, despite the developments, questions remain regarding the meaningful content of forest resource security and its evaluation. Therefore, both theoretical and methodological bases for formulating effective approaches to the assessment of forest resource security require further development, taking into account the peculiarities of the forestry functioning and the negative environmental changes.

The purpose of the article is to develop the provisions on the assessment of forest resource security.

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The study is also aimed at clarifying the essence of forest resource security, substantiating methodological elements of forest resource safety assessment, developing directions for ensuring forest resource security in accordance with the results obtained.

2. INITIAL LINES OF RESEARCH

1. Forestry is a complex dynamic ecosystem, the economic efficiency of which in the long run is largely determined by environmental policy and the implementation of the principles of sustainable and reproducible forest management.

2. Among the main objectives declared by the forestry, a significant part corresponds to the forest resource component, which not only ensures economic performance, but also performing other important functions of the forest – ecosystem, recreational, soil and water protection, climate-forming, and life-sustaining.

3. The study considers the essence of forest resource security as a state of the forest fund, which allows reaching a given level of forestry economic efficiency subject to rational use of forest resources, preserving the quality of the ecosystem where the enterprise operates, and implementing all other forest functions.

4. The main features of forest resource security are: ensuring the forest ecosystem resilience to negative natural influences and man-made load; optimal forest cover; provision of natural and artificial reforestation taking into account the long-term prospects of integrated forest management; updating the structure of forest plantations; ensuring a faster rate of reforestation compared to the rate of logging; introduction of resource-saving and environmentally friendly logging technologies; ensuring optimal species and age composition of forest stands; cultivation of high-yielding and biologically sustainable plantations; ensuring the productivity of forest stands; application of technological processes and equipment in the forestry works, which exclude soil damage that can cause erosion and other negative processes.

3. METHODOLOGY

The assessment of forest resource security should be based on the following basic principles: development, commitment, scientific nature, coherence, consistency and stochasticity.

In the short term, the criterion of forest resource security may be the absence of loss of forest resources because of fires, forest diseases, and inefficient forest management; in the long term – self-renewal of the forest ecosystem capacity and artificial forestry to create optimal forest cover, age and species structure of forest stands.

The main stages of forest resource safety assessment are as follows:

1) clarifying the assessment purpose and objectives;
2) choice of assessment approaches and methods;
3) identifying indicator groups and clarifying the local indicators of each group according to the assessment objectives;
4) calculating local indicators;
5) indicator standardization;
6) defining group indices;
7) defining an integral index of forest resource security;
8) interpreting the results, drawing conclusions.

Search of methods and methodology to assess forest resource safety are determined by the criteria selected. The inputs to be used in the evaluation process must meet the requirements of complexity, relevance, sufficiency, timeliness, accuracy and reliability.

Approaches to the assessment of forest resource security should meet the main activities of forestry, namely forest planting, forest conservation, logging, and demonstrate the forest resource efficiency. Since assessing forest resource security will include indicators characterizing these areas of activity, different indicators will be used. Therefore, index, indicator and system approaches should be applied to determine the level of forest resource security.

An integral index is used to identify the level of forest resource security; it is determined based on three group indices, each of which contains local indicators (Table 1).

Table 1. Indices of forest resource security assessment

Source: Developed by A. Cherchyk.

Group	Simple indices	Calculation formula
Forest exploitation	The coefficient of actual use of the estimated logging area	The ratio of the actual volume of wood harvested to the volume of established logging
	Output of harvested liquid timber within final cutting, cubic meters/ hectares	The ratio of merchantable wood cutting to the final cutting area
	Final cutting coefficient	The ratio of final cutting area to the total cutting
Forest protection	Forest enhancement index	The share of sanitation cuttings in the total cutting area
	Indicator of wood loss due to fires	The ratio of burned and damaged forest (in cubic meters) to the estimated logging area
	Indicator of timber loss due to illegal cutting	The ratio of illegal cutting (in cubic meters) to the estimated logging area
Reforestation	Reforestation rate	The share of artificial and natural forest reproduction in total cutting area
	Indicator of converting forest crops and natural regeneration in forested land	Share of conversion of forest crops and natural regeneration in forested land in the total cutting areas
	Forest planting (forestry) index	The share of forestry areas in the total area covered by forest vegetation

The study uses the additive calculation approach since certain local values can be 0. The indicators are chosen to be of equal weight to avoid subjective impact on determining the weights; they are defined as additive normalized because the indices are different. Therefore, the scheme for determining the integral indicator of forest resource security is as follows: group indices are defined as the sum of local indicators divided by their number; the integral metric is defined as the sum of group indicators divided by their number.

The evaluation results are interpreted based on the threshold values of the forest resource security level (Table 2).

Table 2. The interval scale of the enterprise ecological security indices

Source: Developed on the basis of Harrington's desirability function (Harrington, 1965; Dovbnya & Gichova, 2008).

The level of forest resource security	Indicator values
High	1-0.75
Sufficient	Below 0.75 to 0.5
Low	Below 0.5 to 0.25
Critical	Below 0.25

This approach allows setting the level of the enterprise's forest resource security according to the accepted scale (high, sufficient, low, critical) and identifying factors that may cause problems in the current or strategic (forecasting) period.

4. RESULTS AND DISCUSSION

The methodology of forest resource security assessment was tested on the materials of two forestry enterprises of Volyn region (Kamin-Kashirskyi and Manevychi forestry enterprises) and two forests of Rivne region (Klesiv forestry and Sosnivka forestry enterprise). The main outputs are taken from the enterprise reporting (Form 3-LH) (see Table 3).

Table 4 shows the results of calculating local indicators of forestry farms' forest resource security for 2017.

Indicators of forest exploitation characterize high productivity of enterprises' logging activities.

Forestry activity indicators of forestry enterprises include two disincentives, namely loss of wood, loss of forest stands, and the forest recovery indicator. There were no significant losses from illegal cutting and fires. The forest enhancement rates were very different. In particular, Kamin-Kashyrskyi forestry enterprise had 0.710, while in Sosnivka, it amounted to 0.534.

The reforestation index characterizes the level of coverage of total cutting areas due to planting, sowing of the forest and promoting the natural forest regeneration. During the analyzed period, 25-30% of forest reproduction is ensured. The forest care index characterizes the proportion of cutting for lighting, thinning, and landscape formation, which contributes to the better growth and

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Table 3. Outputs to assess the forestry enterprises' forest resource security

Source: According to the company's reporting documentation.

Forestry indices	Kamin-Kashyrskyi	Manevychi	Klesiv	Sosnivka
Area of permanent use of land, thousand hectares	49.9	52.2	54.6	49.8
Total cutting area, hectares	2,119	2,571	2,829	2,037
Artificial reproduction area, hectares	157	253	459	479
Area of natural forest renewal, hectares	251	409	414	97
The actual volume of timber harvested	106,628	156,830	166,472	157,874
Illegal cuttings, cubic meters	29	52	286	40
The main cutting area, hectares	147	383	379	230
Estimated yield from felling, cubic meters	45,340	89,230	78,800	64,180
Volume of burned and damaged forest, cubic meters	0	0	0	0
Sanitation cutting area, hectares	1,504	1,731	1,643	1,087
Area of care felling, hectares	449	285	791	594
Forestry area, hectares	0	0	0	0
Conversion of forest crops and natural regeneration in forested land, hectares	354	526	508	306

Table 4. Local indicators of forestry enterprises' forest resource security for 2017

Source: A. Cherchyk's calculations.

Indices	Kamin-Kashyrskyi	Manevychi	Klesiv	Sosnivka
Forest exploitation indices				
The coefficient of actual use of the estimated logging	0.634	0.875	0.930	0.863
Output of harvested merchantable wood within final cutting, cubic meter/hectare	195.69	203.83	193.30	265.60
Final cutting coefficient	0.069	0.149	0.134	0.113
Forest protection indices				
Loss of wood due to illegal cutting	0.0006	0.0006	0.0036	0.0006
Wood loss due to fires	0.0000	0.0000	0.0000	0.0000
Forest enhancement index	0.710	0.673	0.581	0.534
Forest reproduction indices				
Reforestation index	0.192	0.257	0.308	0.283
Conversing forest crops and natural regeneration in forested land	0.167	0.205	0.180	0.150
Forest care index	0.212	0.111	0.280	0.292

Table 5. Indices of forestry enterprises' forest resource security

Source: A. Cherchyk's calculations.

Indices	Kamin-Kashyrskyi	Manevychi	Klesiv	Sosnivka
Forest exploitation indices				
The coefficient of actual use of the estimated logging area	0.682	0.941	1.000	0.928
The indicator of output of harvested liquid timber within final cutting	0.737	0.767	0.728	1.000
Final cutting coefficient	0.463	1.000	0.899	0.758
Forest protection indices				
Indicator of timber loss due to illegal cutting	0.999	0.999	0.996	0.999
Indicator of wood loss due to fires	1.000	1.000	1.000	1.000
Forest enhancement index	1.000	0.948	0.818	0.752
Forest reproduction indices				
Reforestation rate	0.623	0.834	1.000	0.919
Indicator of converting forest crops and natural regeneration in forested land	0.815	1.000	0.878	0.732
Forest care index	0.726	0.380	0.959	1.000

Table 6. Group and integral indices of forest resource security of forestry enterprises

Source: A. Cherchyk's calculations.

Indices/Forestry enterprises	Kamin-Kashyrskyi	Manevychi	Klesiv	Sosnivka
Forest exploitation index	0.627	0.903	0.876	0.895
Forest protection index	1.000	0.982	0.938	0.917
Reforestation index	0.721	0.738	0.946	0.884
Integral forest resource security index	0.783	0.874	0.920	0.899

creation of stands. Care felling covers 30% of cutting areas on average.

Table 5 shows the results of calculating the local forest resource security indices for 2017.

Table 6 gives calculation data of group and integral indices of forestry enterprises' forest resource security.

The results show that the level of forest resource security is high in the studied enterprises. This was mostly influenced by high forest protection indices. Group indices allow identifying the strengths and weaknesses of forestry farms. The latter serves as the basis for strategic and corrective (current) management decisions.

In particular, the forest exploitation index of Kamin-Kashyrskyi forestry enterprise indicates a sufficient level of their use; that is, it is necessary to develop measures to increase the productivity of logging, namely: complete harvesting, removal from the logging area and use of logged wood; maximum wood processing.

To have productive forests for the long term, it is necessary to invest in forestry, introduce new forest protection, logging and forest processing technologies in the current period.

Integrated use of the forest ecosystem capacity is ensured by expanding the range of forest products; creating auxiliary farms and introducing new workshops for processing secondary raw materials, non-merchantable wood and by-products; scaling up mushrooms, berries, medicinal plants; developing recreational activities, hunting, and tourism through the use of non-resource forest products.

Kamin-Kashyrskyi and Manevychi forestry enterprises also have a sufficient reforestation index; that is, it is necessary to strengthen efforts towards artificial reproduction of forested areas. This is an urgent problem for most forestry enterprises. The increase of forest resource capacity is ensured by natural reforestation through preserving the undergrowth areas; forest intensification and reforestation; optimization of species composition, increase of areas of high-priced species; optimization of age structure and restoration of forest stands; improving forest land fertility; creating highly productive plantations; promoting natural forest regeneration, expanding the areas of natural regeneration and improving the procedure for transforming forested areas to timbered ones; working pollination, etc.

Group forest protection indices are high, but there is a likelihood of unpublished losses.

The following stakeholders are required to ensure security of forest resources:

- at the state level, it is necessary to develop a strategy of sustainable and efficient forestry management, finance forestry and reforestation, and create a favorable investment climate;
- scientific organizations should substantiate proposals to optimize the species and age composition of forest plantations, develop the latest technologies of forestry, forest management, logging and forest processing, integrated use of the natural forest resource capacity;
- educational institutions should provide training, retraining, advanced training of forestry professionals using the latest training programs and technologies;
- forestry enterprises should participate in implementing the state innovation strategy, ensuring expanded reproduction of quantitative and qualitative characteristics of the forest fund.

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In contrast to the approaches considered (Antonenko, 2008; Artyushok, 2012; Dovbnya & Gichova, 2008; Hliebov, 2008; Koval, 2012; Lytsur, 2010; Mishenina, 2010 et al.), this study focuses on the effective functioning of forestry enterprises, for which the following indicators are important to ensure their forest resource security: available volumes of forest resources; their placement conditions; use accessibility; qualitative indicators (age and species structure); opportunities for reforestation; forestry opportunities. They are implemented in forest resource security components such as: forest management endurance; rates of natural and artificial reforestation; logging volumes; forest structure by species composition and maturity; rational use of forest resources; volumes and effectiveness of forest protection activities.

This study develops and deepens the authors' approaches to assessing the ecological and economic security of forestry enterprises (Cherchyk et al., 2019).

CONCLUSION

Functional and process approach was used to identify local indicators of forest resource security. According to this forest resource security assessment covers the main processes of forest resources exploitation, forest restoration and forest protection activities.

The methodology of forest resource safety assessment was tested on the materials of four forest enterprises in Volyn and Rivne regions of Ukraine. These regions have the highest level of forest cover; their farms have similar objective (natural) factors of forest resource security creation. The volumes of timber harvesting and the main indicators of forestry are found to be high at these enterprises. All farms have a high integral index of forest resource security. However, there are some deviations from the high level of forest resource security, which has resulted in many suggestions for improving the situation. Further research should develop and apply expert methods for assessing forest resource security, as well as a case-study method that, unlike the presented methodology that focuses on the enterprises' reporting, should be based on the independent information on the status of forest resource security in specific situations.

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