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STATUS AND TRENDS OF ASSESSMENT OF ECOSYSTEM ASSETS OF NATURE RESERVED AREAS IN THE CONTEXT OF INNOVATIVE DEVELOPMENT OF THE UKRAINIAN BLACK SEA REGION

СТАН І ТЕНДЕНЦІЇ ОЦІНЮВАННЯ ЕКОСИСТЕМНИХ АКТИВІВ ПРИРОДНО-ЗАПОВІДНИХ ТЕРИТОРІЙ В КОНТЕКСТІ ІННОВАЦІЙНОГО РОЗВИТКУ УКРАЇНСЬКОГО ПРИЧОРНОМОР'Я

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In the current conditions of transformation of Ukraine's economic model and orientation towards the principles of sustainable and innovative development, natural capital is considered as a strategic basis for long-term growth [1]. The preservation and effective use of ecosystem assets is becoming not only an environmental, but also an economic imperative.

For regions with a high concentration of nature reserves, in particular the Ukrainian Black Sea region, the issue of assessing ecosystem assets has a dual significance: on the one hand, as a tool for substantiating environmental policy, and on the other, as a component of an innovative model of regional development. The lack of a systematic methodological approach to assessing ecosystem assets makes it impossible to fully integrate them into financial and economic management mechanisms, strategic planning, and investment processes.

Analysis of recent publications on the problem

The issue of economic valuation of natural capital, natural resources and ecosystem services is the subject of active scientific research in the works of domestic [2-4] and foreign [1, 5, 6] scientists. In modern scientific literature, natural capital is considered as a cumulative stock of natural components that ensures the formation of flows of ecosystem services and creates economic and social benefits for society. In particular, R. Costanza and co-authors (Costanza et al., 2020) justify the need to integrate the valuation of natural capital and ecosystem services into the system of economic analysis and strategic development planning. An important contribution to the development of the concept of ecosystem assets was made by L. Hein, K. Bagstad, B. Edens, C. Obst and other researchers (Hein et al., 2016), who consider them as functional units of natural capital, characterized by certain spatial boundaries, the state of ecosystems and the ability to generate flows of

Vorobiova O.A. Stan i tendencii ocnivannia ekosistemnih aktiviv prirodno-zapovidnih territorii v konteksti innovatsiynogo rozvutku Ukrain'skogo Prichornomor'ya. Naukovo-metodichna statтя.

Проблематика оцінювання екосистемних активів набуває особливої актуальності в умовах трансформації підходів до управління природним капіталом та посилення ролі природно-заповідних територій у забезпеченні сталого розвитку регіонів. Метою дослідження є теоретичне обґрунтування підходів до ідентифікації та економічної оцінки екосистемних активів природно-заповідних територій Українського Причорномор'я. Методологічну основу становлять положення концепції природного капіталу та міжнародної системи еколого-економічного обліку екосистем із використанням методів системного та категоріального аналізу. Розкрито взаємозв'язок категорій природного капіталу, природних ресурсів, екосистемних активів і послуг, обґрунтовано їх роль у формуванні екосистемної основи інноваційного розвитку регіону.

Ключові слова: природний капітал, екосистемні активи, екосистемні послуги, природно-заповідні території, еколого-економічний облік, інноваційний розвиток, Українське Причорномор'я

Vorobiova O.A. Status and Trends of Assessment of Ecosystem Assets of Nature Reserved Areas in the Context of Innovative Development of the Ukrainian Black Sea Region. Scientific and methodical article.

The issue of assessing ecosystem assets is gaining increasing relevance in the context of evolving approaches to natural capital management and the growing role of protected areas in ensuring sustainable regional development. The aim of the study is to provide a theoretical substantiation of approaches to the identification and economic assessment of ecosystem assets of protected areas in the Ukrainian Black Sea region. The methodological framework is based on the concept of natural capital and the international System of Environmental-Economic Accounting for Ecosystems, applying systemic and categorical analysis. The study clarifies the interrelations among natural capital, natural resources, ecosystem assets, and ecosystem services, and substantiates their role in shaping the ecosystem foundation for the region's innovative development.

Keywords: natural capital, ecosystem assets, ecosystem services, nature reserves, ecological and economic accounting, innovative development, Ukrainian Black Sea region

ecosystem services. Further development of this concept is associated with the formation of a system of ecological and economic accounting of ecosystems. Thus, J. Remme (Remme et al., 2018) and co-authors emphasize the need to create national accounts of ecosystem assets as a tool for integrating ecosystem indicators into the system of macroeconomic statistics and state management of natural capital. At the same time, a significant part of scientific research focuses either on general issues of economic assessment of natural resources, or on the analysis of ecosystem services without sufficient disclosure of the category of "ecosystem asset" as an economic unit of accounting and management. The regional specificity of assessing ecosystem assets within nature reserves, in particular in the ecosystems of the Black Sea region, also remains insufficiently studied.

Identification of previously unresolved parts of the general problem

The issues of harmonizing the conceptual and categorical apparatus in the field of natural capital, the formation of a clear logic of the transformation of natural resources into natural and ecosystem assets, as well as the development of applied tools for their economic assessment remain unresolved. The lack of an integrated methodology hinders the implementation of an asset-oriented approach to the management of nature reserves and reduces the possibilities of their use as drivers of innovative development of the region.

Formulation of research objectives (task setting)

The aim of the article is to study the state and trends in the assessment of ecosystem assets of nature reserves in the context of innovative development of the Ukrainian Black Sea region and to substantiate the directions for improving the methodological support of this process.

Materials and methods

The research process used systemic and institutional approaches, methods of categorical analysis, logical modeling and theoretical generalization. The theoretical basis was the provisions of the concept of natural capital and the international system of ecological and economic accounting of ecosystems. The information basis was the regulatory and legal documents of Ukraine, international standards and scientific publications on the issues of the ecosystem approach and environmental economics.

Presentation of main results and their justification

In the Strategy of the State Environmental Policy of Ukraine for the period until 2030 [7] emphasizes that the biological diversity of Ukraine, which ensures the provision of ecosystem services, must be preserved, properly assessed and restored by 2030. This confirms the relevance of the formation of ecosystem-based environmental management tools, the methodological basis for the implementation of which is the process of assessing ecosystem assets and services [3]. However, in Ukraine today there are no practical methodological recommendations on the regulatory and legal consolidation of the category of "ecosystem services" and its integration into economic and business

activities [8]. The very concept of "ecosystem asset" remains new to domestic legal and management practice: there are significant differences in its interpretation and definition of functions, and the structure and relationships between its components are often fragmentary and non-systemic.

Thus, to form a holistic scientific and methodological approach to this issue, it is necessary to clearly distinguish and coherently link a number of interrelated concepts. The broadest of them is the concept of natural capital (hereinafter – NC). This is, so to speak, a common "reserve" of nature, the foundation of economic and social well-being. In the modern sense [4, 9] NC encompasses the set of ecosystem and natural assets that generate flows of ecosystem services necessary to ensure sustainable socio-economic development.

Natural capital traditionally includes natural resources (hereinafter – NR) and natural assets (hereinafter – NA). These components can be considered as two interrelated dimensions of the NC – resource and economic-institutional. We hold the opinion that natural assets are part of the resource base, which has a certain economic value, is subject to accounting and is considered as a component of natural capital stocks. That is, resources become assets at the moment they acquire the status of ownership, value or legal certainty.

A special subcategory of natural assets is ecosystem assets (hereinafter referred to as ESA). According to the international system of ecological and economic accounting of ecosystems (hereinafter referred to as SEEA EA) [9], they are understood as spatially defined areas of certain types of ecosystems, characterized by a specific composition of biotic and abiotic components and their interactions [5, 6]. ESAs are assessed by the area, condition, and scale of the flows of ecosystem services they produce.

Within the framework of the above-mentioned international system of ecological and economic accounting of ecosystems, ecosystem services (hereinafter – ESS) are defined as "the contribution of ecosystems to the benefits used in economic and other human activities". In a broader sense, ecosystem services encompass all useful resources and benefits that humans are able to obtain from nature.

It is worth emphasizing that, according to the principles of the ecosystem approach, ecosystem management cannot be considered effective unless its ability to generate the necessary benefits in the future is maintained or enhanced [2]. It is precisely the focus on future (long-term) outcomes, that is, the potential of ecosystems to provide sustainable flows of services in the future, that is the key characteristic of the concept of ecosystem assets.

All the categories considered above constitute elements of a single system. The logical interdependence between them can be represented in the following sequence: NC (stock) → NR/NA (components) → ESA (functioning units) → ESS (benefit stream).

The assessment of ecosystem services is particularly relevant within the framework of the

nature reserve fund (hereinafter referred to as the NRF), because it is the protected areas that guarantee the highest level of preservation of natural ecosystems, genetic diversity, and ecological stability. They act as the "core" of natural capital, which generates flows of ecosystem services of not only local but also global importance.

Thus, nature reserved areas (hereinafter referred to as NRA) can be defined as spatial carriers of ecosystem assets of the highest quality. They represent an integrated network of ecosystems of various types – forest, steppe, swamp, marine, mountain – organized according to the principle: "core – buffer zone – ecological corridor".

The main unit of conservation within the boundaries of the protected areas is the ecosystem as a

holistic natural complex, which serves as the basis for the stability and reproduction of natural capital. This vision is fully consistent with the UNESCO biosphere approach [10] and the concept of the national ecological network of Ukraine. Therefore, nature reserves fully meet the criteria for ecosystem assets according to the SEEA EA system (table 1).

Therefore, it is appropriate to define ecosystem assets of the NRA as a set of accumulated and functionally active natural assets that produce ecosystem services, have an economic (monetary) valuation, and create material and intangible benefits for nature management entities due to the right to own or use them over a certain period of time, as well as in the long term.

Table 1. Compliance of the NRA with the criteria of ecosystem assets

Criterion	Justification of compliance
Spatial certainty	NRA have clearly defined boundaries, enshrined in cadastres.
Ecosystem structure	They contain natural complexes with biotic and abiotic components.
Ecosystem functions	They carry out key regulatory processes: regulation of climate, water regime, biodiversity, recreational services, etc.
Service generation potential	Provide stable flows of socially beneficial services (regulatory, recreational, cultural heritage services, etc.).
Duration and stability	Thanks to their protected status, they ensure the long-term preservation of their ecological potential.

Source: elaborated by the author based on [9]

The natural capital system, within which NRAs act as spatial centers (nuclei) of ecosystem assets that ensure the generation of flows of ecosystem services and form the natural and economic potential of innovative development of regions, is shown in Figure 1.

We note that, in our opinion, it is the NRA as key providers of ecosystem functions and services that play a decisive role in the socio-economic development of Ukraine, which has significant natural resource opportunities for the development of sectors directly dependent on the state of ecosystems.

In the context of military operations, loss of territories and destruction of economic ties, it is especially important to identify the internal reserves of the country's development. It is precisely the NRA, which combine unique natural, recreational, cultural and intellectual resources, that have the potential to create new forms of employment, develop sustainable tourism, the market for ecosystem services, promote regional branding and implement bioeconomic initiatives. This requires a clear understanding of the prospects for the use of these resources, existing limitations and conditions that will contribute to the realization of their potential.

And recently, at the state level, there has been a growing understanding of the importance of the NRA of Ukraine both in the war and post-war periods. Thus, according to the Order of the Ministry of Environmental Protection and Natural Resources of Ukraine No. 1668 [11], which entered into force on 15.01.2025, institutions and organizations of the nature reserve fund are defined as having strategic importance for the national economy in the field of environmental

protection in a special period (mobilization, war and partial reconstruction). The Ministry's public statements also emphasize the role of NRA as an important element of the regional and national economy, not only because of their environmental or economic contribution, but also because of their social function – contributing to the restoration of human potential in the process of post-war reconstruction.

All this confirms the relevance of studying the role of NRA as ecosystem assets, as well as analyzing their condition and assessment trends. At the same time, the strengthening of this role is also due to the negative consequences of the war: according to the Ministry of Environmental Protection [12], as of August 2024, more than 1.24 million hectares (almost 30%) of the NRA area have been damaged or are under threat of destruction, and about 0.8 million hectares (20%) have been occupied. About 900 animal species are under threat of extinction. Total losses are estimated at 600 billion hryvnias, which makes the issue of assessment, restoration and economic rethinking of the functioning of the NRA extremely important.

As UNEP reports emphasize, the defining characteristic of ESAs is their ability to provide a stable flow of ecosystem services. It is this property that makes them a special category of natural assets, and their productivity directly depends on the volume (quantity) and state (quality) of the ecosystem. As these parameters within the Ukrainian NRA have significantly deteriorated, there is a growing need to develop new approaches to their restoration, in particular by increasing economic potential without harming the natural environment [13].

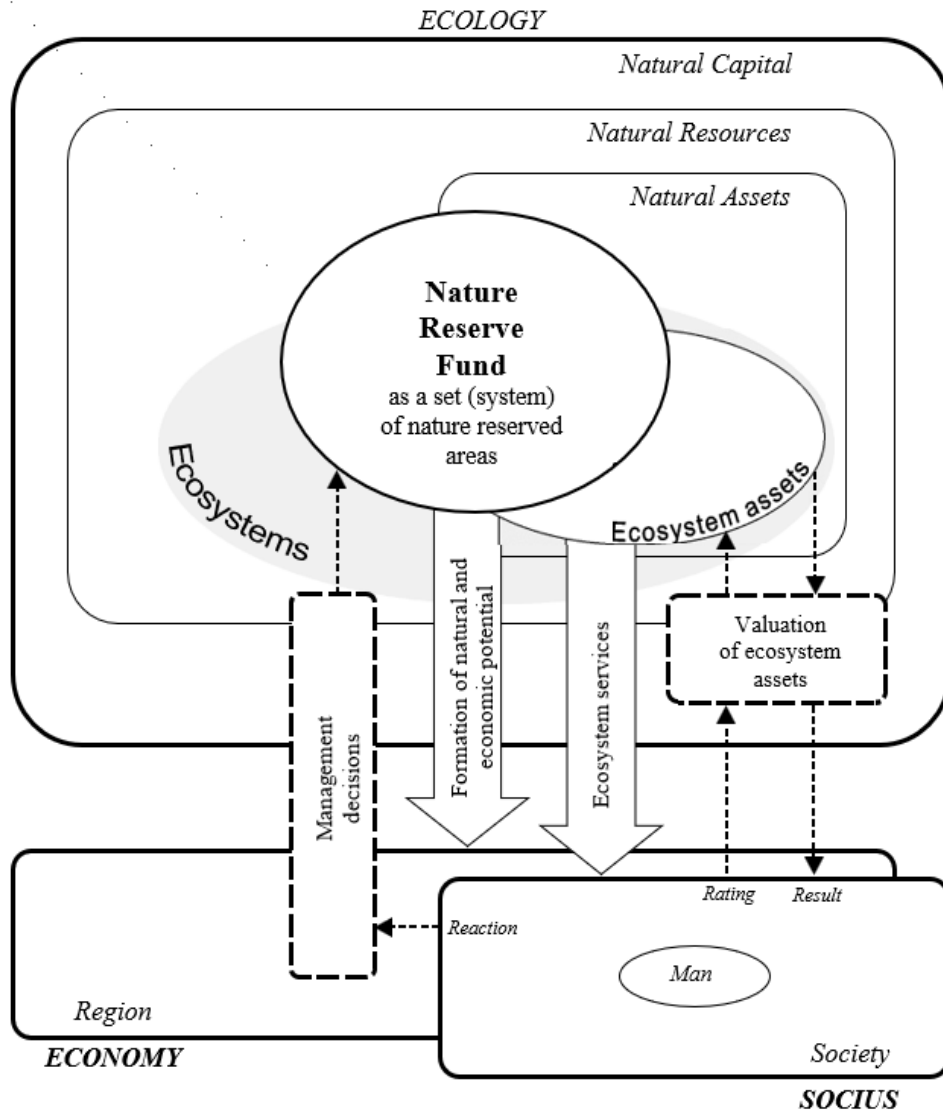


Figure 1. The place of the nature reserve fund in the natural capital system

Source: author's own elaboration

The listed trends, as well as the importance of integrating ecosystem services into socio-economic planning, especially in the context of the tasks of innovative development of the Ukrainian Black Sea Region (hereinafter – the UBSR), are of direct importance for the region. The Ukrainian Black Sea Region is a territory with a unique concentration of biodiversity, significant recreational potential and favorable geo-economic position. That is why the ecosystem services of the NRA of this region have an extremely high potential, because nature reserves (national natural parks, reserves, nature reserves) serve as a base for the development of eco-educational and recreational tourism, forming the image of the region as a territory of harmonious interaction between man and nature.

The ecosystem assets of the NRA form the "natural and innovative capital" of the region, especially in the context of the transition to an economy of ecosystem

services. Therefore, preserving the ecological state of the NRA ensures the preservation of the value of this asset in the long term.

The following types of ecosystems are characteristic of the Ukrainian Black Sea region (Table 2).

According to the ecosystem approach, each type of ecosystem has its own structural and functional organization and specific biotic and abiotic relationships that form the ecological balance of the region. That is why, to preserve biodiversity, maintain the hydrological regime, prevent land degradation, and ensure the sustainability of the natural environment, a network of NFP objects was created, representing all the main types of ecosystems of the UBSR (Table 3).

Together, these territories form a holistic ecosystem-organized spatial and landscape system, which forms the basis of the ecological network and natural capital of the Ukrainian Black Sea region.

Table 2. Types of ecosystems of the Ukrainian Black Sea Coastal Zone

Ecosystem type	Role	Example
Steppe and meadow – steppe ecosystems	Biodiversity conservation, recreation, soil for creation	Nature Reserve "Yelanetsky Steppe" (Mykolaiv region), Black Sea Biosphere Reserve (Kherson region), National Natural Park (hereinafter referred to as NNP) "Buzkyi Gard" (Mykolaiv region)
Estuarine/ delta – floodplain (wetland) ecosystems	Flow regulation, water integration, support of aquatic fauna, recreation	National Nature Reserve "Nizhnyodniestrovskiy" (Odessa region), National Nature Reserve "Nyzhnyodniprovskiy" (Kherson region), Regional Landscape Park (hereinafter referred to as RLP) "Tyligulsky" (Odessa and Mykolaiv regions), Danube Biosphere Reserve (Odesa region)
Coastal marine and coastal sandy ecosystems	Coastal protection, recreation, environment for marine and coastal biota	National Nature Reserve "Biloberezhye Sviatoslava" (Kherson region), Black Sea Biosphere Reserve (Odesa region), RLP "Kinburnska Kosa" (Mykolaiv region), National Nature Reserve "Dzharylhatsky" (Kherson region)

Source: elaborated by the author based on [9, 14]

Table 3. Characteristics of the volume of ecosystem assets of the Ukrainian Black Sea Coastal Zone (as of 01.01.2025)

Name	Region	Area, hectares	Accessibility
Nature reserves			
1. "Yelanetsky steppe"	Mykolaivska	3010.65	Available
Biosphere reserves			
2. "Danube"	Odesa	51547.90	Closed
3. "Chornomorsky"	Kherson	102746.8	Occupied
4. "Ascania Nova"	Kherson	33307.60	Occupied
National natural parks			
5. "Nizhny Dniester"	Odesa	21311.10	Limited
6. "Tuzlivski estuaries"	Odesa	27865.00	Closed
7. "Kuyalnytsky"	Odesa	10800.89	Limited
8. "Sviatoslav's White Coast"	Mykolaivska	35359.34	Occupied
9. "Buzky Gard"	Mykolaivska	6138.13	Available
10. "Nyzhnyodniprovskiy"	Kherson	80177.80	Closed
11. "Dzharylhatsky"	Kherson	10000.00	Occupied
12. "Azovo-Sivasky"	Kherson	52582.74	Occupied
13. "Oleshkivski Sands"	Kherson	11671.06	Occupied
14. "Kamenskaya Sich"	Kherson	12261.14	Closed
	<i>Together, reserves and national parks</i>	-	-
	<i>of them available</i>	-	8.9%
	<i>of them occupied</i>	-	52.9%
Regional landscape parks			
15. "Izmail Islands"	Odesa	1366.00	no data
16. "Tyligulsky"	Odesa	13954.00	no data
17. "Kinburn Spit"	Mykolaivska	17890.20	no data
18. "Granite-steppe Pobuzhhye"	Mykolaivska	7394.30	no data
19. "Vysunsko-Inguletsk"	Mykolaivska	2712.60	no data
20. "Pryingulsky "	Mykolaivska	3152.70	no data
21. "Tyligulsky"	Mykolaivska	8195.40	no data
-	TOTAL largest NRA of UBSR	-	513445.35
-	TOTAL NRA of UBSR	-	647508.52
-	Area of the UBSR	-	8636900.00

Source: elaborated by the author based on [14]

It is worth noting that the reserve indicator, which is used as an international criterion for the ecological efficiency of a territory, within the Ukrainian Black Sea region is 7.49%, which is slightly higher than the average indicator for Ukraine – 6.94% [14]. However, this is only a formal or nominal value that does not reflect the real state of accessibility of the protected areas. If we consider the situation in more detail, in particular the level of access to the reserves and NNP of the region (see Table 4), it turns out that 6 out of 14 such objects are currently under occupation, and their

total area exceeds half of the entire area of the protected areas of the region (52.9%). Only two objects remain fully open to visitors, two more are partially accessible, which together make up 8.9% of the area. The remaining territories (38.2%) are temporarily closed due to the consequences of military operations.

Regarding the assessment of the ESA of natural resources, it involves determining the monetary value of the set of ecosystem services that they generate. Such a process is an integral part of the policy of sustainable nature management, the main goal of

which is to increase the efficiency of the use of natural resources, ensure their preservation and restoration. The assessment of the ESA should take into account the specifics of the territory, its area, natural resource potential (hereinafter referred to as the NRP), ecological state, level of anthropogenic impact and features of economic use. The implementation of such an assessment in the practice of natural resource management should contribute to the rationalization of the use of their NR and increase their added value. In terms of content, the assessment of the ESA can be carried out according to key characteristics inherent in natural assets: capacity (capacity of potential), structural components of the ecosystem, area, ecological state, dynamics of changes, trends towards improvement or degradation.

The assessment of ESA and services requires an interdisciplinary approach and coordinated actions of different agencies responsible for environmental, economic and social policy. The lack of a unified methodological approach to the assessment of NAs of the NRA complicates the realization of their potential in the system of public administration, spatial planning and economic growth.

In the modern conditions of neo-industrial progress and the formation of a knowledge-based economy, NRA are gaining importance as carriers of biological, intellectual and recreational potential. For its effective involvement, a systematic methodological base is needed that will allow integrating the assessment of NA of NRA into financial and economic, environmental and territorial strategies. That is why the creation and improvement of methodological support for the assessment of NA of NRA is a prerequisite for the modernization of the management of the NRP of Ukraine in general.

At the same time, at the global level, there is growing interest in the issues of monetization of ESS, development of green economy and implementation of bioinnovations through environmentally friendly investments. Ukraine, integrating into the European legal field, needs to adapt international resource assessment methodologies to national conditions. This requires the formation of a holistic methodological model that takes into account the specifics of Ukrainian natural resources, the diversity of resources and their legal status.

Another factor that increases the relevance of the researched issues is the lack of a unified system of accounting and assessment of NA of NRA in the official statistics of Ukraine. Most of the available data are fragmentary, are not updated systematically and do not allow for a full analytical assessment of the effectiveness of resource management. At the same time, scientifically based methodological support will allow creating a unified information base, ensuring comparability of results, and forming transparent monitoring and decision-making tools.

Special attention is required to the issue of taking into account different types of resources – not only material, such as biological or recreational, but also intangible, in particular informational, cultural, scientific, spiritual. These resources are often

underestimated, but they form the specificity of the NRA, which ensures their uniqueness and significance for social development. Methodological support should take into account the multifunctionality of such territories and create conditions for an interdisciplinary approach to assessment. At the same time, it is necessary to take into account that a significant part of the NA of the NRA is not subject to direct market assessment, therefore the use of classical economic methods is insufficient. A combination of approaches is required – ecological, geoinformation, socio-economic, expert, as well as methods of assessing ecosystem services, which are actively implemented in international practice today. This justifies the need to adapt global methodologies and create a hybrid assessment model relevant to Ukrainian realities.

An analysis of the current approaches to assessing the NA of the NRA has shown that the main tools that ensure the integration of the environmental component into economic planning, management and accounting systems are the following four approaches - the above-mentioned SEEA EA [9], TEEB (The Economics of Ecosystems and Biodiversity) [15], NCA (Natural Capital Accounting) [16] and SIDA GT (Green Toolbox of Swedish International Development Cooperation Agency) [17]. Their practical significance lies in the ability to carry out both quantitative and qualitative assessments of the role of NC in shaping social welfare, which, in turn, contributes to the adoption of informed management decisions taking into account the ESS and the formation of a sustainable development strategy.

It should be noted that there is currently a growing interest in the use of the listed NC and ESS assessment tools in Ukraine. However, their practical implementation is still limited to individual initiatives, pilot projects or elements within the framework of international technical assistance. For the full-scale use of these tools, appropriate institutional, methodological and personnel training is necessary. In particular, for the integration of SEEA EA [9] and NCA [16] the national statistical system requires the implementation of relevant international standards, interdepartmental coordination, and adaptation of methodologies to national accounting characteristics.

The TEEB tool [15] has high potential for application in Ukraine, especially in the field of EPR assessment of the NPF, but is currently not systematically implemented and requires the creation of national analytical platforms and databases to support such assessments. The situation is similar with the SIDA methodology [17], which is actively used in countries receiving Swedish assistance, but is not yet widely used in Ukraine, despite its potential relevance for regional planning and management of the NPF.

Therefore, the analysis conducted indicates systemic problems in the assessment of ecosystem assets of the NRA in Ukraine:

- Lack of a unified methodology. Existing approaches are fragmented, non-unified, and not adapted to the challenges of today.
- Lack of integration into official systems. The concept of "ecosystem asset" does not have an

established legal definition in Ukraine and is not integrated into national statistics and management systems.

- Limited practical implementation of international instruments. Instruments such as TEEB, SEEA EA, NCA, although they have high potential, are used only in individual pilot projects due to institutional barriers, lack of data, and insufficient level of technical training of specialists.
- Lack of data and information openness. Most of the available data is fragmentary, not systematically updated, and there are no public digital platforms for accounting for ecosystem services.

However, it should be noted that, of course, assessment itself is not the ultimate goal, but serves as a tool used to form informed management decisions, strategic planning of territorial development, rational allocation of resources [18], their preservation and increasing the value of the PRT.

Modern international practice proves that ensuring spatial accuracy, dynamism and predictability of results allows the introduction of innovative technologies into the process of NC assessment. The innovativeness of the ESA NPF assessment lies in the combination of natural, spatial, economic and digital methods in a single NC accounting system. This is a paradigm shift - from inventory to management of the value of nature, when protected areas are perceived not only as objects of protection, but as assets of sustainable development and a source of innovative potential of the region.

The innovative approach to valuing such assets lies in the transition:

- from resource- based logic to value-ecosystem logic, where the key is not the resource itself, but its functioning in space and time;
- from one-time economic assessments to dynamic spatially integrated monitoring, which takes into account the stability of ecosystems, climate risks, and anthropogenic load;
- from in-kind and monetary valuation to a comprehensive eco-innovation system based on digital technologies, satellite monitoring and artificial intelligence.

To overcome this transition and activate the investment and innovative development of the region based on its NC, the following innovative areas of ESA assessment are proposed:

1. Institutional and managerial innovations:

- Adaptation and phased implementation of the standards of the international system of ecological and economic accounting (SEEA EA) into the national accounting system for the official recognition of ESAs of the NRA. That is, legalization and standardization of the concept of "ecosystem asset". It is necessary to develop a national standard (within the framework of the adaptation of European standards) that would clearly define how ESAs of the NRA are recognized, assessed and reflected in reporting.
- Implementation of Integrated Coastal Zone Management [19] based on the ESA. Decision-

making on any activity in the coastal zone (construction, tourism, transport) should necessarily include an assessment of the impact on the ESA of the NRA and their service flow. This will require the establishment of inter-agency bodies with appropriate powers.

- Creation of ecosystem clusters. Bringing together NRAs, scientific institutions, innovative businesses (e.g. in the field of biotechnology, clean technologies, agroecology, etc.) and communities to jointly develop and commercialize products and services based on the principles of biomimicry and sustainable use of biodiversity.
- Launching pilot projects on ESA assessment. Their implementation will allow state and local governments to significantly increase the efficiency of management decisions and at the same time demonstrate the practical feasibility of the proposed methodology [3].

2. Digital and technological innovations:

- Use of geographic information systems and remote sensing methods for spatial identification (mapping) of ecosystems, monitoring their condition and detecting degradation changes (dynamics).
- Creation of "digital twins" of the ESA – digital models of the NRA for predicting changes and making management decisions. This is no longer just a GIS map, but a dynamic, living model of the ecosystem that integrates data from remote sensing, water quality sensors, air, noise, etc., social media (for attendance analysis) and climate forecasts. The model will allow for real-time modeling of the consequences of management decisions, investment projects or climate change.
- ESS modeling using existing software platforms (e.g. InVEST, ARIES, ArcGIS, Google Earth Engine). These digital software platforms model the relationship between biophysical processes and human benefits (ESS).
- Automation of assessment based on the use of artificial intelligence. Machine learning algorithms can automatically classify ecosystem types from satellite images, detect signs of degradation (e.g. illegal logging, plowing), and even predict changes in populations of key species based on big data analysis.

3. Financial and investment innovations:

- Development of payment mechanisms for electronic payment systems (Payments for Ecosystem Services – PES) [20], which incentivize local communities and businesses to conserve nature. These are contractual or voluntary financial models under which users or beneficiaries of ESSs pay owners or custodians of natural areas to maintain or improve these services.
- Creation of a specialized ESF fund or NC fund. The fund could accumulate funds from various sources ("green" bonds, international aid, share of revenues from renewable energy) and purposefully finance projects to assess, restore and improve the quality

of ESF (including NRA), considering them as infrastructure investments.

- Introduction of monetary valuation approaches for ESA. This would facilitate the transition from the traditional resource market to the consideration of intangible benefits (regulatory, cultural services) [5]. Examples include the willingness-to-pay method for ecosystem conservation, the travel cost method for valuing recreational areas, and the benefit transfer approach based on comparable ecosystems.

4. Scientific, educational and social innovations:

- Introduction of the educational program "Ecosystem Manager" as a new profession for the region. Training of specialists with knowledge in the field of ecology, economics, data analytics and finance, capable of comprehensively assessing, managing and attracting investments in ecosystem assets of the NRA.
- The development of public science (Citizen Science) to a new level. That is, involving tourists and locals not only in collecting data (for example, through mobile applications for recording species), but also in analyzing it. Creating interactive platforms where volunteers from all over the world can help process satellite images or analyze acoustic recordings to monitor biodiversity.
- Creation of virtual and augmented eco-spaces. Development of VR/AR applications that allow visiting protected areas of the Black Sea region remotely, seeing historical landscapes or future development scenarios. This is not only an educational tool, but also a way to generate additional resources for the NRA through virtual visits.

5. Biotechnological and genetic innovations:

- Use of bioindicators (ecological DNA analysis, metabarcoding) to assess the state of ecosystems. These methods allow recording the presence of species (including rare and low-numbered ones) without destroying the environment and identifying trends (emergence of invasives, loss of local species).
- Detection of degradation processes at the level of genetic diversity. Useful for early detection of genetic diversity losses and assessment of the effectiveness of restoration measures (reintroduction, population reinforcement, etc.).
- Creation of gene banks of rare species of NPF – long-term repositories of genetic material that provide an "safety margin" of genetic diversity, which is important in scenarios of degradation and climate change. They can serve as a source of material for assessment (as a benchmark for comparison), as well as for reintroductions, increasing genetic diversity and restoring ecosystems.

All of the above trends are aimed at transforming the approach: from passive conservation to active management and "growing" the value of ESA, transforming the NRA of the Ukrainian Black Sea Region from peripheral protection objects into

innovative hubs of sustainable development of the region.

Conclusions and prospects for further research

Ecosystem assets are a basic element in the formation of eco-oriented management and economic systems and a key factor in environmental, social and economic stability. Their assessment is an interdisciplinary process that combines environmental, economic and social approaches and requires systematicity and integration into nature management. The proposed definition of ESA is based on the concept of dual value – internal environmental and external economic. This approach allows us to reflect the real value of ecosystems, which is crucial for sustainable development.

A comprehensive assessment of ESA should take into account the spatiotemporal aspect, which allows combining short-term benefits with long-term ecological stability. The combination of economic, biophysical, spatial-analytical and socio-ecological methods provides a multi-level diagnosis of the state of ecosystems, identification of degradation risks and determination of restoration priorities. Of particular importance are approaches based on the assessment of potential restoration costs, which provide a quantitative idea of the scale of degradation and the effectiveness of environmental protection measures.

In Ukraine, the urgent task is to create a unified methodological base for assessing the ESA of the NPF and an integrated data system at the state and regional levels. The existing methodologies remain fragmented and insufficiently adapted to modern challenges. The integration of the ESA assessment into the system of national accounts will ensure analytical comparability, transparency and the possibility of monitoring the NC.

Innovative directions of ESA assessment form the basis for the transition to an eco-innovative model of the economy, within which the NC is considered as a strategic investment asset. For the Ukrainian Black Sea region, this creates the prospect of combining environmental, social and economic effects, which will contribute to the formation of a positive image of the territory as a safe, comfortable and ecologically balanced space.

So, based on all of the above, the following recommendations can be formulated:

- Develop a national methodology for assessing the ESA of the NRA. It is necessary to create a unified methodological basis for assessing the ESA, consistent with the international standard SEEA-EA. This will ensure data comparability, integration of ecosystem indicators into the system of national accounts, and the formation of a single basis for making management decisions in the field of nature use.
- Integrate the assessment of ESA into the management system of the NRA and regional planning. Data on the condition and value of ESA should be used for planning environmental protection measures, spatial development, eco-marketing and sustainable tourism strategies. This will ensure the transition from administrative to

economically sound management of NRA based on the assessment of their contribution to the well-being of the region.

- Apply innovative digital and biotechnological assessment tools. It is advisable to introduce modern monitoring methods – the use of GIS, remote sensing, satellite monitoring and bioindicator technologies for objective monitoring of the state of the ecosystems of the NRA. This will increase the accuracy of the assessment of the state of the ESA of NRA and will allow for timely

detection of degradation processes and forecasting of restoration.

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Abstract

Relevance. In the context of the implementation of the Strategy of the State Environmental Policy of Ukraine until 2030 and the implementation of international approaches to ecological and economic accounting, the issue of assessing ecosystem assets is gaining strategic importance for the formation of a modern model of natural capital management. This issue is of particular importance for the nature reserves of the Ukrainian Black Sea region, which act as the core of biodiversity conservation and the generation of ecosystem services. At the same time, Ukraine lacks a unified methodological support for the assessment of ecosystem assets, and the conceptual and categorical apparatus remains fragmentary and inconsistent with international standards, which complicates the integration of the ecosystem approach into economic policy and practice of environmental management.

Purpose and objectives. Based on this, the purpose of this study is to determine the status and trends in the assessment of ecosystem assets of nature reserves in the context of innovative development of the Ukrainian Black Sea region and to substantiate the directions for improving their methodological support. To achieve the goal, the following tasks were set: to clarify the content and relationship of the categories "natural capital", "natural resources", "natural assets", "ecosystem assets", "ecosystem services"; to analyze the approaches of the international system of ecological and economic accounting of ecosystems; to determine the place of nature reserves in the structure of ecosystem assets; to outline the trends and problems of their economic assessment.

Materials and methods. The methodological basis of the study is the provisions of the theory of natural capital, the concept of the ecosystem approach and the international system of ecological and economic accounting of ecosystems. Systemic, institutional and structural-functional approaches, methods of theoretical generalization, comparative analysis, logical modeling and categorical analysis were used. The source base was the regulatory legal acts of Ukraine, international methodological documents, scientific works of domestic and foreign researchers.

Results. The work substantiates the logical sequence of the relationship between the categories of "natural capital", "natural resources", "natural assets", "ecosystem assets" and "ecosystem services" as the basis for forming an assessment methodology. The definition of ecosystem assets of nature reserves as spatially defined functioning units of natural capital capable of generating stable flows of ecosystem services and generating economic and social benefits is clarified. It is proven that nature reserves of the Ukrainian Black Sea Region meet the criteria of ecosystem assets in accordance with international standards of ecological and economic accounting. A trend of transition from a resource-accounting model to an asset-oriented approach, which involves taking into account the long-term productivity of ecosystems and their innovative potential, is identified.

Conclusions. Assessment of ecosystem assets of nature reserves is a key prerequisite for their integration into the system of strategic planning of innovative development of the region. In Ukraine, it is necessary to ensure the harmonization of national methodological tools with international standards of ecological and economic accounting, to develop unified approaches to the identification, accounting and economic evaluation of ecosystem assets. Prospects for further research are related to the formation of applied models of ecosystem services monetization, the development of regional balances of ecosystem assets and the integration of their results into mechanisms of public management and spatial development.

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