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Methods of Valuation of Ecosystem Assets and their Assimilation Services

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Abstract. An urgent problem of the modern world is the degradation of ecosystems, which requires a radically new approach to assessing and ensuring further, cost-effective use of their potential. However, the value assessment of ecosystem assets (capital) that provide assimilation and other, in particular, oxygen-producing, services to territorial communities has not yet been conducted. It is proved that if ecosystem assets are recognised as the property of territorial communities and the latter are granted the right to dispose of their property (ecosystem assets), the problem of valuation of such assets becomes a priority task. The purpose of the study is to compare scientific approaches to the valuation of ecosystem assets and develop a method for evaluating them, considering the ecosystem services that they provide to territorial communities during their life cycle. The study involves general scientific methods of economic studies and specific ones. The essential features of methods for evaluating a natural resource object are determined, which are the assessment methodology and financial and economic tools used for its practical implementation. Based on this, the analysis is conducted and the substantive features of the method of discounting cash flows (rent valuation method), cost, market prices, hedonistic pricing (price advantages), transport costs, conditional survey method, etc. are established. It is proved that these methods do not meet the requirements of value-market assessment and do not allow for an adequate assessment of the assimilation potential of ecosystems. An ecosystem asset should be considered from the standpoint of environmental safety, so the assessment methods should be different. In view of the above, the most optimal method is proposed: the value of ecosystem assets is determined by the value of the entire complex of assimilation and oxygen-producing services provided by them for their entire life cycle. The author's method was tested on the example of poplar alley, which is part of Taras Shevchenko Boulevard, located in Kyiv

Keywords: evaluation methods, cost, the object of evaluation, territorial communities, poplars, assimilation and oxygen production services

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INTRODUCTION

The problems that have been accumulating in Ukraine in the environmental sphere for a long time have a nationwide scale and require fundamental official recognition, serious attention, and further solution from society. The seriousness and importance of this issue are evidenced by the fact that it is one of the priorities of the President of Ukraine, who by Decree of March 23, 2021, No. 111/2021 put into effect the decision of the National Security and Defense Council of Ukraine "On Challenges and Threats to the National Security of Ukraine in the Environmental Sphere and Priority Measures to Neutralise Them" [1], which encouraged researchers and civil servants to join the discussion and strengthen the investigation of this area. The head of the All-Ukrainian Ecological League T. Tymochko notes that "environmental security is recognised as an important component of national security of Ukraine" [2].

Therewith, the problems in the field of environmental protection (EP) that humanity is currently facing constantly generate new challenges and necessitate new scientific approaches to ensure interaction between ecosystems, on the one hand, and the population, on the other. In the current market conditions, the question of revising or even developing a new approach to evaluating the interaction mentioned above arises. The formulation of such a problem and its solution are highly relevant for modern Ukraine, which is explained by a number of circumstances: historical indifference to environmental issues, environmentally outdated technologies, inadequately low environmental taxes, chronic budget deficit, and, as a result, the financial inability to provide environmental programmes, including relevant studies, lack of political will to fundamentally resolutely change the situation in this area. This problem is becoming even more relevant, considering the decentralisation transformations in Ukraine. In the Constitution of Ukraine [3]: Articles 142 and 143; in the Civil Code of Ukraine [4]: Art. 319 (p. 1, 5), Art. 324 (p. 1, 2, 3); in the Law of Ukraine "On Local Self-Government in Ukraine" [5]: Art. 26 (p. 24, 35, 36, 37), Art. 27 (p. 2, 5), Art. 28, Art. 33 (a): p. 1, 2, 3), Art. 60 (p. 1) – local communities have the right to own property belonging to them. In particular, Article 142 of the Constitution of Ukraine stipulates: "The material and financial basis of local self-government is movable and immovable property, revenues of local budgets, other funds, land, natural resources owned by territorial communities of villages, towns, cities, districts in cities, and objects of their common property managed by district and regional councils" [3]. According to the provisions of the Constitution of Ukraine [3], The Civil Code of Ukraine [4], the law of Ukraine "On Local Self-Government in Ukraine" [5], it is established that the owner possesses, uses, disposes of their property at their own discretion.

Consequently, natural resources are the property of territorial communities, and their owner has the right to dispose of them considering their (the owner's) economic and other interests. To have such an opportunity (to dispose of their own property to obtain a certain economic benefit), the owner must evaluate it, that is, make a value assessment of the property (assets) belonging to them. In assessing the value of the owner's assets, their potential ability to be useful to the owner – to provide the owner with acceptable living conditions should be considered. This utility of ecosystem assets is conditioned by the fact that they generate ecosystem services, including the assimilation potential of such assets. However, as summarised in the official report of the international company for the promotion of environmental and socially responsible development ECODIT LLC (Virginia, USA) [6, p. 15], no serious systematic assessments of ecosystem services have been conducted in Ukraine, so such a gap in information on the cost of ecosystem services necessitates developments in this area.

Ecosystem services, including assimilation and oxygen production services, often cannot be evaluated using the most common monetary method. Such valuation methods have existed for a long time [7-9], and they are used to determine the value of natural resources that are valued as a commodity (admittedly, this is how everything that is valuable should be valued in a market economy). The assimilation potential of ecosystems is quite different, and the classical market approach is not quite appropriate in this case. Nevertheless, the current methods of evaluating it do not consider this, and, consequently, the current methods cannot adequately assess it. The main disadvantage of this approach is that its practical use does not allow comprehensively assessing the ecosystem: these methods [10-13] do not cover all aspects of the interaction between the ecosystem and consumers of ecosystem services – territorial communities of villages, towns, cities, districts in cities, etc.

For that reason, a need appeared to find a fundamentally new approach along with the task to develop and implement new methods that would be aimed at assessing ecosystems (and their assimilation potential) as objects that ensure the life of people from a comprehensive standpoint of environmental safety. From this position, it is necessary to find the assessment methodology that should be used to assess ecosystem assets from the standpoint of environmental safety, as an object that provides a range of ecosystem services to the population. Thus, the value of these ecosystem assets is determined by the value of the entire complex of assimilation and oxygen-producing services provided by them for their entire life cycle.

In the modern world, which is currently globalising, the issue of developing common approaches and rules, considering the assimilation potential of ecosystems, becomes more acute. This challenge is also very relevant for Ukraine, which focuses on civilised European standards and implements the latest approaches in nature management to ensure the interests of the population

of territorial communities. Therefore, it is advisable to perform a cost assessment of the assimilation potential of ecosystems as an asset of territorial communities, including united ones, and other ecosystem services that contribute to improving EP to preserve local ecosystems in the context of decentralisation of power.

The purpose of the study is to develop the author's method for assessing ecosystem assets that provide assimilation and oxygen-producing services to territorial communities based on the analysis of methods of valuation of natural resources and structuring of their substantive features.

LITERATURE REVIEW

A review of the specialised literature shows that there are successful examples of economic assessment of ecosystem services within the framework of international and national economic mechanisms for solving environmental issues. "Identification and evaluation of ecosystem services, and consequently the development of economic and institutional mechanisms for paying for these services, are extremely important in this context. The concept of ecosystem services has been recognised in national environmental policies and legislation in many countries. Activities are being intensified on a wide range of issues related to ecosystem services, including their assessment, identification of potential sellers and buyers and compensation mechanisms, and the development of markets for these services" [8, p. 3].

For a long time, researchers have been attempting to develop an economic assessment of ecosystems, their components, and services from various positions. Thus, V.M. Zakharov and D.M. Clark conducted an integrated assessment of the health of ecosystems and their individual species [14]; T.I. Makeeva and G.N. Nikonova assessed the anthropogenic load on the territory according to the indicators of plant development stability [15]; O.A. Neverova performed a bioecological assessment of air pollution by the condition of woody plants [16]. Some researchers study bioresources as components of ecosystems. In particular, M.A. Magomedova and K.A. Kasimova examined the properties of poplars and their use in monitoring EP [17]; K.M.Kinzerskaya and N.V. Vyvodtsev investigated the ecological and biological characteristics of Populus suaveolens in conditions of environmental pollution [18]. However, while in Ukraine these issues are just beginning to receive state and professional attention, for example, "in the US, urban plantations are assessed in terms of their potential for air purification, flood protection, and increasing the value of nearby real estate" [10]. Serious attention from the governments of the United States, Germany, Australia, Japan, Spain, The Netherlands, Switzerland, Norway, Finland, Sweden, Denmark, and the United Kingdom to projects in the field of efficient use of ecosystem assets and increasing funding, in particular, forestry, is noted in [8, p. 94-95].

From the standpoint of ensuring environmentally sound human behaviour, on the example of fisheries, C.E. Hunter and M. Lauer [19] explore the value of ecosystem services, emphasising the importance in natural fisheries of mastering and developing unique ecosystem services for the supply of goods (fish resources) that people receive from nature (ocean). In [20], Japanese researchers prove the feasibility of involving municipalities in ecosystem management and propose appropriate official state measures. The need for systematic development of national parks in China and the role of local communities in this, the reform of environmental policy and practice based on these principles, are discussed in [21]. Environmental initiatives in the field of managing local ecosystem services in the format of public activities of the Brazilian population are presented in [22]. It is proposed to conduct seminar cycles in rural areas of Costa Rica to introduce the latest mechanisms (as the authors of the alternative methodology for interaction with ecosystem services discuss) on the interest of local communities in solving territorial ecosystem issues and overall improvement of environmental protection activities at the local level [23]. The importance of examining ecosystem services in the modern world is also evidenced by the holding of official events in the format of conferences, webinars, etc. under the auspices of international organisations [24]. Similar studies are conducted in Russia [25].

Therefore, in the modern world, increased attention is drawn to the mechanisms for developing socio-economic relations in the sphere of consumption of ecosystem services by local communities, which, as mentioned above, is also relevant for Ukrainian society. In general, the assessment of ecosystem assets should take place considering the fact that they are the object of a specific market [26]: "the mechanism for forming ecosystem services markets is one of the modern innovative scientific and methodological approaches, the essence of which is to create new markets that would redistribute financial flows in favour of organisations and enterprises that preserve ecosystems and biodiversity".

MATERIALS AND METHODS

Both general scientific methods of economic studies and specific ones were used to conduct the study. The research materials were the best practices of researchers in the field of assessing the value of natural resources as ecosystem assets. A content analysis of researchers' scientific positions on the definition of these categories was applied to examine the essence of ecosystem assets and their value assessment, which allowed formulating a new vision of their essence and substantive features as objects of the study. The theoretical investigation of the essence of the value of ecosystem assets was based on the concept of the predominance of essence over form, which allowed determining the need to apply the price concept of consumer utility. The concept of consumer utility

in relation to ecosystem assets means evaluating them in terms of their benefits to consumers, which are territorial communities.

Four methods of valuation of ecosystem services are used: the method of direct market valuation; methods of indirect market valuation; the method of conditional valuation; the method of group valuation. The direct market valuation is currently more well-known and familiar to modern pricing, as it is primarily focused on modern market conditions. From the standpoint of direct market valuation, natural resources are a commodity that can be sold or leased, etc., but it does not consider a great number of aspects that are not directly related to the market environment. All methods of cost assessment are aimed at achieving one goal – determining the value of the object, but their economic essence differs in that each of them is based on its individual methodological approach and diverse financial and economic tools.

Financial and economic tools, which are somewhat specific in a particular valuation method, should be used to perform the valuation of an object. For example, if the cost method is considered, then these tools are expenses; as for the method of discounting cash flows, they are the discount rate, net cash flow, and the term of discounting; in the method of futures contracts – other tools. Financial and economic tools can also be the initial data for calculation. The actual process of discounting cash flows can be an economic tool, and the initial data is the discount rate, cash flow, and the period of its discounting. To compare these methods, classical methods of analysis and synthesis, logical comprehension, and segmentation by their substantive features were used.

In the course of the study, systematic and integrated approaches are used, which is conditioned by the systemic and diverse nature of both ecosystem assets and the composition of the ecosystem services that generate these assets. In contrast to the current estimates of the value of such assets, the use of systematic and integrated approaches allows considering the entire range of ecosystem services that ecosystem assets provide to territorial communities, including assimilation and oxygen production.

The development of a valuation of ecosystem assets involves the use of analytical and calculation methods and the use of appropriate formalised procedures. The long period of functioning in the useful state of the studied ecosystem assets has necessitated calculations with discounting of the cost of ecosystem services that are remote and somewhat "extended" in time. Forecast calculations of the value of ecosystem assets should consider the probabilistic nature of the impact of objective and subjective factors that individually or in combination affect the studied cost indicators. Therefore, they are evaluated using classical methods of financial risk management theory, in particular probability theory and the pragmatic risk method (Hurwitz method). The scientific and logical substantiation was applied to develop proposals for changing environmental taxation in the context of accounting for the value of ecosystem assets in tax norms.

RESULTS AND DISCUSSION

Methodological approaches to identifying and evaluating ecosystem assets of territorial communities

In the context of Ukraine's strategic progress in the EU, appropriate innovations are being introduced to preserve ecosystems and ensure the competitiveness of Ukrainian enterprises. In Ukraine, theoretical, methodological, and methodological approaches to the valuation of easily vulnerable ecosystems, ecosystem assets of territorial communities, ecosystem services, ecosystem capital that provides ecosystem (including assimilation and oxygen production) services to the population have begun to be developed at the academic level, which is a considerable shift, albeit belated compared to economically developed countries. Today, the valuation of ecosystem assets can become an effective tool for making informed management decisions for their rational use and preservation of ecosystems.

The object of valuation is an ecosystem asset (capital) that provides assimilation and oxygen-producing services to territorial communities. Based on the price theory of utility, it is necessary to determine the essence of ecosystem services to assess ecosystem assets: "ecosystem services should be defined as economic benefits that economic entities receive from the use of existing ecosystem functions, and those developed as a result of generation, restoration, support, regulation of ecosystem processes" [8, p. 12]. Therefore, the economic (cost) assessment of ecosystem capital should be conducted by determining the cost of ecosystem services that it is capable of providing to society (territorial communities) during its life cycle.

The proposed methodology is based on the cost of ecosystem services, with an ecosystem asset having value as long as it provides environmental services to the population. Therefore, the essence and substantive features of the method are as follows: an object (ecosystem asset) is evaluated through the cost of ecosystem services, as long as it has the ability to provide them. It is advisable to specifically consider a simple example: if the forest absorbs CO_2 and emits O_2, it provides ecosystem services (assimilation and oxygen production), that is, as an ecosystem asset, performs certain functions.

Notably, an ecosystem asset (capital) is also capable of assimilating harmful substances and improving EP. Therefore, it is necessary not only to assess the assimilation potential of ecosystems but also to consider it comprehensively, that is, for example, to assess the release of oxygen by plants, which should also be included in the ecosystem services of these ecosystem assets. This corresponds to the principle of complexity because, from the standpoint of environmental safety,

ecosystems should be evaluated as an object that ensures the life of the population by providing the latter with a set of ecosystem services.

Based on this, the following, relatively more capacious, definition of the object to be assessed (ie which is the object of valuation) is formulated: ecosystem asset (capital), which provides assimilation and oxygen production services to the population is a set of natural resources, which, in close cooperation with each other, are capable of providing ecosystem services to the population (including local communities): capturing and absorbing harmful emissions, enterprise and household emissions, digesting waste (ie assimilation services), emitting oxygen into the atmosphere, etc. The assimilation potential of ecosystems is a component of an ecosystem asset (capital) that provides ecosystem services to the population. Ecosystem capital can include the sea, forest, and other ecosystems. For a brief explanation, some good examples can be provided: a tree simultaneously absorbs greenhouse gases (CO_2 and others) and at the same time releases oxygen; sewage is dumped into the sea, and it digests them.

The following substantive features of methods and parameters for assessing ecosystem assets of territorial communities are determined (systematised list) based on these positions:

1) the property-legal feature, i.e., ecosystem assets and assimilation potential of ecosystems is the property of territorial communities, which should be assessed; that is, the feature is a property right;

2) a feature according to the "polluter pays" principle: methods for assessing ecosystem assets and the assimilation potential of ecosystems should be based on the "polluter pays" principle (that is, considering the fact that, for example, someone would pollute the lake, etc.);

3) a feature in accordance with the principle of preserving ecosystems and their assimilation potential for future generations (especially today, this applies to forests that are mercilessly cut down in Ukraine, so the assessment of forest ecosystems should be based on this feature);

4) assessment of all components of ecosystems, including bioresources that are living organisms;

5) a substantive feature of the efficiency of using ecosystems, that is, in market conditions, it is advisable to determine how effectively ecosystems are exploited by territorial communities.

Analysis of methods for assessing ecosystem assets of territorial communities and determining their substantive features

To analyse the methods and their substantive features, their classification is conducted, their essence is investigated, and the possibilities of practical use are determined (Table 1). A comprehensive analysis of methods for assessing both ecosystem services and the assimilation potential of ecosystems was conducted in the following areas: the economic essence and target orientation of methods for assessing ecosystem assets; the substantive features of existing methods for estimating ecosystem assets of territorial communities and the assimilation potential of ecosystems; the fundamental methodology and tools (financial and economic tools); the disadvantages of these methods of assessment and the possibility of their elimination to improve the accuracy of calculations; the level of acceptability of assessment methods for their application in Ukraine; the differences of methods from each other and their adaptation to market conditions of application.

***Table 1**. Substantive features of methods and parameters of assessment of natural resources and determination of possibilities of their use for valuation of ecosystem asset (capital), which provides ecosystem services to territorial communities*

No.	Method for evaluating natural resources	Substantive features of the method (methodology and financial and economic tools)	Possibility of use
	***1. Market (marketing) methods** (economic),* in which the methodology is to estimate the expected income		
1.1.	Market price method	Income, market prices, prices for goods and services on domestic and global markets (tools)	–
1.2	Shadow price method	Revenue, shadow prices – market prices adjusted for transfers, market failures, and policies (tools)	–
1.3	Rent method (rent estimation method or cash flow discounting method)	Income, rent (tools). Economic rent – the price or rent paid for the use of natural goods, the number of which is limited	It is possible, but not in all cases because the term of use of soil or aquatic ecosystems can be 1000 years or even endless
1.4	Cadastral method	Income, cadastres (tools); methodology: a regulatory assessment of their value based on the possibility of generating income from the use of these resources	–
1.5	Method of production functions	Revenue, production functions (tools); methodology – modelling changes in economic results depending on the contribution of resources and functions	–

Table 1, Continued

No.	Method for evaluating natural resources	Substantive features of the method (methodology and financial and economic tools)	Possibility of use
2. Cost methods *(economic),* in which the methodology is to determine the amount of costs for the maintenance of goods rather than the evaluation of the goods themselves, in the absence of markets for goods, services, and benefits			
2.1	Replacement cost method	Replacement costs (tools). The replacement cost method determines the cost of artificially replacing goods and services in the ecosystem	+
2.2	Recovery cost method	Reproduction costs (tools)	+
2.3	Relocation cost method	Relocation costs (tools); the relocation cost method determines the cost of relocating objects	–
2.4	Preventive cost method	Preventive costs (tools); methodology: identification of the costs of damage prevention, degradation of environmental services	(Partially) possible (to assess potential damage, but not to assess the usefulness of environmental services)
2.5	Averted damage method	Damage prevention costs (tools)	Possible (the same as 2.4)
3. Comparative methods *(economic)*, in which the methodology is the use of one or more methods based on the comparison of this natural resource with similar already estimated			
3.1	Method of analogies	Analogies (tools)	–
3.2.	Product replacement method	Replacement of products (tools); methodology: information about the relationship between a product that does not have a market and a product that has a market is used	–
4. Methods of conditional assessment *(sociological)*, in which the methodology lies in conducting various types of sociological surveys, among which one of the main is the concept of willingness to pay and the method of transport and travel costs			
4.1	Subjective preference method (willingness to pay)	Subjective preferences (tools); methodology: the subjective value estimation method involves constructing a hypothetical market to identify consumer preferences	–
4.2	The method of transport and travel costs	Travel expenses (tools); methodology: the willingness to pay for environmental benefits located in a particular place is evaluated based on information about the time and money spent on visiting that place	–
4.3	Hedonistic pricing method	Hedonistic pricing (tools); methodology: assessment of environmental goods at real estate or labour market prices	It is impossible to apply it to avoid inefficient management decisions in modern conditions

Source*: developed according to [10-13]*

A) Table 1 shows that the most optimal methods for assessing the ecosystem assets of territorial communities in modern conditions are ***cost methods***: replacement cost method and recovery cost method. The essential features of *the cost method* are a determination of the cost of cleaning atmospheric air, water, and soil; the cost of protecting public health; the cost of restoring disturbed territories if the ecosystem is vulnerable, depleted, and ceases to self-clean and provide waste assimilation services, etc.

The assessment of ecosystem assets of territorial communities should be conducted using other methods than the assessment of natural resources, because they are not a commodity that can be sold or bought, donated, leased, etc., so if the use of more effective methods is not possible, the method of preventive costs or the method of averted damage should be applied. It should be noted that the consideration of only possible losses from any negative changes in the environment substantially limits the value of ecosystem assets because in this case the positive (useful) influence of the latter on the territorial community is not considered at all (which violates the principle of systematic consideration of the ecosystem that provides ecosystem services).

B) ***Market methods*** cannot be used for such an assessment. *The market price method* has market prices as substantive features, that is, it considers only monetary indicators set by the market and ignores an important component of ecosystem services, which is assimilation potential.

However, in some cases, the method of discounting cash flows can be used, but it is advisable to carefully determine the term of use of soil or aquatic ecosystems because such a period can be 1000 years or even endless. Since this method is quite widely used for assessing natural resources, an analysis was conducted, and substantive features of *the cash flow discounting method (rent valuation method)* were determined. Thus, the economic

essence of the cash flow discounting method is to bring future receipts (net cash flows without taxes and fees) to the present point of time (at the valuation date, i.e., to date) by discounting.

The calculation for determining the value of ecosystem assets of territorial communities using the method of discounting cash flows can be the most accurate and most acceptable if this refers to a natural resource as a commodity, but it cannot be applied to assess the assimilation potential of ecosystems, because the essential features (tools) of this method are annual net cash flow, discount rate, and discount period. To apply this method, it is necessary to determine the term of use of ecosystems or their services, or ecosystem capital that provides environmental services to the population, or the assimilation potential of ecosystems. There is a specific period for the extraction of minerals or the use of forest resources, for example, a license for the use of mineral resources is granted for 20 years. When using forest resources, it is advisable to know the time when the crowns close, etc. In other words, it is known on a planned basis for what period it is worth discounting cash flows. However, it is not possible to estimate the absorption of carbon dioxide (CO_2) and oxygen release.

The cash flow capitalisation method is not suitable for making such estimates.

C) ***Comparative methods***: evaluation should not be used in this case.

D) ***Conditional evaluation methods*** cannot be used either. For example, *hedonistic pricing method (price advantages)* has a different set of tools. Its substantive features are that environmental benefits are evaluated at the prices of the real estate market or the labour market [12, p. 92]. In other words, the ecosystem assets of territorial communities can be evaluated using this assessment method. However, in the current economic conditions of Ukraine, the use of the hedonistic method can lead to an insufficiently accurate assessment of ecosystems and the adoption of inefficient management decisions. With regard to assessing the assimilation potential of ecosystems using this method, it is worth noting that there are no relevant specific opportunities or examples.

Essential features of the *method of transport and travel costs* are transportation costs, vacation expenses, etc.; therefore, applying this approach is also quite problematic. There is also a conditional survey method and others, but they would not allow for an accurate assessment of the assimilation potential of ecosystems. Therewith, Ukraine has been using existing methods for estimating land, forests and other isolated natural resources for many years, but it is incorrect or even impossible to estimate the value of ecosystems or ecosystem services on these grounds because they are designed to assess a natural resource as a commodity, not as an object that ensures the life of people from the standpoint of environmental safety, which digests harmful emissions (and releases oxygen), discharges into reservoirs, waste.

The above refers to the practical use of mainly market-based or cost-based pricing methods, despite the fact that, as noted above, this is not an adequate approach to evaluating ecosystem assets that generate and provide ecosystem services to consumers. Ecosystems meet the needs of the population, that is, they ensure the life of people from the standpoint of environmental safety, hence the methodology should be different. Collectively, land, water, forests form ecosystems, but the value of the system of objects can not become the value of the ecosystem, and it is advisable to develop fundamentally new methodological approaches to assessing the ecosystem as an object that ensures human life, using new financial and economic instruments [27].

However, there are still attempts to use valuation methods from classical economic theory to evaluate ecosystems or their services exclusively as goods that can be sold, bought, rented, exchanged, bequeathed, etc. [10-13]. However, it is impossible to adapt such methods to assess the assimilation potential of ecosystems or other ecosystem services, because it is necessary to evaluate an ecosystem asset (capital) as an object that provides environmental services: absorption, neutralisation, digestion, etc. It should be emphasised that completely different methods of assessing the ecosystem are needed (in relation to which the author's attempt was made) because an ecosystem is a set of living organisms that have adapted to living together in a certain habitat, forming a single whole with it. It is substantiated that the practical implementation of the valuation of such assets should be based on the theory of utility. However, such a value estimate cannot be complete in relation to an ecosystem as an object that provides environmental services. As noted above, plants not only absorb and retain CO_2, but they also release oxygen. Therefore, it is necessary to determine the cost of working with the assimilation potential of ecosystems and the cost of oxygen production by the ecosystem. The cost of oxygen can be estimated, for example, as the cost of its production using oxygen separation plants or other methods.

Substantiation of the author's methodology for estimating the value of ecosystem assets

The analysis of existing methods of estimating the value of ecosystem assets allowed assessing their feasibility in practice and substantiating the scientific basis for changing the prevailing price concept in science in estimating the value of these assets. This refers to the fact that in economics two classical price theories coexist: cost and marginal utility (value). Upon comparing the views of modern supporters of "cost" and "value" approaches to price formation, O.O. Orlov and Ye.H. Riasnykh note that modern authors are clearly divided into two camps – some assert that prices should be formed based on costs, and others that the basis of pricing should be "value", but emphasise that the "cost" is predominant in practice [28, p. 35]. Other researchers also cover this [29, p. 255].

I. Homyn wrote about the dualism of pricing and the possibility of comparing the exchange value of goods and its usefulness [30, p. 44]:

$$Pu=C \quad (1)$$

where Pu – physical utility of goods; C – exchange value of goods.

The inadequacy of market methods for valuing ecosystem assets is compared to "market failures", and the inaccuracy of conventional methods of valuing eco resources is that they are mainly based on consumer prices of these resources, the cost of their use, for which it is necessary to know their market price. Evidently, this approach considers only a small part of the real value of natural goods, since the market does not know how to adequately assess them. In this regard, the concept of common economic value is widely used in the world, which allows approaching the assessment of biological resources more comprehensively, considering not only direct resource but also assimilation functions, natural services, and the "cost of consumption" [31, p. 120-121].

In this sense, it is worth noting that an ecosystem asset should be considered from the standpoint of eco-safety, so the methods of its assessment should be based on the theory of consumer utility. An ecosystem asset is not an ordinary market commodity, but it has consumer utility, so the utility theory is suitable for its assessment, which is what further study is based on. The utility of an ecosystem asset lies in the fact that it naturally generates ecosystem services for consumers (the population).

Thus, the essential feature of such a method would be that the ecosystem asset (capital) is valued for the entire period of its existence through the value of ecosystem services it provides (as opposed to the assessment of natural resources as a commodity). Given that the assessment must take place over the entire period when an ecosystem asset provides its services to consumers (and such a period can be measured in tens of years), the methodology of this assessment requires the use of the discounting method mentioned above. This would allow evaluating future ecosystem services at the time of valuing the ecosystem asset.

For a fairly long period of time, during which the ecosystem asset is assessed, in addition to discounting the value of ecosystem services, it is also necessary to consider the risks and any negative deviations in the processes of consumption of ecosystem services. Notably, the above refers to objective and subjective factors influencing the ability of ecosystem assets to generate ecosystem services for consumers. The natural, climatic, and weather conditions of the functioning of these assets are considered to be objective influencing factors, while the decisions and actions of state institutions, regulatory authorities, including even consumers of such services, to be subjective. The subjectivity of such influence is conditioned by the fact that these entities may have their own interests and goals, which do not always coincide with the conditions for ensuring the rational use of the potential of ecosystem assets.

Therefore, it is necessary to consider the risk of consumers not receiving the desired ecosystem services, which makes it necessary to appropriately adjust the approach to assessing ecosystem services and apply a certain risk factor. Methodically, this is ensured by using the theory of risk management and predicting the level of shortfall in ecosystem services over a certain period of time. The importance of the risk factor is enhanced both by the relatively long period of study of ecosystem assets and the existing objective uncertainty of their functioning.

Development of the author's methodology for evaluating assimilation and oxygen-producing services of forest ecosystems

The above scientific basis for assessing ecosystem assets is implemented in this study using the example of forest assets. The evaluation procedure is developed on the above-mentioned scientific and theoretical provisions: application of the price concept of consumer utility; consideration of the life cycle period of an ecosystem asset; assessment of the fair value of ecosystem services as a result of the functioning of an ecosystem asset; discounting of the specified cost of ecosystem services, considering a fairly considerable period of functioning of an ecosystem asset. I.K. Bystryakov and D.V. Klynovyi also wrote about the need for discounting within the ecosystem capital assessment procedure [32], but their formulas have gross errors from an economic standpoint, so it is impossible to focus on their methodology; forecasting and appropriate calculation of emergencies (that is, the risk of not receiving ecosystem services for of both objective and subjective reasons); consideration of the specific assimilation properties of particular ecosystems.

The cost of an ecosystem forest asset from an ecological and economic standpoint consists of the cost of assimilation and oxygen-producing services of forest ecosystems. The following substantive features of the assessment method are considered to perform a cost assessment of ecosystem capital (in this case, forests) that provides ecosystem services to the population:

– years required for forest growth;

– the annual ability of trees to absorb CO_2 (to calculate this indicator, it is advisable to multiply the number of years required for forest growth by the amount of CO_2 absorption per year and the cost of quotas for greenhouse gas emissions into the atmosphere);

– the tree simultaneously absorbs co_2 and releases oxygen;

– bushes absorb less CO_2 compared to trees, they emit less oxygen, so differentiation in calculations is necessary;

– the cost of oxygen production is determined based on data on the operation of converter oxygen separation plants, etc.; and other methods can be used to determine the cost of oxygen production.

It is necessary to calculate the costs associated with the absorption of CO_2 and the costs associated with oxygen production; that way the methodology for estimating the ecosystem capital that provides environmental services to the population considers the cost of greenhouse gas absorption (CO_2 and others) plus the cost of releasing oxygen. Consequently, properly selected methods of cost assessment of the assimilation potential of ecosystems would allow for an adequate cost assessment and contribute to maintaining a balance between the man-made load and the recovery potential of ecosystems.

The author's method of determining the value of forest ecosystem assets (plants) of territorial communities that provide assimilation services to society is based on the price concept of utility; and their value is determined by the cost of ecosystem services that he (ecosystem asset) provides to society throughout its life cycle. One of the author's methodological approaches to valuing the assimilation potential (AP) of ecosystems as an asset of local communities is to determine the "work" of AP forest ecosystems or plants, which can be indicated in the form of formula (2):

$$C_{ASfe} = \sum_{1}^{n} \frac{1}{(1+i_t)^t} \cdot (M_{CO_2})_t \cdot (C_{CO_2})_t \cdot S_{fe} \cdot (C_p)_t \cdot C_{pr} \quad (2)$$

where C_{ASfe} – the cost of assimilation services (work of assimilation potential) of forest ecosystems for the entire period of functioning of the forest ecosystem, UAH.; $(Mco_2)_t$ – mass of carbon dioxide emissions (CO_2), which is absorbed by plants per year t, t/ha/year; $(Cco_2)_t$ – cost of carbon dioxide (CO_2) per year t, determined based on the price of quotas for carbon dioxide emissions, UAH/tonne; S_{fe} – area of the forest ecosystem, ha; i_t – discount index for the year t; t – year of the life cycle of plants in the forest ecosystem (trees, undergrowth, grass tier), years; $(C_p)_t$ – coefficient of emergencies (risk of shortfall in ecosystem services) in the year t of the life cycle of plants of the forest ecosystem (trees, undergrowth, grass tier), determined by the expert method of predicting the influence of objective and subjective factors on the efficiency of the functioning of the forest ecosystem; C_{pr} – coefficient that characterises the assimilation properties of natural areas where ecosystems are located, such as forest-steppe, mixed forests, etc.

The author's method of determining the value of forest (plant) ecosystem assets of territorial communities that provide oxygen-producing services to the population is based on the cost of these services. In turn, the cost of oxygen-producing services of forest ecosystems (plants) can be determined by the formula (3):

$$C_{OSfe} = \sum_{1}^{n} \frac{1}{(1+i_t)^t} \cdot (M_{O_2})_t \cdot (C_{O_2})_t \cdot S_{fe} \cdot (C_p)_t \quad (3)$$

where C_{OSfe} – the cost of oxygen-producing services of the forest ecosystem for the entire period of its operation, UAH; $(Mo_2)_t$ – oxygen volume (O_2), which is released per year t from 1 ha of plantings surface, t/ha/year; $(Co_2)_t$ – the cost of oxygen (O_2) per year t, is determined: either 1) based on the price of quotas for carbon dioxide emissions; 2) according to data on the implementation of natural photosynthesis – planting and conservation of forests; 3) according to the passport data of the operation of an air separation plant in metallurgical production, in coke chemistry, medicine; or 4) according to the passport data of the operation of an installation for artificial photosynthesis), UAH/tonne. On this basis, the total cost estimate of the forest ecosystem C_{fe} equals (4):

$$C_{fe} = C_{ASfe} + C_{OSfe} = \sum_{1}^{n} \frac{1}{(1+i_t)^t} \cdot (\mathrm{M}_{CO_2})_t \cdot (C_{CO_2})_t \cdot \cdot S_{fe} \cdot (C_\mathrm{p})_t \cdot C_{pr} + \sum_{1}^{n} \frac{1}{(1+i_t)^t} \cdot (\mathrm{M}_{O_2})_t \cdot (C_{O_2})_t \cdot \cdot S_{fe} \cdot (C_\mathrm{p})_t \quad (4)$$

Practice and prospects of introduction of the author's methodological approach to the assessment of the ecosystem asset of territorial communities

Testing of the developed methodology was conducted on the example of poplar alley, which is part of Taras Shevchenko Boulevard, located in Kyiv. The properties of poplars and other plants are analysed to perform a correct cost assessment of the assimilation potential of green spaces. Green spaces use their functions to purify, moisten, and enrich the soil and air, change the temperature and radiation regime, and reduce noise and wind strength.

It is advisable to pay special attention to various types of poplar (for example, *Populus suaveolens*) because they are leading in the purification of air among trees. Due to their cleaning properties, poplar plantings restrain toxic fumes and gases, preventing them from spreading. These trees are able to neutralise and absorb harmful compounds from the soil and air. The essential role of this tree is evidenced by the following statements of experts: due to the active photosynthetic apparatus, poplars process a huge amount of carbon dioxide and emit a lot of oxygen [18], and one poplar produces as much oxygen per season as one person needs per year [33]. Such properties of poplars determined the field of assessing the assimilation potential for these trees.

For the development of this method of assessing ecosystem capital that provides environmental services, a cost assessment of the assimilation potential (capital) of an individual ecosystem was conducted using the example of the poplar alley on Kyiv's Taras Shevchenko Boulevard.

If in rural areas in most of the territory of Ukraine there are green spaces that provide relatively clean air, in cities and mining regions the number of forest and park ecosystems is insufficient, so the air there is polluted. In Kyiv, from Khreschatyk Street to Victory Square in the middle of Taras Shevchenko Boulevard, there is the poplar alley with a length of 1.8 km and an area of 3.0 ha.

550 poplars grow on Taras Shevchenko Boulevard in Kyiv. Poplar alley is a park ecosystem and an ecosystem asset of the territorial community of the Shevchenko district of the city, which is confirmed by the memorial sign installed by the state – "State nature monument of local importance".

The boulevard was built as a city street in the 1830s. Simultaneously with the construction of the building of the University of Kyiv on the neighbouring Volodymyrska Street, an alley was planted in the middle of the street – first chestnuts, then, from the 1840s, poplars. By the decision of the Executive Committee of the City Council of March 20, 1972, No. 363 Taras Shevchenko Boulevard was included in the list of territories and objects of the nature reserve fund of Ukraine as a botanical monument of nature of local importance. The length of the poplar alley on the boulevard is about 1.5 km.

The following data and assumptions were used to calculate the cost of assimilation services of the poplar alley of Taras Shevchenko Boulevard:

– mass of carbon dioxide emissions absorbed by poplars of the poplar alley of Taras Shevchenko Boulevard in Kyiv, 40.0 t/ha/year;

– the cost of quotas for carbon dioxide emissions, UAH/tonne – 30 EUR [34];

– the area of poplar plantations in the poplar alley of Taras Shevchenko Boulevard in Kyiv – 3.0 hectares;

– the life cycle of poplars is more than 40 years (poplars can live for an average of 60 years, but in the city – much less; in Kyiv, poplars are often cut down and new ones are planted immediately);

– the discount rate (or, synonymously, capitalisation) "should be set, considering the existing experience of assessing natural resources, primarily the World Bank, in relation to the social rate of return on investment (SRRI – Social Rate of Return on Investment). According to the recommendations of this institution, the capitalisation ratio for developed countries is at least 4%, for developing countries, – a maximum of 7-9% [32, p. 51]. The value of this coefficient is substantiated by the level of the inflation index, which, according to the forecast of economic and social development of Ukraine for 2022-2024 [35], respectively by years, is: 2022 – 7.2%, 2023 – 6.0%, 2024 year – 5.2%, average – 6.13%; the average coefficient of 0.0613 (this value, apparently, meets the modern requirements of the World Bank) is taken in this paper for further calculations. Notably, similar studies of the economic assessment of forest ecosystems in regulating the composition of atmospheric air (using the discounting method) have been conducted before: for example, [36], but the authors of this study chose bank percentage, which cannot be considered scientifically correct in relation to assessing the value of ecosystems or their services because it is not an investment project, the effectiveness of which must be compared with an alternative option for bank depositing funds or some other. The use of ecosystem potential and the provision of services to consumers by ecosystems has prevailing environmental and social effects, not purely economic ones. This gives grounds to assert that the discount rate for ongoing study does not require the inclusion of alternative profitable components in its composition;

– the coefficient that characterises the assimilation properties of an ecosystem (forest-steppe), according to various sources, differs slightly in its value. Thus, according to Appendix A DBN B. 2.2-12:2019 [37, p. 127], the northern (and most) part of Kyiv is located in the zone of mixed forests (polissia) (I), and the southern (smaller) part of the city is located in the forest-steppe zone (III). According to some geographical maps, the northern part of Kyiv belongs to the zone of mixed forests. The entire city of Kyiv is located in the forest-steppe zone. Since the city has much less greenery than the outside of the city, the coefficient was used for the city of Kyiv as for the forest steppe. Based on this, this coefficient is calculated by O.M. Sukhina by determining the correlation coefficients for considering the assimilation properties of ecosystems (as a component of the author's economised classification of assimilation services of ecosystems of Ukraine) [38; 39] and is equal to K_{vl}=1.060;

– the risk factor for non-receipt of ecosystem services, as noted, is established by an expert method of predicting the impact of factors on the efficiency of the forest ecosystem. The Hurwitz risk assessment method is used to determine it, which allows establishing a balance between cases of extreme optimism and cases of extreme pessimism regarding the development of the studied events in the future, involving the optimism coefficient. This coefficient takes values from zero to one and shows the degree of the propensity of the decision-making expert to optimism or pessimism; it is recommended not to be guided by extreme optimism or extreme pessimism, but to take some average result [40, p. 41]. Given that there are certain hopes for an optimistic development of events in connection with the increased attention to the problems under study on the part of officials, researchers, and the international community, it is worth assuming and possibly accepting this coefficient at the level of 0.8.

In addition to assimilation services, forest ecosystems also provide oxygen-producing services. A similar method is used to determine the cost of oxygen-producing services of the poplar alley of Taras Shevchenko Boulevard in Kyiv, for which the following data were used: oxygen volume (O_2), which is released per 1 year from 1 ha of poplar plantings surface, $(Mo_2)_t$=33.6 t/ha/year; cost of oxygen $(Co_2)_t$=1 362,9 UAH/tonne.

In the study [41], the cost of oxygen was determined by various methods of its production: using an installation for artificial photosynthesis, based on the price (sales) of quotas for CO_2 emissions, using natural photosynthesis – planting and conservation of forests and using an air separation plant in metallurgical production, in coke chemistry, medicine.

This study focuses on a method based on the

implementation of CO_2 emission quotas. Thus, the Russian power engineer V. Boldyrev [42] noted back in 2001: "If industrialised countries are willing to pay 10 USD for one "over-limit" tonne of CO_2, and 0.727 tonnes of oxygen are formed when this tonne is decomposed, these countries are willing to pay 13.8 USD (10/0.727) for the production of a tonne of atmospheric oxygen by "green lungs".

Then, if the cost of carbon dioxide (CO_2) quotas is 30 EUR/t in the EU, 1 tonne of atmospheric oxygen is 41.3 EUR (30/0.727). As of November 7, 2021, the euro exchange rate is UAH 30.2, then 1 tonne of atmospheric oxygen would be UAH 1,247.26. However, to assess the value of the assimilation potential of ecosystems in the summer of 2021, the euro exchange rate against the hryvnia was used – 33 UAH, so this figure will be focused on in these calculations. Then the cost of 1 tonne of oxygen would be 1,362.9 UAH. That is, the determination of the cost of assimilation services of ecosystem assets of territorial communities and the cost of their oxygen-producing services is conducted based on the price of quotas for CO_2 emissions, that is, using a single method.

For comparison, it is advisable to substantiate the determination of the cost of oxygen based on determining the cost of forest planting. In addition, the value of the discount coefficient is taken in calculations for the entire period (for all years) of the functioning of the forest ecosystem, that is: i_t = *and* = 0.0613; and environmental services for this period (in any year) are equal to those defined above the average annual, i.e.: $(M_{CO2})_t = M_{CO2}$ and $(M_{O2})_t = M_{O2}$. The averaging of the volume of environmental services for a fairly long period determines the use of annuity discounting their value. Formula 4 can then be changed to consider the current annuity value factor as follows:

$$C_{fe} = \sum_1^n \frac{1}{(1+i_t)^t} \cdot (\mathrm{M}_{CO_2})_t \cdot (C_{CO_2})_t \cdot S_{fe} \cdot (C_\mathrm{p})_t \cdot C_{pr} + \sum_1^n \frac{1}{(1+i_t)^t} \cdot (\mathrm{M}_{O_2})_t \cdot (C_{O_2})_t \cdot S_{fe} \cdot (C_\mathrm{p})_t = \\ = (1 - \frac{1}{(1+i)^n}) / i \cdot S_{fe} \cdot C_p \cdot (M_{CO_2} \cdot C_{CO_2} \cdot C_{pr} + \mathrm{M}_{O_2} \cdot C_{O_2}) \quad (5)$$

The results of calculations of the alley's oxygen production services are:

$$C_{fe} = (1 - \frac{1}{(1 + 0.0613)^{40}}) / 0.0613 \cdot 3.0 \cdot 0.8 \cdot (40.0 \cdot 990.0 \cdot 1.060 + 33.6 \cdot 1362.9) = 3128103 \text{ UAH, or}$$

3128.1 thousand UAH

The cost of services of the herbaceous tier of poplar alley of Taras Shevchenko Boulevard in Kyiv was estimated in a similar way, for which the following data were used:

– mass of carbon dioxide emissions absorbed by the herbaceous tier, 0.6 t/ha/year [43, p. 13];

– the cost of quotas for carbon dioxide emissions, UAH/t – 30 EUR [34], i.e., 990.0 UAH/t;

– the area of the herbaceous tier of poplar alley Taras Shevchenko Boulevard in Kyiv is 3.0 hectares;

– the life cycle of a herbaceous tier can be 30 years or more;

– the coefficient that characterises the assimilation properties of an ecosystem (forest-steppe) is 1.060.

Under these conditions, the cost of assimilation services of the herbaceous tier of poplar alley is $(C_{fe})_{he}$:

$$(\mathrm{C}_{fe})_{he} = (1 - \frac{1}{(1 = 0.0613)^{30}} / 0.0613 \cdot 0.6 \cdot 990.0 \cdot 3.0 \cdot 1.060 = 25576 \text{ UAH, or } 25.6 \text{ thousand UAH}$$

Thus, the total cost estimate of assimilation and oxygen production services of poplar alley (together with its herbaceous tier) of Taras Shevchenko Boulevard in Kyiv is 3153.7 thousand UAH (3128.1 thousand UAH + + 25.6 thousand UAH).

The valuation of an ecosystem asset (capital) that provides environmental services would contribute to a sound reform of environmental tax legislation, since the environmental payment or environmental tax act as compensation for the ecosystem services used. The Tax Code of Ukraine on Environmental Tax states the following provisions of Article 242 "Object and Base of Taxation" [44]:

242.1. The object and base of taxation is:

242.1.1. volumes and types of pollutants released into the atmospheric air by stationary sources;

242.1.2. volumes and types of pollutants discharged directly into water bodies;

242.1.3. volumes and types (classes) of disposed waste, except for volumes and types (classes) of waste as secondary raw materials placed on the territories (objects) of business entities.

As noted above, unfortunately, in Ukraine there is no connection between the amount of environmental tax and the cost of ecosystem services (which is asserted with confident responsibility), and the rates of this tax are introduced without any economic substantiation, which is absolutely unacceptable. Therefore, it is necessary to reform environmental taxation in Ukraine, which should be based on establishing a correlation (relationship) between the cost of ecosystem services and the amount of environmental tax, since there are much more effective and efficient environmental payments or taxes in the world and the government itself decides: who and how to pay for the use of environmental services – to the

state or territorial communities. In addition, it is advisable to pay more attention to the conservation of ecosystems in the mining regions [45] and areas of military operations.

CONCLUSIONS

The object of valuation is an ecosystem asset that provides environmental services to the population, and its component is the assimilation potential of ecosystems. It is advisable to establish the cost of such an object by determining the cost of its services. The paper evaluates all currently known approaches to assessing the value of ecosystem assets, which were divided into four groups: marketing methods, in which the methodology is the assessment of expected income; cost methods, based on determining the size of costs to support goods, rather than on evaluating the goods themselves in the absence of markets for goods, services, and benefits; comparative methods, which provide for comparing a natural resource with similar ones already estimated; methods of conditional assessment (sociological), the basis of which is to conduct various kinds of sociological surveys, for example, the concept of willingness to pay and the method of transport and travel costs.

The analysis conducted in this paper determines the advantages and disadvantages of these methods, and the possibilities of their practical application. The most correct available methods are cost-effective, but their adequacy is not absolute. Profitable valuation methods narrow the interpretation of natural resources to a commodity, comparative, and sociological ones, they are not correct and practically unsuitable for performing a cost assessment of the object under study. Other methods are even more unsuitable for determining the sought value because they fundamentally ignore the very essence of the object of valuation. Whereas the essence is that the value of an asset should be determined by the cost (equal to the cost) of ecosystem services that it provides to society during its life cycle; only the costs associated with the provision of environmental services should be considered.

The proposed method of estimating the value of ecosystem assets is based on: the application of the price concept of consumer utility; consideration of the period of the life cycle of the ecosystem asset; estimation of the fair value of ecosystem services as a result of the functioning of the ecosystem asset; discounting of the specified value of ecosystem services, given the rather considerable period of operation of the ecosystem asset; forecasting and calculation of emergencies (ie the risk of not receiving ecosystem services for objective and subjective reasons); consideration of the specific assimilation properties of specific ecosystems.

The method was tested on the example of a separate ecosystem – the poplar alley of Kyiv's Taras Shevchenko Boulevard, the assimilation potential of which was measured along with oxygen-producing services of this ecosystem. The assessment was conducted for trees and the herbaceous tier of poplar alley. The total cost of this ecosystem is set at UAH 3.15 million.

In the future, it is advisable to create a systematic list of methods for assessing ecosystems and ecosystem services, including the assimilation potential of ecosystems, which should indicate the methods that are closest to the economic realities of Ukraine. Rationally selected methods of valuing ecosystem capital should be applied to all territorial communities of districts, oblasts, etc., which would help improve the ownership structure and maintain the balance between man-made load and regenerative potential of ecosystems in terms of ecological and economic development of local communities.

The valuation of an ecosystem asset is performed to determine the economically sound amount of future environmental rent payments, to ensure consistency between the value of ecosystem services and the size of the environmental tax that currently compensates ecosystem services used, and to determine payments for ecosystem services. In other words, the assessment of ecosystem assets should become the basis for substantiating environmental tax rates and the amount of environmental rent payments based on determining the amount of environmental rent.

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Методи вартісного оцінювання екосистемних активів та їх асиміляційних послуг

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Анотація. Актуальною проблемою сучасного світу є деградація екосистем, що потребує кардинально нового підходу до оцінювання і забезпечення подальшого, економічно ефективного, використання їх потенціалу. Однак наразі ще не здійснювалось вартісного оцінювання екосистемних активів (капіталу), які надають асиміляційні та інші, зокрема, киснепродукуючі, послуги територіальним громадам. Обґрунтовано, що за умови визнання екосистемних активів власністю територіальних громад і для надання останнім права розпоряджатися своїм майном (екосистемними активами) проблема вартісного оцінювання таких активів стає першочерговою задачею. Метою статті є порівняльний аналіз наукових підходів щодо вартісного оцінювання екосистемних активів і розробка методу їх оцінки із урахуванням екосистемних послуг, які вони надають протягом свого життєвого циклу територіальним громадам. Для наукової розробки використані як загальнонаукові методи економічних досліджень, так і специфічні. Визначено сутнісні ознаки методів оцінки природно-ресурсного об'єкту, якими є методологія оцінки та фінансово-економічні інструменти, що застосовуються для практичної її реалізації. На базі цього здійснено аналіз і визначено змістовні ознаки методу дисконтування грошових потоків (методу рентної оцінки), витратного, ринкових цін, гедоністичного ціноутворення (цінових переваг), транспортно-шляхових витрат, умовно-опитувальний метод та інші. Доведено, що названі методи не відповідають вимогам вартісно-ринкового оцінювання і не дозволяють здійснити адекватну оцінку асиміляційного потенціалу екосистем. Екосистемний актив повинен розглядатися з точки зору екологічної безпеки, тому й методи оцінювання повинні бути іншими. З урахуванням цього запропоновано найбільш оптимальний метод: вартість екосистемних активів визначається вартістю всього комплексу наданих ними асиміляційних та киснепродукуючих послуг за весь їх життєвий цикл. Авторська методика апробована на прикладі алеї тополь, яка є складовою бульвару Тараса Шевченка, розташованої в місті Києві

Ключові слова: методи оцінки, вартість, об'єкт оцінювання, територіальні громади, тополі, асиміляційні та киснепродукуючі послуги