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O. Motuzka,
PhD in Economics, Associate Professor, Associate Professor of the Department of Management, Marketing and Public Administration,
National Academy of Statistics, Accounting and Audit
ORCID ID: https://orcid.org/**0000-0001-9028-6994**
M. Grod,
PhD in International Economic Relations, Associate Professor, Department of Management, Marketing and Public Administration, National Academy of Statistics, Accounting and Audit
ORCID ID: https://orcid.org/**0000-0002-7539-5778**

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THE ARCHITECTONICS OF INTERNATIONAL STATISTICAL SYSTEMS AND THE ROLE OF SEEAW WITHIN THEIR STRUCTURE

О. М. Мотузка,
к. е. н., доцент, доцент кафедри менеджменту, маркетингу та публічного управління,
Національна академія статистики, обліку та аудиту
М. І. Грод,
доктор філософії зі спеціальності "Міжнародні економічні відносини", доцент кафедри менеджменту, маркетингу та публічного управління, Національна академія статистики, обліку та аудиту

АРХІТЕКТОНІКА МІЖНАРОДНИХ СТАТИСТИЧНИХ СИСТЕМ І РОЛЬ SEEAW У ЇЇ СТРУКТУРІ

The purpose of the article is to reveal the content and functions of the architectonic principle in international statistics and to determine the place of the SEEAW system within its structure. The implementation of this purpose involves, first, clarifying the concept of architectonics as both a principle and a result of building statistical systems; second, identifying architectonic interconnections among the fundamental international standards SNA, SEEA, and SEEAW; third, analyzing the architectonics of environmental economic accounting for water as a specific model of integrating natural science and economic data; and finally, comparing three types of water related statistics as structural levels of a single system of knowledge.

The study aims to form a theoretical foundation for harmonizing environmental statistical systems with international economic standards. The expected result lies in defining architectonics as a methodological mechanism for integrating data on the natural environment, economic processes, and social interrelations.

The study further developed the concept of the architectonic principle in the construction of international statistical systems, which made it possible to reveal its methodological meaning not only as a general principle of data harmonization but also as a structural basis for integrating natural and economic types of statistics. As a result, the place of the System of Environmental Economic Accounting for Water (SEEAW) within the general hierarchy of international standards was clarified, and it was proven that SEEAW functions as a specific model for applying the architectonic approach in resource accounting.

The theoretical understanding of architectonics as a methodological form of organizing statistical knowledge was advanced. Within this framework, physical, ecological, and economic indicators are combined into a single logical structure. This made it possible to explain the process of transition from hydrological statistics, focused on measuring natural processes, to environmental economic accounting, which integrates physical data into the system of economic analysis.

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The conceptual view of SEEAW as an intermediary link between natural science and macroeconomic standards was refined. An interpretation of the architectonics of water accounting was proposed as an ordered three level structure in which physical supply and use tables, hybrid accounts, and asset accounts form a single hierarchy of knowledge.

It was proven that the application of the architectonic approach ensures methodological integrity among different levels of statistics, creates a foundation for integrating hydrological, ecological, and economic data, and forms a conceptual basis for the further development of international standards for natural resource accounting.

It was substantiated that architectonics is not only a philosophical but above all a methodological category that describes the ordered logic of constructing statistical systems. It combines the principles of structural coherence, continuity, and systematicity, ensuring the integrity and comparability of statistical data. It was found that architectonics in statistics functions as a means of coordinating multilevel systems of knowledge in which each subsystem develops rather than contradicts the basic methodology.

It was shown that in international statistics the architectonic principle manifests itself through a consistent hierarchy of standards, where the System of National Accounts serves as the basic level, the System of Environmental Economic Accounting acts as its satellite system, and the System of Environmental Economic Accounting for Water functions as its thematic module. Such a three level structure forms the internal logic of development of international statistical systems and ensures coherence between economic and environmental dimensions.

It was proven that SEEAW represents a practical realization of the architectonic principle. Its structure, based on three levels physical, hybrid, and asset, forms an integrated system in which hydrological data are transformed into indicators of economic analysis. This hierarchical organization makes possible the transition from natural observations to integrated accounts suitable for use within the System of National Accounts.

It was established that within SEEAW three types of statistics hydrological, ecological, and environmental economic form an interconnected system. Hydrological statistics provide the base of physical data, ecological statistics supply indicators of quality and condition, while environmental economic statistics integrate them into a unified model for analyzing the interaction between economy and nature. Such an architectonic structure ensures internal coherence and enables the use of data for assessing sustainable development.

A theoretical proposition was formulated according to which the architectonics of international statistics serves as a methodological instrument for integrating different levels of knowledge. It creates the prerequisites for developing comprehensive systems of natural resource accounting, in which every element has a clearly defined place within the overall structure of knowledge. The application of the architectonic approach enhances the analytical capacity of statistics, reveals the interdependence between the natural environment, economic activity, and social processes, and ensures the unity of approaches to measuring sustainable development at the international level.

Мета статті полягає у розкритті змісту і функцій архітектонічного принципу в міжнародній статистиці та визначенні місця системи SEEAW у її структурі. Реалізація цієї мети передбачає: по-перше, уточнення поняття архітектоніки як принципу і результату побудови статистичних систем; по-друге, розкриття архітектонічних зв'язків між базовими міжнародними стандартами SNA, SEEA і SEEAW; по-третє, аналіз архітектоніки еколого економічного обліку води як конкретної моделі інтеграції природничих і економічних даних; і, нарешті, порівняння трьох типів статистики, пов'язаних із водою, як структурних рівнів єдиної системи знання.

Дослідження спрямоване на формування теоретичного підґрунтя для узгодження статистичних систем довкілля з економічними стандартами міжнародного рівня. Очікуваний результат полягає у визначенні архітектоніки як методологічного механізму інтеграції даних про природне середовище, економічні процеси і соціальні наслідки їхнього взаємозв'язку.

Набуло подальшого розвитку дослідження архітектонічного принципу у побудові міжнародних статистичних систем, що дозволило розкрити його методологічний зміст не лише як загальний принцип узгодження даних, а як структурну основу інтеграції природничих і економічних видів статистики. У результаті уточнено місце системи еколого економічного обліку водних ресурсів у загальній ієрархії міжнародних стандартів та доведено, що SEEAW функціонує як конкретна модель реалізації архітектонічного підходу у сфері ресурсного обліку.

Розвинено теоретичне уявлення про архітектоніку як методологічну форму організації статистичного знання, у межах якої фізичні, екологічні та економічні показники поєднуються у єдину логічну структуру. Це дозволило пояснити процес переходу від гідрологічної статистики, зорієнтованої на вимірювання природних процесів, до еколого економічного обліку, що інтегрує фізичні дані у систему економічного аналізу.

Удосконалено концептуальне бачення системи SEEAW як проміжної ланки між природничими та макроекономічними стандартами. Запропоновано інтерпретацію архітектоніки статистичного обліку води як впорядкованої трирівневої структури, у якій фізичні таблиці постачання і використання, гібридні рахунки та рахунки активів утворюють єдину ієрархію знань.

Доведено, що застосування архітектонічного підходу забезпечує методологічну цілісність між різними рівнями статистики, створює підґрунтя для інтеграції гідрологічних, екологічних і економічних даних та формує концептуальну основу для подальшого розвитку міжнародних стандартів обліку природних ресурсів. Обґрунтовано, що архітектоніка є не лише філософською, а передусім методологічною категорією, яка описує впорядковану логіку побудови статистичних систем. Вона поєднує принципи структурної узгодженості, спадкоємності та системності, забезпечуючи цілісність і порівнянність статистичних даних. З'ясовано, що архітектоніка у статистиці функціонує як засіб узгодження різнорівневих систем знання, у межах яких кожна підсистема розвиває, а не заперечує, базову методологію.Показано, що у міжнародній статистиці архітектонічний принцип виявляється через послідовну ієрархію стандартів, де базовим є System of National Accounts, сателітною системою виступає System of Environmental Economic

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Accounting, а її тематичним модулем є System of Environmental Economic Accounting for Water. Така трирівнева побудова формує внутрішню логіку розвитку міжнародних статистичних систем і забезпечує узгодження між економічними та екологічними вимірами. Доведено, що SEEAW є прикладом практичної реалізації архітектонічного принципу. Її структура, побудована на трьох рівнях, фізичному, гібридному і рівні активів, утворює цілісну систему, у якій дані гідрологічної статистики трансформуються у показники економічного аналізу. Саме ця ієрархічна організація забезпечує можливість переходу від природничих спостережень до інтегрованих рахунків, придатних для використання в системі національних рахунків. Виявлено, що у межах SEEAW три типи статистики, гідрологічна, екологічна та еколого-економічна, утворюють взаємопов'язану систему. Гідрологічна статистика формує базу фізичних даних, екологічна надає індикатори якості і стану, а еколого економічна інтегрує їх у єдину модель аналізу взаємодії економіки і природи. Така архітектонічна побудова забезпечує структурну єдність і робить можливим використання даних для оцінювання сталого розвитку. Сформульовано теоретичне положення, згідно з яким архітектоніка міжнародної статистики виступає методологічним інструментом інтеграції різних рівнів знання. Вона створює передумови для розвитку комплексних систем обліку природних ресурсів, де кожен елемент має визначене місце у загальній структурі знань. Застосування архітектонічного підходу дозволяє підвищити аналітичну спроможність статистики, розкрити взаємозалежність між природним середовищем, економічною діяльністю і суспільними процесами та забезпечити єдність підходів до вимірювання сталого розвитку у міжнародному масштабі.

Key words: architectonics, SEEAW, SNA, environmental economic statistics, environmental statistics, hydrological statistics, water accounting, international statistical standards, sustainable development, water resources, strategic resource, statistical systems.

Ключові слова: архітектоніка, SEEAW, SNA, еколого-економічна статистика, екологічна статистика, гідрологічна статистика, водний облік, міжнародні статистичні стандарти, сталий розвиток, водні ресурси, стратегічний ресурс, статистичні системи.

INTRODUCTION

The global sustainability policy in our times imposes increased demands on statistical systems, a principal one being capacity-building required for adequate recording of interactions between economy and environment. Water, being a crucial component of the natural capital, is not only the basis for life activities but a strategic resource determining the boundaries of economic growth. The increasing water scarcity, the degrading ecosystems, urbanization burdens, and climate change require a single statistical approach for description of the causal links between economic activities and water resources.

The environmental statistics is regarded nowadays is a principal tool for implementing Sustainable Development Goals approved by the United Nations. International statistical standards, e.g. SEEA and SEEAW, lay the methodological foundation for measurement of the progress towards rational use of natural resources. They enable for integrating environmental data in the macroeconomic policy, which is a required condition for balanced development at national and global level.

In view of the above, the creation of System of Environmental-Economic Accounting for Water (SEEAW) became a logical continuation of integrative tendencies in the international statistics, initiated by the System of National Accounts (SNA) and furthered in the System of Environmental-Economic Accounting (SEEA). SEEAW is designed as a conceptual and methodological bridge between economic, environmental, and social dimensions of the sustainable development. Its approval by the United Nations in 2007 ushered in the transition from fragmented observations of water resources to a unified statistical architecture.

THE REVIEW OF THE LITERATURE

The evolution of international approaches to water accounting reflects a progressive convergence of environmental and economic perspectives within a unified statistical architecture [1-3]. Core international standards such as the SEEA-CF and SEEAW establish the conceptual and methodological foundation for harmonized measurement of interactions between the economy and the environment, with particular attention to water as both a natural resource and an economic asset [1—2]. These frameworks extend and complement the System of National Accounts (SNA), providing mechanisms for incorporating environmental resource information into economic analysis and policymaking processes [4—5].

Contemporary scholarship highlights the increasing significance of water accounting as a key element of environmental-economic statistics, supporting the formulation of indicators for

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sustainable resource use and integrated management strategies [6—8]. Empirical findings confirm that the application of SEEAW principles enhances transparency, data comparability, and the overall quality of governance, while also improving efficiency in water resource management and institutional capacity for sustainability [6].

At the national scale, practical implementation of water accounting systems demonstrates continuing efforts to reconcile administrative and hydrological datasets with international statistical standards [9]. The Ukrainian experience underscores the importance of methodological alignment between physical and monetary indicators, as well as the inclusion of environmental information within the broader framework of national economic accounting.

The theoretical foundations of sustainable development and environmental-economic integration have been advanced by interdisciplinary research addressing macroeconomic resilience, global sustainability, and transitions toward green and circular economic models [10—18]. These contributions provide a conceptual context for interpreting water resource accounting not merely as a technical procedure, but as a mechanism that ensures systemic coherence between ecological constraints and economic growth objectives.

Recent literature further expands this discourse into the field of environmental governance, emphasizing institutional arrangements aimed at achieving sustainable balance between developmental rights and ecological responsibilities [20—22]. Studies on water markets, pollution regulation, and governance within the green transition highlight the relevance of SEEAW as a statistical framework for assessing environmental performance and policy effectiveness [22].

In summary, the reviewed body of work illustrates that the concept of water accounting has evolved from a primarily hydrological activity into a multidimensional domain of environmental-economic statistics, serving as a methodological bridge between natural processes and the tools of economic policy.

In spite of a large body of research, the latest studies feature fragmentation in interpreting the structure of international statistical systems. The overwhelming majority of them are focused on technical issues of constructing selected accounts or on industry-related issues of the environmental statistics, with the conceptual framework for account building often neglected. This is specifically true for the system of environmental-economic accounting of water resources, which has a complex multilevel buildup, and aims to link natural and economic data.

The researchers tend to interpret SEEAW as a technical tool for assessment of water use, but its status in the overall structure of the international statistics and the principles underlying its structure are not always given an appropriate theoretical explanation. This results in a persisting methodological gap between the categories of water-related statistics. On the one hand, there exists hydrological statistics recording natural processes; on the other hand, economic statistics focused on economic indicators. Environmental statistics, placed between them, is not capable to provide for a full integration of the national accounts. Lack of a single conceptual model that would align the three areas confirms the need in methodological rethinking of the structure of the statistical systems. This justifies introduction of "architectonics" concept as a means of description and explanation of the holistic buildup of the international statistics.

The research hypothesis is that the current SEEAW is a manifestation of the architectonic principle underlying the international statistics. SEEAW structure is not confined to a set of technical tables, but reflects the logic of regularized knowledge navigating integration of hydrological, environmental, and economic data. The architectonic buildup ensures coordination between various levels of statistics, creates a methodological continuity between natural observations and SNA, and lays a basis for the assessment of sustainable use of water resources.

THE PURPOSE OF THE ARTICLE

The purpose of the article is to highlight the contents and functions of the architectonic principle in the international statistics, and to pose SEEAW within its structure. The purpose was achieved by (i) specifying of the architectonic concept as a principle and an outcome of building up statistical systems, (ii) revealing architectonic links between basic international standards SNA, SEEA, and SEEAW, (iii) analyzing the architectonics of environmental-economic accounting of water as a specific model for integrating natural and economic data, and (iv) comparing the tree types of water-related statistics as structural levels of a single knowledge system.

This study aims to lay a theoretical background for aligning statistical systems of the environment with international economic standards. The expected result is reinterpretation of architectonics as a methodological scheme for integrating

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Table 1. Two dimensions of "architectonics" concept in the statistics domain

Criterion	Architectonics as a principle	Architectonics as a result
Character	Methodological, procedural	Structural, descriptive
Function	Ensuring the logic for system's buildup, aligning the components	Fixing the established system's structure, revealing its causal links
Object	The process of system creation, methodological interactions of standards	A specific model of international standards and classifications
Level of generalization	Abstract-methodological	Institutional-applied
Manifestation in the international statistics	Defined principle of continuity between SNA, SEEA, and SEEAW	Three-tiered architecture of international standards
Example	Methodological integration of economic and environmental statistics	SEEAW as an established model of integration

Source: developed by the authors.

data on environment, economic processes, and social implications of their relationship.

RESEARCH RESULTS

The concept of architectonics belongs to a methodological glossary of the European science and has a profound significance for systemic thinking. This concept has deep philosophical roots. In the classical tradition, I. Kant interpreted architectonics as the art of systemic thinking that helps rationalize the knowledge by a single principle. In the statistical field, this approach will acquire a methodological meaning when a set of concepts, classifications and links is organized into a structural integrity applicable in scientific analyses and management decisions.

In the current statistical methodology, the concept of architectonics acquires a special meaning: it denotes the principle of constructing aligned data systems in which various types of accounting (economic, environmental, social, resource) create a shared analytical space. Architectonics in statistics is not so much a scheme as a means for regularization of knowledge, ensuring its internal logic, integrity, and capability for integration.

In the international statistics domain, the architectonic principle means that each new standard needs to be developed as part of a larger system rather than its isolated segment.

For example, System of National Accounts (SNA) sets basic economic categories, whereas System of Environmental-Economic Accounting (SEEA) extends them by including natural resources. System of Environmental-Economic Accounting for Water (SEEAW) specifies this approach within the water sector. This buildup is architectonic, because it involves a cross-level alignment: from the general to the specific.

Architectonics as a principle is a kind of normative code that defines how the statistical system should be structured in order to keep its methodological integrity intact. It sets the rules of compatibility of concepts, classifications and accounts, and defines the hierarchy of levels: from macroeconomic aggregates to industry-specific indicators. In this sense, architectonics functions as a methodological form of the order: it denies random links, to ensure consistency and logical continuity.

Architectonics as a result is a certain form or configuration occurring once this principle is implemented. In the statistics domain, it is a specific structure of standards, techniques or classifications, where it can be clearly seen that one system relies on another, creating an orderly hierarchy. The result of architectonic buildup is the system of international standards wherein SEEAW has a fixed status as part of the environmental-economic accounting.

The duality of architectonics as a principle and a result allows one to see at the same time a process and a form, a logic and a structure, which support each other. The principle enables one to understand how a system is built, whereas the result shows what it becomes once this principle is implemented. That is why architectonics is a central concept in the international statistics methodology: it underlies standardization along with conceptual harmonization of statistical systems (Table 1).

Hence, architectonics in statistics is, at the same time, a method and a product of the scientific thinking. As a principle, it requires consistency and continuity; as a result, it creates an orderly hierarchy of systems where each successive subsystem does not deny the preceding one, but deepen its contents. Its methodological power is that it

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enables natural, economic, and social categories of statistical knowledge to function within a single conceptual framework.

The architectonics of environmental-economic accounting acquires special importance in the environmental-economic accounting context. It transforms statistics from a means of description into an explanative tool, enables for the transition from fragmentary data to the holistic understanding of causalities between environment and economic activities. Analysis of architectonics is, therefore, not a mere theoretical objective, but key to a systemic vision of the sustainable development.

The architectonics of international statistics is a result of the prolonged process of conceptual streamlining of knowledge, which began in the middle of the 20th century along with building of SNA. SNA authors were the first to create an integrated logic for measurement of economic activities for all the countries by setting principal categories of macroeconomic analysis: production, consumption, revenues, investment. SNA became an "architectural core" for the subsequent economic thought: its structure, terminology, and classifications laid the basis to which new modules would be added.

The architectonic principle in statistics suggests that any extension of the system must be compatible with its framework. It means that new types of statistical knowledge cannot exist beyond the structural logic of SNA. This compatibility enables integration of indicators pertaining to the financial, production, and natural domains in the shared analytical space. Due to the architectonic consistency, SNA could develop into a universal interface between various statistics fields.

The second half of the 20th century was marked by scientific reinterpretation of the economy: economic growth started to be seen as not only a quantitative process, but as qualitative interactions between human and environment. This called for statistics capable to record not only production output but the impact of production on natural resources, emissions, environmental degradation. The challenge was met by SEEA that could be regarded as the first step in implementing the architectonic principle of integration of economic and environmental knowledge.

SEEA did not substitute SNA, but became part of it as a satellite system extending its conceptual space. The architectonic logic implies that a new subsystem cannot be created autonomously but should be built in the already existing structure, with the preserved integrity of methodological principles. SEEA is built by the logic of accounts, flows and balances similar with SNA, but with a supplementary dimension, namely the natural environment. This results in a two-tiered structure: the economic tier describing economic transactions, and the natural tier characterizing resources, stocks, and impact on ecosystems.

This transition from SNA to SEEA is a crucial point in the development of architectonics of the international statistics. It demonstrated that statistics has ceased to be only a mirror of economic processes and turned into a tool to explore causalities between economy and environment. Architectonics here occurs as a methodological "bridge" between two domains: economic and natural. It is through the architectonic principle that the system's integrity can be achieved, where the concepts "production", "consumption" or "investment" are reinterpreted with inclusion of environmental flows and expenses on regeneration of resources.

The next step in proceeding with this logic was SEEAW. It was not designed as an isolated project, but as a technical SEEA module elaborating its application to a specific resource, namely water. The choice of water was not random: (i) it is a universal component of the natural capital involved in all the economic activities, (ii) water resources have natural limits allowing to clearly define physical balances, (iii) data on water were well-established in hydrology, which simplified methodological aligning.

SEEAW can be regarded as an example of practical implementation of the architectonic principle. It demonstrated that physical data obtained from the natural statistics could be integrated in the system of economic accounts. It has three-tiered structure: physical tables of supply and use of water, hybrid accounts combining physical and monetary indicators, and asset accounts recording stocks and changes in water resources. The system built in this way is architectonically complete: it has a hierarchy of tiers aligned by methodological principles and terminological compatibility.

When the three systems (SNA, SEEA, and SEEAW) are compared, a clear hierarchical structure can be seen, with each lower tier revealing the essence of the higher one without disrupting its framework. SNA sets a formal logic of the accounting; SEEA extends this logic to environmental dimensions; SEEAW specifies it for the water sector. This buildup implements the architectonic principle in its purest form, i.e. the principle of integrity through aligning of the parts.

To be sure, the architectonic approach could suppress a chaotic multiplication of standards in

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Table 2. The content evolution of "architectonics" concept in the statistical thought

Conceptualization level	Essence	Principal function	Example in statistics
Philosophical	The idea of knowledge integrity, internal logic of a system's buildup	Streamlining, thinking, and cognition	The concept of system approach
Methodological	The principle of hierarchical organization of statistical systems and harmonization of concepts	Building up single standards and classifications	The hierarchy of SNA, SEEA, SEEAW
Applied	Practical implementation of the principle for specific categories of resources	Integrating physical, economic, and social data	The architectonics of water resource accounting in SEEAW

Source: developed by the authors.

the international statistical practices. All the statistical systems created under the aegis of the United Nations had the common methodological framework ensuring their reciprocal integration. This framework results from using standard classifications (e.g. ISIC), standard principles for recording of transactions (based on dual recording), and the shared aggregation logic.

The architectonic of international statistics is not only a technical result. It reflects the evolution of scientific thinking from isolated descriptions of phenomena to a holistic vision of the world as an interlinked network of processes. Statistics built by the architectonic principle can measure and explain at the same time: it enables for tracking causal links between economic activities, consumption of resources, and changes in the environmental status.

SEEAW in this context is assigned the role of a linking chain between natural and economic types of knowledge. It shows how the data from hydrological observations (precipitations, runoffs, level of ground waters, evaporations) can be aligned with economic indicators of production, consumption, and revenues. It is not a mere adding of a new data set, but integration of physical and value-based patterns of thinking in a single system of accounts. This integration is a real manifestation of the architectonic principle.

Hence, the architectonics of international statistics has a dual function. On the one hand, it sets the rules of a system's buildup, being an organizing principle. On the other hand, it creates a visible structure or a result of the implemented principle. Architectonics features the methodological universality: it is a way of thinking and an existential form of the statistical system.

The above-made analysis allows us to proceed from philosophic interpretation of architectonics to its methodological content in the contemporary statistics (Table 2).

When the architectonics is examined as a methodological form of integrating statistical knowledge, it can be discerned that it occurs in a specific thematic field. The most remarkable example of its practical implementation is the system for environmental-economic accounting of water resources, known as SEEAW. It demonstrates how the general principle on which statistical systems are built transpires in an applied field, creating a new level of analytical thinking.

The architectonics of statistical accounting of water forms at the intersection of the three types of statistics: hydrological, environmental, and economic. Each of them reflecting a specific aspect of the reality, but only in an integrated system can they create a complete picture. The hydrological statistics in focused on natural processes determining scopes, allocation, and dynamics of water resources. It measures indicators like scopes of precipitations, surface runoff, level of groundwater, speed of evaporation, water balance of river basins. These data characterize a physical status of the water environment and lay the basis of natural environmental statistics.

The environmental statistics is focused on characteristics of water ecosystem status, water quality, pollution, quantity of biogenic elements, concentration of toxic substances, and on the impact of anthropogenic factors. Its principal objective is tracking upward or downward trends in the environmental performance. It links physical observations to assessments of environmental effects, but it remains to be descriptive by origin and does not include economic relations.

The economic statistics, by contract, describes human activities related with use of water resources. It covers indicators of production and consumption, investment in water infrastructures, costs for water cleaning, tariff for water supply, subsidies, taxes and expenses of households. It deals with value-based flows and enables to analyze the

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Table 3. The architectonics of statistical assessment of water in SEEAW

System level	Principal content	Measurement unit	Data source	Methodological function
Physical accounting	Scopes of water incoming in various economic sectors and returning to the environment	Cubic meters, liters, percentage	Hydrological observations, data from monitoring	Laying the primary information base
Hybrid accounts	Combined physical and economic indicators, analysis of the efficiency of water use	Cubic meters and monetary units	Data from hydrological monitoring, business enterprise statistics, financial reports	Integrating natural and economic dimensions
Asset accounts	Stocks and changes of water resources, estimates of water capital	Monetary estimates of stocks, physical volumes	Combined data of hydrology and national statistics	Setting a strategic perspective for the policy of sustainable water use

Source: developed by the authors.

economic efficiency of resource management. However, per se it does not describe a status of the environment wherein these activities are performed.

To sum up the results of comparison, it can be argued that the three types of statistics form a hierarchical system, with hydrological statistics laying the physical base, environmental statistics showing a quality status of the water environment, and environmental-economic statistics aligning natural and economic indicators. This structural interaction creates a background on which the architectonic principle within SEEAW is implemented, transforming it into a methodological bridge between natural processes and socio-economic analysis.

The architectonic approach implemented in SEEAW combines the three systems into a single whole. It creates a methodological bridge between natural and socio-economic data by posing each of them in the overall structure of knowledge. The architectonics of statistical assessment of water forms at this level. Its content lies in streamlining the whole system of data about water in a way to make it show physical scopes along with economic and environmental value of the resource.

The statistical assessment of water by SEEAW covers three accounting levels forming a consistent hierarchy. The first level comprises physical tables of supply and use of water. They record quantitative characteristics of water flows incoming in various economic sectors and returning to the environment. These tables lay the basis for constructing further accounts and ensure the comparability with data from hydrological observations.

The second level comprises hybrid tables and economic accounts where physical scopes are related to monetary indicators. They allow one to pass from measurement of natural processes to analysis of economic interactions with them. Thus, the amount of water used by industry is combined with the cost of its intake, cleaning, and transportation. It results in an analytical system designed to estimate the efficiency of resource utilization from the cost-benefit perspective.

The third level comprises asset accounts showing stocks of water, their changes, replenishment, and depletion. This level gives grasp of the water capital in a country as part of its national wealth. Asset accounts combine information about physical stocks and their economic estimates, enabling to analyze the sustainability of water use and risks of resource degradation.

This three-level structure is an embodiment of the architectonic principle in its practical dimension. It demonstrates a way of moving from separate observations to system knowledge wherein all the components are interlinked. Physical data lay the basis of estimations, economic accounts provide for analytical interpretation, and asset accounts show a strategic perspective of management. This buildup is logically complete and holistic.

The structure of architectonics of statistical assessment of water can be illustrated in the summary Table 3.

Hence, the architectonics of statistical assessment of water in SEEAW ensures a logical and methodological integrity of various data levels. It enables to proceed from natural information to economic assessment, and to combine hydrological facts with sustainability indicators. This buildup is

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Table 4. A comparison of hydrological, environmental, and environmental-economic statistics by subject and object of observation

Criterion	Hydrological statistics	Environmental statistics	Environmental-economic statistics
Subject of observation	Physical processes of water movement in natural systems	The status of water ecosystems, and the impact of human activities	The relationship between economic activities and use of water resources
Object of observation	Precipitations, runoffs, water level, evaporations, water balance	Water quality, pollution, biological indicators	Water flows between economic sectors, expenses for water supply, stocks and changes of water capital
Measurement unit	Cubic meters, liters, percentage of humidity	Concentrations of substances, shares of pollution, number of types	combination of physical and monetary units
Level of spatial coverage	River basin, reservoir, territorial region	Water ecosystem or observation zone	Economic system at national or industry level

Source: developed by the authors.

not a mechanic sum of indicators, but an orderly structure, with each component posed in the overall hierarchy.

Summing it up, water in the context of the architectonics of statistical accounting is interpreted as not as a mere resource, but as a multidimensional category combining natural, economic, and social content. This approach transforms statistics into a means for deeper understanding of development processes, because the integration of data reveals the real relationship between economic activities and natural environment.

When interpreting water as an object of statistical accounting, various categories of statistical knowledge need to be considered. Each category of knowledge, whether hydrological, environmental or environmental-economic, has own thematic domain, methodology, and functional purpose. All of them show various levels of reality and altogether form a system wherein natural, environmental, and economic data are mutually consistent.

This comparison helps understand how the architectonic principle is applied in SEEAW. It shows how observations of natural processes are translated into integrated accounts incorporating physical, environmental, and value-based indicators. The below given Tables 4, 5, and 6 illustrate principal distinctions between hydrological, environmental, and environmental-economic statistics by various criteria.

Hydrological statistics describe a physical reality of the water environment, the environmental statistics explore a status and quality of water ecosystems, and environmental-economic statistics translate these observations in a system of economic analysis. Moving from a description of the natural status to an analysis of its relationship with economic activities is the first step in the architectonic streamlining in SEEAW (Table 5).

Methodological distinctions show that various types of statistics reflect various phases of analytical thinking. Hydrological statistics relies upon laws of nature, environmental statistics sys-

Table 5. A comparison of hydrological, environmental, and environmental-economic statistics by methodological approach and data source

Criterion	Hydrological statistics	Environmental statistics	Environmental-economic statistics
Methodological framework	Laws of natural water movement, balance estimations, hydrometeorological observations	Monitoring of water quality, environmental classification, impact assessment	Methodology of SNA, tables of supply and use, integrated asset accounts
Type of data	Data from primary physical observations	Indicators of environmental status	Combination of physical and financial data
Information source	Hydrological services, meteorological stations, field observations	Environmental agencies, laboratory measurements, audits	National statistics agencies, financial reports of business enterprises, government reports
Method of processing	Estimations of water balance, determining of trends	Estimations of environmental parameters, normalization of indicators	Aligning indicators with economic classifications, constructing hybrid accounts
Тип результату	Scientific (evidence-based) indicators of natural processes	Indicators of ecosystem status	Analytical tables combining natural and economic dimensions

Source: developed by the authors.

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Table 6. A comparison of hydrological, environmental, and environmental-economic statistics by functional purpose in the management system

Criterion	Hydrological statistics	Environmental statistics	Environmental-economic statistics
Principal purpose	Determining the status of water resources and natural processes	Measuring water quality and impact of human activities	Efficiency assessment of water resource utilization within an economic system
Level of application	Scientific research, forecasting of hydrological processes	Official monitoring of environment, assessment of environmental risks	Setting up sustainability policy, planning resource efficiency
Principal user of data	Research institutes, hydrometeorologica l services	Environmental agencies, nature-protection organizations	Ministries of economy, finance, water resources, international institutions
Role in the sustainability system	Basic information on the status of water environment	Indicators of environmental stability	An integrated tool for assessing the relationship between economy and nature
Significance for SEEAW architectonics	A source of primary physical data	Supplying environmental parameters	Integrating physical, environmental, and economic indicators in a system

Source: developed by the authors.

tematizes data on status of water systems, and environmental-economic statistics forms a consistent link between natural facts and indicators of economic activities. This link is a manifestation of the architectonic integration (Table 6).

Within this perspective, hydrological statistics lay the background, environmental statistics add it with characteristics of quality and impact, and environmental-economic statistics combine them in a holistic model for decision-making. Hence, the essence of architectonic approach is that it combines scientific observation, environmental assessment, and economic analysis in a single system.

To sum up the results of these comparisons, it can be argued that the three types of statistics constitute a holistic hierarchy. Hydrological statistics provide for a basic empirical background, environmental statistics create a set of indicators for water ecosystem, and environmental-economic statistics integrate these data in the structure of economic accounts. This buildup is an embodiment of the architectonics of international statistics, where SEEAW has intermediate position between physical measurement of nature and macroeconomic indicators of national accounts.

The architectonic logic of SEEAW is that it does not substitute either of the previous types of statistics, but streamlines them to a holistic system. It results in creating a single information structure allowing one to describe a full cycle of interactions between humans and water environment, from a natural process to an economic outcome.

CONCLUSIONS

A theoretical and methodological analysis of the architectonics of international statistical systems, aiming to reveal the content and functions of this principle and pose SEEAW within its structure led to the following conclusions.

1. Architectonics is not a mere philosophical category, but rather a methodological one, describing the logic of statistical systems' buildup. It combines the principles of structural alignment, continuity, and consistency, to ensure the integrity and comparability of statistical data. Architectonics in statistics functions as a means of aligning multilevel knowledge systems, with each subsystem developing rather than denying a basic methodology.

2. The architectonic principle in international statistics shows through a continual hierarchy of standards, with SNA being the basic one, SEEA being a satellite system, and SEEAW being is thematic module. This three-tier buildup forms an internal logic in the development of international statistical systems, and ensures harmonization of economic and environmental dimensions.

3. SEEAW is an example of practical implementation of the architectonic principle. Its structure is built on three levels (physical level, hybrid level, and level of assets), forms a holistic system where data of hydrological statistics transform into indicators of economic analysis. This hierarchical organization enables one to proceed from natural observations to integrated accounts applicable in SNA.

4. SEEAW incorporates three types of statistics (hydrological, environmental, and environmental-economic) creating a holistic system. Hydrological

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statistics form a physical database, environmental statistics provide indicators of quality and status, and environmental-economic statistics integrates them in a single model for analysis of interactions between economy and nature. This architectonic buildup ensures the integrity and makes the data applicable in the sustainability assessment.

Also, we formulated a theoretical position that the architectonics of international statistics constitutes a methodological tool for integrating various levels of knowledge. It lays the background for creating holistic systems for accounting of natural resources, where each component is posed within the overall structure of knowledge. The architectonic approach helps enhance the analytical capacity of statistics, reveal the causality between natural environment, economic activities and social processes, and ensure the integrity of approaches to the sustainability measurement of on global scales.

Hence, the study confirms our hypothesis and demonstrates that SEEAW is not only a mere technical tool for water resource accounting, but a full-fledged architectonic construct of the international statistics, showing the logic of interpretation of natural and economic knowledge in scientific and management practices in our days.

The analysis enabled us to propose a definition of the architectonics of statistical accounting as a structured conceptual system wherein each category of accounting — economic, environmental, resource — forms a single hierarchical level, which ensures compatibility of indicators, methods, and classifications. The architectonics of statistical accounting poses indicators in the knowledge structure rather than determines their meaning, enabling one to proceed from autonomous observations to a holistic system of sustainability measurement. Interpreted in this way, the architectonics is not a set of technics but a structure of thinking streamlining the cross-level hierarchy of notions and links. Its purpose is to create a logical integrity between physical, social, and economic dimensions of the reality. The architectonics, therefore, can be defined as a methodological form of the integration of statistical knowledge. This approach becomes an imperative in building the architectonics of statitistical assessment of water, where physical hydrological indicators, environmental parameters, and economic accounts are combined in a holistic analytical system. Water in it constitutes a specific object in implementing the overall architectonic principle.

Література:

1. United Nations, European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development, World Bank. System of Environmental-Economic Accounting for Water (SEEAW). New York: United Nations, 2012. 154 p.

2. United Nations Statistical Division. System of Environmental-Economic Accounting 2012 — Central Framework (SEEA-CF). New York: United Nations, 2014. 378 p.

3. United Nations, European Commission, Organisation for Economic Co-operation and Development, International Monetary Fund, World Bank. Integrated Environmental and Economic Accounting: Handbook of National Accounting. New York: United Nations, 2003. 616 p.

4. United Nations. Transforming our world: the 2030 Agenda for Sustainable Development. New York: United Nations, 2015. 41 p.

5. European Commission, OECD, United Nations, World Bank. Environmental and Economic Accounting and Indicators for Sustainable Development. Luxembourg: Publications Office of the European Union, 2020. 112 p.

6. Vardon M. J., Le T. H. L., Martinez-Lagunes R., Pule O. B., Schenau S., May S., Grafton R. Q. Accounting for water: A global review and indicators of best practice for improved water governance. Ecological Economics. 2025. № 227. 108396. https://www.sciencedirect.com/science/article/pii/S0921800924002933?via%3Dihub

7. Meurer S., Van Bellen H. M. Water accounting: an overview of the corporate scenario. Revista Catarinense da Ciencia Contabil. 2024. № 23. e3469. https://revista.crcsc.org.br/index.php/CRCSC/article/view/3469/2638

8. Hepworth N. D., Brewer T., Brown B. D., Atela M., Katomero J., Kones J., Gashaw M. Accountability and advocacy interventions in the water sector: a global evidence review. H2Open Journal. 2022. Т. 5, № 2. С. 307. https://iwaponline.com/h2open/article/5/2/307/88802/Accountability-and-advocacy-interventions-in-the

9. Державне агентство водних ресурсів України. Державний облік водокористування. Офіційний вебсайт Держводагентства України. Опубліковано 08.09.2020. URL: https://www.davr.gov.ua/derzhavnij-oblik-vodokoristuvannya (дата звернення: 06.11.2025).

10. Булатова О. В., Захарова О. В., Карпенко О. І., Федоров Е. В. Економічна безпека країн в умовах сучасних глобальних трансформацій: виклики, загрози, ризики / за заг. ред. д.е.н., проф. О. В. Булатової. Київ: МДУ, 2024. 290 с.

ISSN 2306-6792

11. Булатова О., Панченко В., Іващенко О. Мегатренди міжнародного економічного розвитку і виклики економічній безпеці: потенціал управління політикою стійкості та протидії ризикам. Modeling the development of the economic systems. 2023. № 2. С. 215—222. https://doi.org/10.31891/mdes/2023-8-29.

12. Панченко В., Птащенко О. В., Резнікова Н. В., Карп В. С. Міжнародні стратегії зменшення економічних, соціальних і технологічних розривів між країнами: історичні паралелі адаптації моделей стрибкоподібного і наздоганяючого розвитку. 2025. Агросвіт. № 7 (квітень). С. 4—15. https://doi.org/10.32702/2306-6792.2025.7.4

13. Панченко В., Птащенко О., Резнікова Н., Карп В. (2025). Стрибкоподібний і наздоганяючий розвиток як імператив модернізації та структурної трансформації азійських країн: історичні аспекти реалізації політики стимулювання експорту. Агросвіт, 6, 17-29. https://doi.org/10.32702/2306-6792.2025.6.17 (дата звернення: 19.05.2025).

14. Панченко В., Резнікова Н. Міжнародні стратегії економічного розвитку: навчальний посібник. Київ: АграрМедіа, 2025. 471 с.

15. Панченко В., Резнікова Н., Іващенко О. Стратегічний форсайт як інструмент протидії сучасним глобальним викликам економічній безпеці і нерівності: досвід ЄС для України у сприянні стійкості та сталості. Вісник Хмельницького національного університету. Серія: економічні науки. 2023. № 4 (320). С. 31—39. https://doi.org/10.31891/2307-5740-2023-320-4-5

16. Панченко В.Г., Резнікова Н.В., Іващенко О.А. Форсайт як інструмент відповідального державного управління і стратегування міжнародної економічної політики в умовах загострення глобальних проблем розвитку. Вісник Хмельницького національного університету. Серія: Економічні науки. 2024. № 326 (1). С. 350—358. https://doi.org/10.31891/2307-5740-2024-326-55

17. Яценко О., Дугінець Г., Панченко В. Євроінтеграційні імперативи повоєнного відновлення України на засадах сталості: у пошуках джерел фінансування. Вісник Хмельницького національного університету. Економічні науки. 2024. № 334 (5). С. 616—623. https://doi.org/10.31891/2307-5740-2024-334-93.

18. Bulatova O., Reznikova N., Sarbash S. Asymmetry of the modern conflicts. Przeglad Strategiczny. 2024. № 17. P. 25—34. https://doi.org/10.14746/ps.2024.1.2.

19. Резнікова Н. В. Глобальні і регіональні екологічні проблеми. Київ: Вістка, 2016.

20. Цибуляк А. (2025). Екологічний імператив парадигми сталості VS право на розвиток: у пошуках інституційних механізмів досягнення системного компромісу. Ефективна економіка. (квітень). https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5231630

21. Цибуляк А. Еволюція теорій екологічної модернізації як прояв зростання ризиків міжнародної економіки: актуалізація сталих бізнес-практик в умовах цифрового переходу. Економічний простір: Збірник наукових праць. 2025. № 201 (травень). С. 370—377. https://economic-prostir.com.ua/wp-content/uploads/2025/06/201-370-377-czybulyak.pdf

22. Цибуляк А. International water markets in the context of the green transition: regulatory mechanisms for managing water pollution. Європейський науковий журнал Економічних та фінансових інновацій. 2025. С. 171-179. Том 3. № 17. https://economic-prostir.com.ua/wp-content/uploads/2025/06/201-370-377-czybulyak.pdf

References:

1. United Nations, European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development, & World Bank. (2012), System of Environmental-Economic Accounting for Water (SEEAW), United Nations, New York, USA.

2. United Nations Statistical Division. (2014), System of Environmental-Economic Accounting 2012 — Central Framework (SEEA-CF), United Nations, New York, USA.

3. United Nations, European Commission, Organisation for Economic Co-operation and Development, International Monetary Fund, & World Bank. (2003), Integrated Environmental and Economic Accounting: Handbook of National Accounting, United Nations, New York, USA.

4. United Nations. (2015), Transforming our world: the 2030 Agenda for Sustainable Development, United Nations, New York, USA.

5. European Commission, Organisation for Economic Co-operation and Development, United Nations, & World Bank. (2020), Environmental and Economic Accounting and Indicators for Sustainable Development, Publications Office of the European Union, Luxembourg.

6. Vardon, M. J., Le, T. H. L., Martinez-Lagunes, R., Pule, O. B., Schenau, S., May, S., & Grafton, R. Q. (2025), "Accounting for water: A global review and indicators of best practice for improved water governance", Ecological Economics, vol. 227, 108396, available at: https://www.science-

ISSN 2306-6792

direct.com/science/article/pii/S092180092400-2933?via%3Dihub (Accessed 05 Jan 2026).

7. Meurer, S., & Van Bellen, H. M. (2024), Water accounting: An overview of the corporate scenario. Revista Catarinense da Ciencia Contabil, vol. 23, e3469, available at: https://revista.-crcsc.org.br/index.php/CRCSC/article/view/3469/2638 (Accessed 05 Jan 2026).

8. Hepworth, N. D., Brewer, T., Brown, B. D., Atela, M., Katomero, J., Kones, J., & Gashaw, M. (2022), "Accountability and advocacy interventions in the water sector: A global evidence review", H2Open Journal, vol. 5 (2), 307, available at: https://iwaponline.com/h2open/article/5/2/307/88802/Accountability-and-advocacy-interventions-in-the (Accessed 05 Jan 2026).

9. State Agency of Water Resources of Ukraine. (2020), "State water use accounting", available at: https://www.davr.gov.ua/derzhavnij-oblik-vodokoristuvannya (Accessed 05 Jan 2026).

10. Bulatova, O. V., Zakharova, O. V., Karpenko, O. I. and Fedorov, E. V. (2024), Ekonomichna bezpeka krain v umovakh suchasnykh hlobalnykh transformatsii: vyklyky, zahrozy, ryzyky [Economic Security of Nations amid Contemporary Global Transformations: Challenges, Threats, and Risks], MDU, Kyiv, Ukraine.

11. Bulatova, O., Panchenko, V. and Ivashchenko, O. (2023), "Megatrends of international economic development and challenges to economic security: the potential of resilience and risk management policy", Modeling the Development of the Economic Systems, vol. 2, pp. 215—222, https://doi.org/10.31891/mdes/2023-8-29

12. Panchenko, V., Ptashchenko, O. V., Reznikova, N. V. and Karp, V. S. (2025), "International strategies to reduce economic, social and technological gaps between countries: historical parallels of leapfrog and catching-up development models", Ahrosvit, vol. 7, pp. 4—15, https://doi.org/10.32702/2306-6792.2025.7.4

13. Panchenko, V., Ptashchenko, O., Reznikova, N. and Karp, V. (2025), "Leapfrog and catching-up development as an imperative of modernization and structural transformation in Asian countries: historical aspects of export promotion policy", Ahrosvit, vol. 6, pp. 17—29, https://doi.org/10.32702/2306-6792.2025.6.17

14. Panchenko, V. and Reznikova, N. (2025), Mizhnarodni stratehii ekonomichnoho rozvytku: navchalnyi posibnyk [International Strategies of Economic Development: A Textbook], Ahrar-Media, Kyiv, Ukraine.

15. Panchenko, V., Reznikova, N. and Ivashchenko, O. (2023), "Strategic foresight as a tool to counter current global challenges to economic security and inequality: EU experience for Ukraine in fostering resilience and sustainability", Visnyk Khmelnytskoho natsionalnoho universytetu. Seriya: Ekonomichni nauky, vol. 4 (320), pp. 31—39, https://doi.org/10.31891/2307-5740-2023-320-4-5

16. Panchenko, V. H., Reznikova, N. V. and Ivashchenko, O. A. (2024), "Foresight as a tool of responsible public governance and strategic planning of international economic policy under escalating global development problems", Visnyk Khmelnytskoho natsionalnoho universytetu. Seriya: Ekonomichni nauky, vol. 326 (1), pp. 350—358, https://doi.org/10.31891/2307-5740-2024-326-55

17. Yatsenko, O., Duhynets, H. and Panchenko, V. (2024), "European integration imperatives of Ukraine's post-war recovery on the basis of sustainability: in search of financing sources", Visnyk Khmelnytskoho natsionalnoho universytetu. Ekonomichni nauky, vol. 334 (5), pp. 616—623, https://doi.org/10.31891/2307-5740-2024-334-93

18. Bulatova, O., Reznikova, N. and Sarbash, S. (2024), "Asymmetry of the modern conflicts", Przeglad Strategiczny, vol. 17, pp. 25—34, https://doi.org/10.14746/ps.2024.1.2

19. Reznikova, N. V. (2016), Hlobalni i rehionalni ekolohichni problemy [Global and regional environmental problems], Vistka, Kyiv, Ukraine.

20. Tsybuliak, A. (2025), "Ecological imperative of the sustainability paradigm vs the right to development: in search of institutional mechanisms for achieving systemic compromise", Efektyvna Ekonomika, vol. 4, available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_-id=5231630 (Accessed 05 Jan 2026).

21. Tsybuliak, A. (2025), "Evolution of theories of ecological modernization as a manifestation of the increasing risk of the international economy: actualization of sustainable business practices in the conditions of digital transition",Ekonomichnyi Prostir, vol. 201, pp. 370—377, available at: https://economic-prostir.com.ua/wp-content/uploads/2025/06/201-370-377-czybulyak.pdf (Accessed 05 Jan 2026).

22. Tsybuliak, A. (2025), "International water markets in the context of the green transition: Regulatory mechanisms for managing water pollution", European Scientific Journal of Economic and Financial Innovation, vol. 3 (17), pp. 171—179, available at: https://journal.eae.com.ua/index.php/journal/article/view/533 (Accessed 05 Jan 2026).

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