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ЭКОСИСТЕМНЫЙ УЧЕТ ЛЕСОВ В УСТОЙЧИВОМ ПРИРОДОПОЛЬЗОВАНИИ: ОСНОВНОЕ СОДЕРЖАНИЕ И РАЗВИТИЕ

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В исследовании рассматриваются актуальные вопросы формирования экосистемного учета лесов в контексте становления и развития природно-экономического учета. Данной проблеме посвящены многочисленные научные работы как белорусских, так и зарубежных ученых. Однако экосистемный учет лесов с позиций природного и формирующего экологического учета исследуется не в полной мере. Предпринята попытка определить концептуальные и методологические основы построения экосистемного учета лесов как функции лесопользования и структурного элемента системы национальных счетов (СНС). Обращается внимание на аргументацию авторов в отношении рассмотрения содержания и отличительных черт экологического учета, объектом которого являются экологический капитал и экосистемные услуги. Различие между природным и экологическим учетом имеет принципиальное значение для раздельного

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выражения ценности природных ресурсов разных сфер (экономической и экологической), динамики жизненно важных и незаменимых экосистемных услуг и в целом экологического капитала. Отдельно изучено построение обобщенных счетов экосистемных услуг на основе принципов системы природно-экономического учета (СПЭУ) [1]. Авторами предлагается метод физического и стоимостного учета лесов. В качестве основного носителя экосистемных услуг лесов выступает древесный запас и его динамика во времени, а в основе стоимостного измерения лежит экологическая рента. Данный методический подход основан на теории воспроизводственной ренты и имеет свое практическое воплощение в ТКП 17.02-10-2013(02120) «Порядок проведения оценки экосистемных услуг и определения ценности биологического разнообразия», разработанном под научным руководством профессора А. В. Неверова.

Ключевые слова: экосистемные услуги; леса; природно-экономический учет; экологический капитал; лесные ресурсы; экологический актив.

ECOSYSTEM ACCOUNTING OF FORESTS IN SUSTAINABLE ENVIRONMENTAL MANAGEMENT: BASIC CONTENT AND DEVELOPMENT

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The presented article examines the topical issues of the formation of ecosystem accounting of forests in the context of the formation and development of environmental and economic accounting. Numerous scientific works by both Belarusian and foreign scientists are devoted to this problem. However, ecosystem accounting of forests, from the formative environmental accounting, is not fully investigated. In this paper, an attempt is made to define the conceptual and methodological foundations for building ecosystem accounting of forests as a function of forest management and a structural element of system national accounting (SNA). It is important to pay attention to the authors' arguments regarding the consideration of the content and distinctive features of environmental accounting, the object of which is environmental capital and ecosystem services. The difference between economic and environmental accounting is of fundamental importance for the separate expression of the value of natural resources using in different spheres and as well as dynamics of vital and irreplaceable ecosystem services and, in general, environmental capital. The construction of generalized accounts of ecosystem services based on the principles of the system environmental and economical accounting (SEEA) [1]. The authors propose a method of physical and cost accounting of forests. The main carrier of ecosystem services of forests is the wood stock and its dynamics over time and the cost measurement is based on environmental rent. This methodological approach is based on the theory of reproductive rent and has its practical output in the TCP 17.02-10-2013(02120) «Procedure for conducting valuation, ecosystem services and determining the value of biological diversity» developed under the scientific guidance of prof. A. V. Neverov.

Keywords: ecosystem services; forests; natural economic accounting; environmental capital; forest resources; environmental asset.

Introduction

Recently, with the emergence of new priorities to achieve sustainable development goals, such as green and circular economy, climate change mitigation, biodiversity conservation, and prevention of environmental degradation, research and practical recommendations on the assessment and use of resource and ecological potential, functions and services of ecosystems [2]. This is largely due to the negative consequences of the transformation and disappearance of the latter, primarily forest ecosystems. The economic assessment of forest ecosystems that has existed until now was determined only by the value removed from them and sold on the timber market. At the same time, the valuable ecosystem services provided by forest vegetation and its ecotopes, ensuring the conservation of biodiversity, climate regulation, soil protection from degradation, recreational, aesthetic values, and the maintenance of natural, cultural and sacred heritage, were completely ignored. Often these services significantly exceed the results of their production and operation. Thus, according to the UN FAO, the share of the forest sector in global GDP exceeds 1.52 trillion. US dollars, and taking into account the ecosystem services provided by forests, it is estimated at 7.5 trillion. US dollars [3].

The multifunctionality of forest ecosystems provides society with a variety of socio-economic and environmental benefits and benefits, which are an economic category called «natural capital». Typically, this term

refers to the economic value, including its value expression, of ecosystems, taking into account their resource and environmental potential. However, taking into account the importance and specificity of the ecosystem functions of forests, the authors of the article support the idea of the need for separate assessment of their natural and ecological ecosystem accounting. Natural accounting covers the timber stock, its territorial distribution and cost measurement, and environmental accounting records the values of the ecosystem, provisioning, regulating and cultural services provided by forests [4]. In this regard, it is advisable to distinguish, along with natural capital, environmental capital, which has an independent status. Thus, natural ecosystem accounting of forests reflects a purely economic (commercial) approach to forest management, and ecosystem accounting reflects its environmental and economic interest, which consists in determining the value of forest ecosystem services [5]. This methodological approach can be an effective tool for maintaining national accounts in the field of forestry and environmental activities.

Materials and research methods

The main sources of information in preparing the article were the results of an analytical review carried out by its authors of foreign and domestic literature on the methodological framework and assessment of ecosystem services of forest resources. To determine indicators of the physical measurement of ecosystem services of forests in Belarus, statistical information on the area, productivity and reserves of wood raw materials was used, as well as their cost expression indices of the value of the forest as an ecological object [6; 7]. In order to use the information and value of forest ecosystem services and their accounting in state statistics and forestry bodies, they were harmonized accordingly with the requirements and methodology approved by the UN Statistical Committee, the System of Natural and Economic Accounting (SEEA) in relation to all biological assets, including forest vegetation [1]. The calculation of the value of forest ecosystem services was carried out in accordance with the recently approved Resolution of the Council of Ministers of the Republic of Belarus «On the economic assessment of ecosystem services» [8]. The calculation is based on the rental approach to determining the value of forest resources, separating from the economic (differential) rent the value of the ecosystem services they provide [9; 10].

Results and its discussion

Among the priority measures to achieve the goals of sustainable development and the transition to a green economy, along with measures to stimulate socio-economic growth and improve human well-being, is the conservation and restoration of natural ecosystems, assessment, accounting and use of the ecosystem services they provide. The latter modern economic science and practice understand non-market material and intangible benefits and benefits that humanity receives from ecosystems to provide them with natural resources, a healthy and comfortable living environment, regulation of natural processes, maintaining sustainability and environmental protection, etc., which complement the economic the value of natural potential. In this regard, issues related to the management of ecosystem services are currently becoming very relevant and practically in demand, namely: their statistical accounting, functions performed, environmental and economic assessment, formation of a market for such services, identification of potential sellers and buyers, as well as implementation mechanisms and tools for their compensation.

The lack of indicators of the value of the entire complex of ecosystem services provided (providing, regulating, supporting, cultural) leads to an underestimated reflection of environmental damage and external costs in price. It is known that with adequate economic consideration of the environmental factor, the efficiency of resource use is noticeably higher than when increasing the environmental intensity of the economy, which has been confirmed by the development of a number of countries in the last few decades [11]. The prevailing opinion so far about maintaining technogenic, nature-intensive development requires more and more funds for nature-exploiting complexes and industries, the functioning of which is often accompanied by the depletion and degradation of natural complexes and their individual components. In turn, this requires additional costs to maintain the same level of exploitation and extraction of natural resources, including forests. Other, resource-saving ways of economic development are needed, which should be based on taking into account environmental factors. This is the goal of the Millennium Ecosystem Assessment, developed under the auspices of the UN, UNEP, IUCN, FAO, and the International Monetary Fund, developed in 2005, which emphasizes: «...Modern knowledge and technologies can significantly reduce human impact on ecosystems. However, their potential is unlikely to be fully exploited until then, but ecosystem services will continue to be viewed as free and infinite, and their value will not be fully taken into account» [12].

This conclusion significantly expands the content of the concept «natural capital» used until recently, which was interpreted only as a resource category with a value reduced to world prices for these resources. Today, it is increasingly realized that natural capital includes not only a resource component, but also a wide range

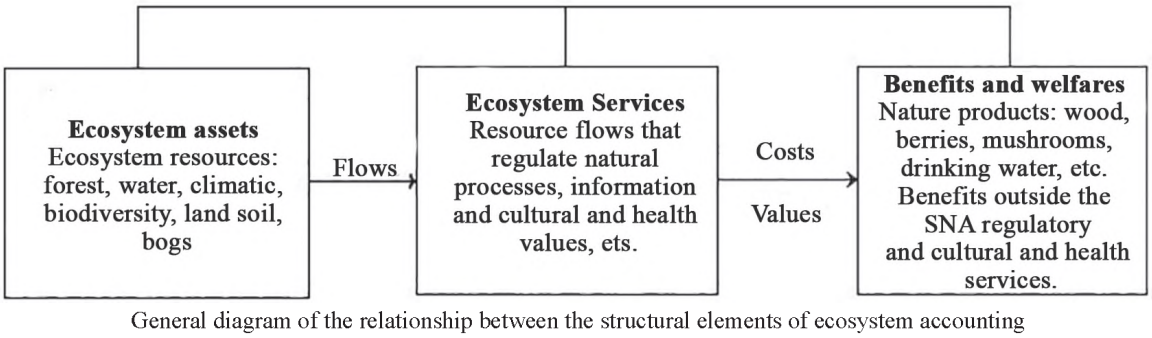
of ecosystem services provided, necessary not only for the self-sustainment of natural resources, but also for anthropogenically sustainable use of resources at different levels of environmental organization [13].

Among a wide range of areas that require disclosure of the content and use of ecosystem services provided, the most significant is the determination of environmental and economic value, including the valuation of benefits received in the process of functioning of forest ecosystems with the subsequent integration of their assets into the system of national accounts [14; 15]. It should be recognized that the last area is among the most poorly developed issues.

Despite the existence of many developed approaches and methodologies that could be used in assessing ecosystem services, they have not been widely used. This is due not only to the complexity and complexity of the problem being solved, the need to take into account ethical and cultural aspects, but also to the fact that the services in question and their assets are not objects of market turnover. In this regard, non-market methods for determining price parameters must be implemented and applied. The most famous is the assessment of ecosystems based on total economic value, recommended by the UN Statistical Commission when maintaining the System of Natural and Economic Accounts (SEEA-12) [1]. The latter serves as an internationally accepted method for accounting for natural capital within national accounts. SEES-12 involves the development of ecosystem services assessments and the inclusion of ecosystem accounts as a separate section. One of the motivations determining the need to study natural resource assets, including forests, was the concern of the world community for the continued intensification of environmental management, leading to the reduction and degradation of environmental components and thereby reducing the value of natural resources. In the report from the previously existing system of national accounts (SNA), which reflected only natural resource value, in SEES-12, environmental-economic accounting expands the category of assets by including all ecosystems that perform environmental functions and services provided in the form of material and intangible assets. This document is of a recommendatory nature, but its main provisions are reflected in the practice of national accounting in many countries, including Belarus, especially in terms of physical accounting of forest and water resources.

The initial category of ecosystem accounting is an ecosystem service, which determines the content of an ecosystem asset and the multidirectional satisfaction of environmental needs (benefits – benefits, revenues, income).

The relationship between ecosystem services, ecosystem assets and benefits can be schematically represented as the following diagram (Fig.).



General diagram of the relationship between the structural elements of ecosystem accounting

As can be seen from the presented diagram (figure), flows of ecosystem resources (in the form of an ecosystem asset) are transformed into various types of benefits. There is an organic connection between the concepts of «ecosystem service» and «ecosystem utility function».

An ecosystem service is the annual production of an asset, and an ecosystem useful function is the asset itself, its ability to produce and «self-reproduce». Etymologically, these two words (service and function) express the same meaning: the manifestation of the properties of a natural resource, the performance of useful work by it. Depending on the set of utilities (benefits) of the ecosystem and their participation in meeting human needs, two fundamentally different assets are formed: economic and environmental. Accordingly, there are two fundamentally different accounts: economic and environmental.

In the system of ecosystem accounting, natural capital, expressed by its nominal value, is characterized by a dual feature: on the one hand, being a purely economic category of economic activity, on the other hand, it is determined by environmental values [16]. In this regard, in many scientific studies devoted to ecosystem services, the latter are interpreted from the perspective of three characteristic functions of natural capital: 1) resource, according to which the production of goods and services is ensured as a result of the use of natural resources; 2) ecosystem-providing environment-forming and regulatory functions with natural components; 3) social – services of nature related to its cultural, historical, scientific, recreational and spiritual aspects. Based on this, a classification of ecosystem services was proposed, divided into 4 groups: providing, regulating, supporting and cultural. This classification was first reflected in the International Program «Millennium Ecosystem Assessment» developed in 2005 [17].

Other most used classifications include the one developed by The Economics of Ecosystems and Biodiversity (TEEB) project [18], and the third one called the Common International Classification of Ecosystem Services, CICES). The CICES classification was carried out under the auspices of the European Environment Agency [19], has a 5-level hierarchical structure, consisting of sections, divisions, groups, classes and class types, and is most consistent with and reflects the structural and functional features of Belarusian ecosystems and the services they provide. According to the above classification, 83 types of ecosystem service classes are identified, which are currently used in assessing the six most common ecosystems on the European continent: forest, agricultural, wetland, marine, urban, soil ecosystems.

It should be recognized that despite the rapidly developing area of identification, assessment, mapping and practice of applying the results of ecosystem services in foreign, including neighboring countries, in the Republic of Belarus all these issues are at the initial stage of their implementation. All the necessary prerequisites for intensifying work in this area exist. First of all, this concerns the presence in the structure of the republic's land fund of natural complexes and ecosystems, which occupy 11.84 thousand hectares or 57 % of the country's territory, represented by forests, trees and shrubs, natural meadows, swamps, aquatic and agricultural ecosystems [20].

Some experience in assessment, including its monetary expression and accounting of ecosystem services, has been accumulated in our republic. Thus, for the first time, it was recommended to calculate the value of ecosystem services and biological diversity, regulated by a specially developed technical regulatory act: TKP 17.02-10-2013 (02120) «Environmental protection and natural resource management. The procedure for determining the valuation of ecosystem services and biological diversity». Depending on the purposes of the valuation of ecosystem services and the scope of application of its results, two types were used: integral valuation and the cost value of biodiversity used to justify alternative options for their use and element-by-element valuation related to taking into account the value of specific ecosystems (forest, meadow, swamp, aquatic). In the above-mentioned TCP for a detailed calculation of the cost of ecosystem services for the four main natural types of ecosystems and their individual functional properties (carbon dioxide absorption, water treatment and their assimilative capacity), formulas are provided by which the cost is determined such services.

This problem has been most fully solved in relation to forest ecosystems, the area of which in the Republic of Belarus is 8.34 million hectares or 40.1 %, due to which a fairly high ecological asset is formed. Let us briefly consider the main stages and approaches to the assessment, its content and the state of ecosystem accounting in national statistical activities. First of all, in contrast to the SEEA recommendations, the forests of the republic are considered as an independent natural complex, including, along with forest, tree and shrub vegetation, living ground cover, wild animals and microorganisms within the forest fund [21].

This emphasizes the polystructural nature and multifunctional significance of forest ecosystems, which not only have bioproductive potential, but are also characterized by water protection, climate regulation, protective, recreational, aesthetic, scientific and educational properties and suppliers of non-wood by-products. In this regard, forests are distinguished, taking into account their location in landscapes, into categories: operational, protective, recreational and environmental. For each forest category, its own differentiation of ecosystem services according to the degree of their importance is proposed, which made it possible, based on expert assessment, to determine the importance of ecosystem services in each forest category (Table).

Preliminary expert assessment of ecosystem services of different categories of forests [22]

Forest category	Ecosystem services				Sum of points	Value factor
	providing	regulating	cultural	supportive		
Environmental	+	++++	++++	++++	13	1,3
Recreational and health	+++	++	++++	++	12	1,2
Protective	++	+++	+++	+++	11	1,1
Operational	++++	++	++	++	10	1,0

Note. Not high (+); moderately high (++); high (+++); very high (++++).

As follows from the table, the initial basis for measuring the value of different categories are operational forests with a total score of 10. The ratio of the sum of points of the specified category of forests with the sum of points with other categories of forests determines the coefficient of the value of ecosystem services of a particular category of forests.

To perform a cost measurement of forest ecosystem services, the concept of total economic value is most often used, combining the direct cost of using ecosystems, indirect cost of use, potential value, and cost of existence [23]. The concept represents an integrated approach to assessing nature as a whole, including resource ecosystem functions, regulatory functions and cultural services of nature.

The formula for total economic value can be presented as:

$$TEV = DV + IV + OV + EV,$$

where DV is the direct cost of use, IV is the indirect cost of use; OV – value of deferred alternative (potential value); EV – cost of existence.

The advantage of this technique is that, using cost indicators, it is possible to trace economic changes in environmental services, i.e. perform an analysis of the costs and benefits obtained from them at all levels of management. At the same time, the disadvantage of this approach is the combined use of both analytical methods for calculating cost indicators and methods based on sociological research, which reduces the accuracy of estimates. In addition, the obvious shortcomings of the methods include the use of simple summation of the value of both functions and ecosystem services, without taking into account the fact that in reality one function can provide several ecosystem services. In addition, the concept of «general economic assessment» suffers from eclecticism, incorporating economically incorrect summation as an expression of the value of a natural resource (for example, wood, berries, mushrooms, etc.) and natural products obtained as a result of human labor and transformed into finished goods. products, in particular wood. It is of interest to have other methods for economic assessment of ecosystem services that determine the demand for a good or service in monetary terms, i.e. both the willingness of consumers to pay for a particular benefit and the willingness of people to accept compensation for giving up that benefit. Their list and contents are described quite fully in the published review [24]. In our opinion, the rental concept of their value should be used as an integral valuation of ecosystem services, which is leading for the environmental accounting system. According to this concept, the key category expressing the economic value of ecosystem services is natural capital, in which the environmental effect is taken into account using a reduced discount rate. The latter is used in determining the capital value of natural resource rent. This methodological approach was used in the preparation of a technical regulatory legal act (TKP) dedicated to the mechanism for calculating the valuation of forest ecosystem services and determining the value of biological diversity in relation to the natural and economic conditions of the Republic of Belarus [7].

This manual provides formulas for calculating the value of forest ecosystem services (specific environmental rent) in relation to their main object - the timber stock, as well as the regulating and socio-ecological services of forest ecosystems. It has been established that, from the standpoint of the physical measurement of ecosystem services, the timber stock of Belarusian forests as a producer of ecosystem services as a whole is 1.82 billion m^3, of which 1.14 billion m3 (62.6 %) are production forests, 332 are protective forests, 0 million m3 (18.2 %), recreational and recreational 63.5 million m^3 (3.5 %), environmental forests – 285.0 million m^3 (15.7 %). The recently published work [22] provides information on the results of the valuation of ecosystem services of forests in Belarus, based on determining their total capital cost, which averaged 1.00 thousand rubles/ha. Its size ranges from 0.88 thousand rubles/ha in production forests to 1.64 thousand rubles/ha in conservation forests. The completed capital assessment was then converted, taking into account the percentage of annual forest use, into the current annual amount of ecosystem services. Their average annual cost was 25.5 rubles/ha. At the same time, its maximum value is for environmental forests – 37.7 rubles/ha, the minimum for operational forests is 25.5 rubles/ha.

The completed valuation of ecosystem services of forests in Belarus, despite the fact that it is preliminary, emphasizes the importance of ecosystem accounting and is an additional tool for justifying the strategic development of forestry and an important argument for the environmental protection role of forest ecosystems and sustainable socio-economic development. Considering the fact that in Belarus the identification and assessment of ecosystem services of forest ecosystems is at an early stage, as well as the presence of some methodological gaps and difficulties in accounting for them at the national level, a scientific solution to a number of priority tasks is required. These include the justification and definition of key criteria and indicators characterizing the ecosystem services of forest resources [25; 26]. These indicators should fully reveal the essence and characteristics of the forest ecosystem assets of the republic, and also be adapted to international methods and recommendations and harmonized with national legislation in this area.

Conclusion

In the context of the formation of a mechanism for sustainable environmental management, the system of ecosystem accounting of natural complexes of the natural environment, where forests play a key role, is noticeably updated and acquires practical significance. The concept of ecosystem accounting of forests is based on the identification of forests as independent, but closely interrelated economic and environmental assets as part of natural capital. The latter are determined by the variety of functions performed by forests and the wide range of ecosystem services they provide in the form of tangible and intangible benefits and benefits. In this regard, it is advisable to highlight the natural accounting of the forest as a source of its timber and secondary forest reserves, which have a certain purely economic (commercial) value. At the same time, forests perform important functions in the

form of regulated, environment-forming and socio-cultural ecosystem services that require separate environmental accounting. To carry out the valuation of forest ecosystems, it is proposed to use a rental approach, the application of which determines the profit due to the high level of not only their productive capacity, but also the savings in future costs associated with the reproduction of the ecological functions performed by forests. Among the promising and popular activities that contribute to a more complete and comprehensive reflection of the beneficial properties of forest ecosystems and their reflection in the system of ecosystem accounting in national and international accounting include the justification and definition of criteria and indicators of ecosystem services of forests of the Republic of Belarus, their territorial manifestation and mapping at different levels of organization of the natural environment.

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