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Statistical Accounting and Classification of Water Resources

The article examines the role of statistical accounting and classification of water resources in ensuring sustainable development, environmental balance, and economic security. Water is not only a fundamental component of the natural environment but also a critical factor in the economic activity, determining the operation of key sectors such as agriculture, industry, energy, and urban infrastructure. In the face of global challenges – freshwater scarcity, water pollution, climate change, and increasing water stress – the development of a reliable system for water statistics becomes crucial. Such a system allows for quantitative and qualitative assessment of water availability, use, management efficiency, and environmental risks.

The study contains a review of leading international approaches to water statistics, particularly the SEEA-Water and IRWS frameworks, which integrate hydrological and economic indicators into the national accounting systems. Special attention is paid to conceptual approaches to assessing water as an economic asset, including the notions of water stress, virtual water, water footprint, full-cost pricing, and polycentric water governance.

The article substantiates the need to develop a comprehensive system of sustainable water use indicators that includes water intensity, deficit ratios, pollution indices, and water supply reliability metrics. This approach enables tracking of water use dynamics and supports evidence-based decision-making at national and international level.

A significant part of the study is devoted to the analysis of water classification systems. International classification approaches are considered, based on renewability, source, geography, quality, and sectoral use. Additionally, the article presents a national classification system that takes into account the legal status of water bodies, their physical form, affiliation with the water fund, economic purpose, and features of accounting in business entities.

The findings highlight the need to harmonize national statistical practices with international standards, ensure institutional transparency, engage communities in data collection, and establish an integrated water monitoring system as a foundation for water security and sustainable development.

Key words: *water resources, statistical accounting, water footprint, water resource classification, sustainable development, indicators, resource management, international standards.*

Introduction. The rational use of water resources is an important premise of the sustainable development, covering environmental equilibrium, food security, and the economic stability of the nation. The increasing water scarcity, pollution of water resources, climate change and irrational water use provoke a series of challenges to the effective governance of water ecosystems. Water is not only an essential resource for life, but a core factor of the production process with impact on the performance of agriculture, industry, power engineering, and local infrastructures.

In view of the abovementioned, the creation of a system for statistical accounting of water resources, allowing for a quantitative and qualitative assessment of their condition, dynamics, availability, and utilization is becoming crucial. This accounting is designed as a tool for monitoring, forecasting and governance, especially on the way toward the Sustainable Development Goals (SDGs).

The relevance of this theme stems from the need to standardize approaches to the assessment of water resources at country and international level, to allow for the informed policy setting in the water governance field. This study aims to sum up statistical methods for water resource accounting and critically review the existing classifications, to enable for their effective use in environmental, economic and resource governance systems.

Materials and methods. This study relies on the interdisciplinary approach combining the components of economics and nature use, environmental statistics, accounting and legal regulation. Its theoretical framework are provisions of the Water Code of Ukraine, the Law of Ukraine "Accounting and Financial Reporting in Ukraine", international standards of the statistical accounting of water resources, SEEA-Water and IRWS in particular, and analytical reports of international organizations such as FAO, UN Water, OECD and Eurostat.

The research methodology is based on content analysis of normative and legal acts, research literature and international reports, to sum up the valid approaches to classification and statistical accounting of water resources. The structuring of water resources by various characteristics was made by the classification analysis, enabling for a typology of waters by natural, economic and legal features. The comparative analysis was used to reveal the differences between national and international systems for statistical accounting of water resources. The research results are provided in the form of tables, schemes and descriptive structure, to make the research presentation illustrative and logical.

The overall methodological framework of the research is based on advanced concepts of integrated water resources management, natural capital assessment, and statistical support for SDGs.

Results and discussion. Water resources are a fundamental component of the natural capital, crucial for the efficiency of community and economy. Water supports the life and health of the population, generates energy and serves as the basis for industry and ecosystems [1]. According to the website of the World Bank, water is our most valuable yet overlooked resource. It sustains people, grows food, powers economies, and supports ecosystems. But this vital asset is under greater stress than ever before [2]. No country can achieve a sustainable economic prosperity without a reliable water base, because water is a required condition for the employment, basic human necessities and the development of economic sectors. The reliable water supply increases the productivity in agriculture, power engineering and industry, i.e. the sectors providing jobs for millions of people. A water scarcity, on the contrary, may disrupt the economic activity: for instance, the drought of 2018 in Cape Town caused the loss of 20,000 jobs in the agriculture [2]. Hence, water is a strategic resource determining the food security, energy stability and economic welfare of nations.

Below we will elaborate on the coverage of the notion "water resources", to have a deeper grasp into the significance of water for the sustainable development, food and economic security (Table 1).

Table 1

Interpretations of the notion "water resources" by Ukrainian researchers

Author, source	Definition of the notion "water resources"
S. Movchan, N. Boltianska, [3]	Water resources are reserves of underground and surface waters, both fresh and mineralized, which can be used today or in the future, with consideration to environmental requirements
Water Code of Ukraine, [4]	Water resources are the totality of underground, surface and sea waters on a given territory
N. Kobetska, [5]	Water resources encompass all the waters (surface, underground, sea) that a part of the natural water circuit
I. Berdnik, [6]	Water resources are underground, surface, internal sea waters and the territorial sea, with clear boundaries, volumes, water regime, included in the water cadaster, and the related natural wealth
K. Chursina, [7]	Water resources are the quantities of underground and surface waters of a particular territory, with a quality suitable for current and future utilization
V. Pavlov, [8]	Water resources are all the water reserves of the dry land and the World Ocean, suitable for utilization, as well as their energy, with inclusion of underground waters, soil moisture, ice and snow cover

To sum up the above interpretations, water resources can be defined as the totality of surface, underground, sea waters suitable for utilization, and related natural components (soil moisture, ice, snow), which have certain quantitative and qualitative characteristics, and which provide for the needs of society, economy and environment. They are a part of the water circuit accessible for the current and future rational use with reference to the environmental requirements.

In view of the crucial importance of water, the international discourse relied upon the concept of water resources as an economic good. It was as early as at the beginning of 1990s that the Dublin International Conference on Water and the Environment set the principle that water had an economic value in all the areas of utilization, and it had to be treated as an economic good. This idea was brought forward by scientists in economics, who emphasized that the recognition of the economic value of water would make it distribution and use more effective. P. Rogers, R. Bhatia, A. Huber showed in the report to the Global Water Partnership that applications of economic tools (for instance, the full reimbursement of costs for water supply) could make water use more effective and fair. The recognition of water as an economic commodity does not deny its social significance. Instead, a proper assessment of water allows for better accounting for economic and social priorities in its distribution [9].

Besides that, water is considered as a common-pool resource accessible by many users, thus creating the tragedy of the commons problem. Nobel Laureate E. Ostrom demonstrated that the shared water resource management at local level (for instance, management of irrigation system) could be successful given the proper institutional rules and shared actions of communities [10]. It is the reason why the need in the inclusive water management and alignment of interests of various groups of users, from agriculture to industry and households, is underscored in research. As water is an economic factor of production and a basic human necessity alike, the water-related policy must balance the criteria of effectiveness, equal access and sustainability of ecosystems.

Finally, water scarcity has direct impact on the sustainability of development. The shortage of water is admittedly a largest threat at global level. According to the World Economic Forum, the water crisis was a top global risk by the potential impact on economies and communities in 2015. Nearly one third of the global population resides in the regions with a high level of water stress, and about one billion of people have no access to safe drinking water [11].

The excessive depletion of underground waters (providing for more than 95% of the rare fresh waters on the planet) creates a hidden threat: in most productive agricultural regions (California's Central Valley (U.S.), North China, North India, valleys of Pakistan), the consumption of ground waters is considerably higher than their replenishment [11]. Given the projection of demographic and economic growth, the need in water will be increasing.

Hence, water resources are crucial for the sustainable development, economic stability, and social welfare. Their rational use and effective management are critically important in addressing global challenges related with water scarcity. Preservation of water resources requires a balance between economic, social, and environmental concerns of the humanity.

Studies of the water resource performance rely upon statistical accounting providing for regular collection, processing and analysis of quantitative and qualitative data about socio-economic phenomena. According to Yu. Slobodianyk, statistical accounting is a systematic study of mass processes in a particular place and time using methods such as mass and sample observation, computations of average and relative values, etc. [12]. I. Sadovska argues that statistical accounting reflects the development of both individual industries and the economy as a whole, offering a tool for control, planning and management. It the economic accounting context, it carries out an organizing role by summarizing the data of operative and bookkeeping accounting [13]. According to N. Tkachenko, statistical accounting allows for analyzing typical economic phenomena like the labor productivity or housing using specific methods: aggregation, grouping, averages, indexes, etc. [14]. Hence, it lays the basis for quantitative and qualitative analysis of economic activities.

Statistical accounting of water resources can be defined as a system for collection, processing and analysis of data about the quantitative and qualitative condition of waters, their distribution, use and rehabilitation, designed to assess the water use effectiveness, reveal the vectors of change and set informed policies on water management.

The effective water management policy requires reliable statistical data about water. A series of standards and techniques have been developed at international level, to ensure the cross-country comparability of indicators and integration of water statistics with economic statistics (Table 2, compiled by data from [15; 16]).

Table 2

International approaches to statistical accounting of water resources

Approach / system	Description	Main features
SEEA-Water (system for environmental-economic accounting of water)	International framework combining hydrological and economic data into an integrated accounting system	Tracking water reserves, flows, consumption and return; it is compatible with the System of National Accounts (SNA)
IRWS (International Recommendations for Water Statistics)	Methodological guidelines for collection, classification and dissemination of statistical data about water	Standardization of terminology, support of IWRM, harmonized indicators
ISIC / CPC	International classifications for identification of water-using industries	Harmonization of data about water use in economic sectors
Joint Eurostat/OECD questionnaire	Collection of statistics on water intakes, discharges, purification by sector	Comparative indicators for EU and OECD member countries
AQUASTAT (UN World Food Program)	Global information system on water resources and water use	Standardized notions: water intake, consumption, irrigated areas, etc.

Crucially important is the system for environmental-economic accounting of water, developed under UN auspices (SEEA-Water), the conceptual framework and set of accounts which presents hydrological information alongside economic information in a consistent way. SEEA-Water, designed to track the relationship of natural water resources with the economy, accounts for the water reserves (assets), water flows in the environment and between the economy and the nature, and water consumption and water return to the natural environment. Because SEEA-Water is compatible with the SNA system, water accounts can be directly related to macroeconomic indicators, thus supplementing the gross domestic product (GDP) with data about use of natural capital.

To implement water accounting, UN designed International Recommendations for Water Statistics (IRWS), supplying countries with standardized notions, definition and classifications pertaining to collection of water statistics on a comparative basis. The principle objective of IRWS is helping countries create a multipurpose information system about water, to support Integrated Water Resource Management (IWRM). IRWS are designed to:

- support collection and dissemination of comparative statistical data on water;
- help introduce SEEA-Water system;
- supply information for computations of harmonized indicators and cross-country comparisons [15].

IRWS sums up the experience of various countries and organizations, placing emphasis on the need for integrating social, economic and environmental data about water for better water management. This is compliant with the principles of Integrated Water Resources Management (IWRM), an approach calling for holistic management of water resources with consideration of all the users and ecosystems.

An important component of the international accounting is the alignment of the statistical classifications. IRWS and SEEA-Water rely on the existing international standards such as International Standard Industrial Classification (ISIC) and Central Product Classification (CPC), to identify water-using industries [15]. It allows for comparisons of data on water use in various sectors (agriculture, industry, municipal services, etc.) and assessments of water capacity of the economy. For instance, the joint Eurostat/OECD environmental questionnaire involves data collection by sector: fresh water intakes by agriculture, power engineering, industry and households, water discharges, water purification quantities, etc.

The United Nations Food and Agriculture Organization (FAO) also collects national data about water resources and water use via the AQUASTAT system, using harmonized definitions (e.g. water intake, consumption, irrigated areas, etc.) to ensure comparability [16].

Scientific approaches to water resources accounting have been widely used in international practices alongside official statistical systems (Table 3, compiled by data [17–23].

Table 3

Scientific approaches to assessment and management of water resources

Author(s), sources	Key concept / approach	Description	Practical significance
1	2	3	4
J. A. Allan, [17]	Virtual water	Accounting of quantities of water embedded in the products subject to cross-country imports / exports	Rethinking of water self-sufficiency; used in analyses of the global water trade
A. Y. Hoekstra, [18]	Water footprint	Quantitative assessment of the total water consumption (direct and indirect) by individuals, companies, countries	A tool for assessing the environmental footprint, planning of resources, corporate responsibility
M. Falkenmark, [19]	Falkenmark indicator	Grading the water supply in regions depending on the annual quantity of the renewed fresh water per capita	Used by UN and international organizations for comparisons of water resources in countries
P. Gleik, [21]	Basic water supply / the second era of water	The minimal water consumption (50 liters / day per capita); emphasis on human rights, effective management, water reuse	Setting policies on water security, human rights, equitable access to water
E. Ostrom, [10]	Polycentric shared resource management	Effective management of water systems with community engagement, bottom-up, without excessive centralization	Support of local initiatives, decentralized accounting, trust in data, preservation of irrigation systems

Table 3, Continued

1	2	3	4
P. Rogers, R. De Silva, R. Bhatia, [22]	Full cost pricing	Inclusion of costs for nature's services, scarcity and pollution in tariffs along with other exploitation costs	Stimulating water preservation, investment in technologies, equitable pricing
F. Devoto, E. Duflo, P. Dupas, W. Parienté, V. Pons [23]	Cost-effectiveness of investment in water	Analyses of the relationship between the water infrastructure and the growth in economy and welfare, the reduction in healthcare costs	Argumentation for public policies, international financing, development programs

One of the best-known approaches, the virtual water concept, was proposed by British geographer and economist J. A. Allan. This scientist, a winner of Stockholm Water Prize, pointed out that countries with limited water resources (Middle East countries in particular) provided for their food needs by agricultural imports, thereby importing the water spent on their growing in other countries. The scientist called this water hidden in commodities "virtual" and showed that the global trade in agrarian products offered a scheme for water resource redistribution on the planet [17]. These insights had a strategic importance, because they demonstrated that water-scarcity countries could compensate a shortage of water by economic means, with water self-sufficiency not always being an optimal decision.

The virtual water concept was further developed by Dutch researcher A. Hoekstra who introduced the notion of water footprint. This notion allows for a quantitative assessment of the total fresh water required for the production of goods and services consumed by individual, company or country. A. Hoekstra with colleagues revealed that many developed countries had a significant external water footprint, because they imported water-intensive products like meat, cotton, coffee, etc. It means that their actual water consumption is significantly higher than the one reported in the national statistics. For instance, estimations show that the production of one ton of wheat requires nearly 1,300 m^3 of water, whereas 1 ton of beef requires more than 15,000 m^3. Accordingly, these quantities of water, embedded in the products, move between countries through the international trade [18].

It should be noted that although data (information) about water footprint or virtual water are not part of the official country-level statistics, they have become important tools in environmental and economic studies. These concepts supplement traditional water accounts, give a deeper insight of global water flows and help set policies on food security, resource management and international water responsibility. Also, water footprint is widely used at company and municipal level for the assessment of their activities' impact on water resources, thus making this concept especially important amidst the increasing global interdependence, when local consumption may have essential influence on ecosystems in other regions of the planet.

As regards quantitative and qualitative assessments of water resources, the research community have designed the approaches that are accepted by many specialists and have impact on international water accounting and water management practices. A pioneer in this field is M. Falkenmark, a Swedish researcher who created an indicator of water stress, known as Falkenmark indicator. The researcher proposed a simple but effective scale of the renewable fresh water consumption:

- less than 1,000 m^3: a region is water-scarce;
- less than 500 $м^3$: there is an absolute water scarcity [19].

This indicator is widely used by international organizations in classifying the countries by water supply level. M. Falkenmark underscored the importance of the total resources along with their correlation with the population and environmental needs, being the first one to clearly relate the demography with natural limitations. Her approach gave rise to many modern models of water stress assessment and furthered the research on sustainable water use [20].

An important approach to understanding the water security is the concept of basic water supply proposed by P. Glik, which determines the minimal required quantity of water providing for vital needs of a human. This concept implies the daily supply of at least 50 liters of safe water per capita to meet the needs in drinking water, sanitation and hygiene [21]. Hence, this research led to the recognition of water access as an essential human right and a reference point in elaborating national and international strategies on water supply. The approaches of Falkenmark and Glik combine economic, environmental and social dimensions of the water policy, which makes them relevant for SDGs, especially for the provision of universal access to water and sanitation.

A substantial contribution in the formation of a modern paradigm of decentralized water management was made by E. Ostrom, the author of the polycentric management concept. She pointed out that the effective management of water systems was feasible given the active engagement of local communities, especially in agricultural regions. The researcher showed that water users were able to jointly formulate the rules of distribution, keep independent cost accounting, control the observance of agreements and participate in financing of infrastructures, thus considerably enhancing the effectiveness and resilience of the system [10]. This approach underscores the need for community engagement in collection and verification of statistical data about water use, to ensure transparence, accountability and efficiency of management decisions.

Another important area of modern research is cost-effectiveness of water use. The economists P. Rogers, R. De Silva, R. Bhatia emphasized the need to show the full value of water, which, apart from direct exploitation costs, includes the costs for ecosystem-related services, the rarity of resource and pollution effects in the tariffs for final consumers [22]. In the final end, it provides a stimulus for economical consumption and investment in water-saving technologies.

At the same time, researchers point out to the need to provide for the basic quantity of water supply for the population by accessible price. This entailed the introduction of the social tariff concept involving minimal-value or even free-of-charge quantities of water for vulnerable population strata (this approach is widely used in many countries today).

Prominent economists like F. Devoto, E. Duflo, P. Dupas, W. Parienté, V. Pons explored the correlation between the investment in water infrastructures (water supply, sanitation) and the economic growth. They demonstrated that investment in this sector had a high socio-economic return: the increasing labor productivity, the reducing healthcare costs, the improving welfare of the population [23]. These conclusions provide an important evidence for substantiating budgeting decisions of governments, international assistance priorities, and sustainable development programs.

Hence, international approaches to water statistics combine official recording systems (SEEA-Water, IRWS) and scientific methods (water footprint, virtual water) for collection, analysis and interpretation of data on water reserves and uses. Statistics in this context constitutes not only a recording tool, but a framework for interdisciplinary analyses with reference to environmental, economic and social factors. This approach enables for setting informed policies on water management, especially in view of global challenges.

Assessments and analyses of statistical data on water resources involve a set of quantitative methods allowing to reveal changes in water use, management effectiveness and environmental trends. The key methods for statistical accounting include analyses of the indicators' upward or downward dynamics (growth rates, percentage increases), estimations of absolute and relative deviations (from reference or previous periods), structural comparisons (share of water consumption by sector), computations of averages (for instance, average water consumption per capita), and building of dynamic series. These methods provide for a holistic view of the water resource status and dynamics, and lay the ground for forecasting, risk assessment and taking informed management decisions.

A notable scientific approach designed to improve statistical recording of water resources involves a set of indicators of the sustainable water supply, proposed by O. Matsenko, A. Bavykina, S. Kalchenko [24]. The indicators are designed as tools for qualitative and quantitative measurement of the correlation between the condition of water ecosystems, effectiveness of their use, and socio-environmental factors (Figure 1, constructed by data from [24]).

The proposed system constitutes a structural approach to the monitoring of water use, it allows to track the tendencies over time and reveal the risks. It is based on statistically measurable indicators like water intensity of GDP, water scarcity, share of polluted discharges, etc.

The advanced water management relies on integral (composite) indicators allowing for a quantitative assessment of the overall water use and the effectiveness of water management at regional and global level (water pollution index, water scarcity coefficient, anthropogenic burden coefficient, water use balance, virtual water intensity per 1 UAH GDP, water footprint of a country (region)) [25]. These indicators combine environmental, economic and social characteristics in an integrated analytical system, complying with the statistical accounting of sustainable development.

A separate group consists of the indicators measuring the reliability of water supply systems, which increasing importance is associated with the requirements to quality of services and infrastructure management:

- average duration of water supply disconnections per user (hours/year);
- average frequency of disconnections (times/year);
- average time of one disconnection (hours);
- number of complaints per 1,000 users (units);
- quick repair coefficient (repair in 3 to 24 hours) [25].

These indicators characterize the operational stability of water supply and can be used as components of a statistical report designed for analyses of the reliability of water supply systems.

The abovementioned composite indicators reflecting the multidimensional nature of the water governance can be incorporated in national statistical systems as a framework for sustainable water-use policy setting. Their computation requires a regular collection of credible information, which underscores

Figure 1. A classification of integral indicators

the importance of creating an integrated statistical center for monitoring of water resources.

An effective statistical accounting of water resources needs to involve their classification, allowing to group information by type, source or terms of use. International normative documents set several criteria for water resource classification (Table 4, compiled by data [15; 16; 26; 27]).

By natural characteristics and renewability, water resources are grouped into renewable and non-renewable. Renewable waters are part of the hydrological cycle regularly renewed due to precipitations, river flows, etc. They include surface waters (rivers, lakes) and shallow underground aquifers that have a considerable resupply. Non-renewable waters are underground waters of deep accumulating aquifers (the so called fossil waters), which are not resupplied currently within the scope of a human life. Such aquifers occurred in other climatic conditions thousands years ago, they have a fixed water quantity and composition not renewable after depletion (for instance, ancient waters of the Sahara Desert). The renewable resources are usually measured as the average annual discharge (m^3/year), whereas the non-renewable resources are estimated as the total reserve (m^3) [16].

By origin and geography, water resources are distinguished between internal and trans-border (external) ones. Internal renewable water resources (IRWR) are a long-term average quantity of water formed within the country's boundaries due to precipitations (river flow and underground resupply from endogenic precipitations). External renewable water resources (ERWR) are water inflows

Table 4

A classification of water resources

Criterion	Category
Renewability	Renewable, non-renewable
Origin / geography	Internal (IRWR), external (ERWR), total (TARWR)
Type of water basin	Surface, underground, soil moisture
European typology (WFD)	Rivers, lakes, transitional waters, coastal sea waters, underground waters
Quality (WFD)	High, good, satisfactory, bad, very bad
Purpose	Agriculture, industry, municipal services

from neighboring countries (river discharge or underground flow coming across the border).

The sum of IRWR and ERWR with reference to international agreements on distribution of water discharge is the total available renewable water resources of a country. For instance, the overwhelming part of water resources in Egypt is external, as the Nile water comes from the countries located upstream; in Brazil or Congo, however, the nearly total discharge has internal origin, due to rains. UN and FAO statistics have introduced the notion "total actual renewable water resources" (TARWR), i.e. the total internal and external water resources adjusted for water flows reserved by agreements for neighboring countries [16]. Hence, this indicator shows the quantity of water available in a country annually in view of the international context.

There is a typology of water bodies by component of hydrosphere. International Recommendations for Water Statistics (IRWS) distinguish the following bodies as statistical units of the environment:

- surface water bodies (rivers, streams, lakes, water reservoirs, swamps, snow, and glaciers);
- underground waters (aquifers);
- soil waters (soil moisture) [15].

This typology is important for the accounting of reserves: the quantity of water in lakes or water reservoirs, the reserve of ice in glaciers, the quantity of underground waters in aquifers, etc. Each category has its own usability-related features: surface waters are more accessible, but more changeable seasonally; underground waters are more stable by quality and accessibility, but their excessive use causes depletion of reserves or land subsidence. International standards recommend that countries keep water reserves accounting by main categories. For instance, the FAO set of indicators is designed for separate computations of the river discharge, the renewed underground waters, the waters in water reservoirs, and the total renewable waters.

The legislation of EU involves a classification of water objects, used for monitoring and governance purposes. The Water Framework Directive 2000/60/EC defines surface water bodies as rivers, lakes, transitional (estuarial) waters and coastal sea waters, and, separately, underground waters. Each water body is identified and classified (for instance, lowland or highland rivers, large or small lakes, etc.) depending on natural characteristics. Apart from the typology, Directive introduces the grades of status to assess the quality of these waters: environmental status (from high to bad) for surface waters, to reflect the condition of ecosystem, and chemical / quantitative status for underground waters [26]. This classification aims at legal protection and renewal of waters: EU member countries are obliged to achieve at least the "good" status for all the water bodies. Although this system is environmentally focused, it has implications for the economy, because the "bad" status may limit water use, require investment in purification, etc. From the statistical accounting perspective, the Directive-based monitoring (for instance, the number of water bodies in each status grade) supplement economic statistics by data about the quality and availability of water resources.

Regarding the purpose, water resources are often classified by economic sector, although this pertains to not so much the resources per se, as their consumption. The international statistics of water use sets three main categories: agriculture (mainly irrigation), industry (including power engineering), and municipal services (municipalities and households). This typology allows for classifying water intakes from natural sources by purpose. For instance, according on UN, nearly 72% of the water resources are used by the global agriculture, 12% by industry, and 16% by municipal services. These shares show the economic structure of water demand, and they are often used for international comparisons and assessments of the effectiveness of water use in each sector (for instance, indicators of water intensity of production in industry or productivity of irrigated farming) [27].

Hence, classification of water resources in international practices encompasses various dimensions: natural type and renewability (surface, underground, renewable, fossil), geographic location (internal, trans-border), legal status and quality (grades of water bodies), and distribution by economic purpose. Such a multidimensional classification provides for a holistic insight of the resource and its characteristics, required for a comprehensive assessment and management.

A classification of water resources constitutes a crucial component of their accounting from either legal or economic perspective. Following T. Shapovalov's approach, the Ukrainian classification is based on a combination of norms of the Water Code of Ukraine and the Law of Ukraine "Accounting and Financial Reporting in Ukraine" (Table 5, compiled by data from [28]).

Table 5

A classification of water resources (the Ukrainian approach)

Criterion	Category	Description
Form of existence	1. Surface waters (rivers, lakes, water reservoirs, ponds, swamps). 2. Underground waters (boreholes, wells). 3. Sea waters (internal, coastal sea)	In compliance with the Water Code of Ukraine, it encompasses all the dry land and sea waters, comprising the country's water stock
Legal status	1. Water bodies of nationwide significance. 2. Water bodies of local significance	It is determined by the importance and the territorial coverage (more than one oblast, conservation territories, etc.)
Belonging to the water stock	1. Lands under water bodies (rivers, lakes, water reservoirs, etc.). 2. Coastal protective strips. 3. Lands for hydrotechnical structures	It creates a regulatory framework for use and recording of water stock lands
Nature of accounting	1. Tangible assets (artificial water bodies, boreholes). 2. Intangible assets (rights to use waters)	It determines the procedure for water resource accounting by business entities in compliance with the accounting standards
Economic purpose	1. Production (watering, cooling). 2. Administration (for office needs). 3. Household (for staff)	The recording is made in accounts 23, 91, 92, etc., depending on a water use purpose
Form of accounting	1. Account114.1 "Water resources" (tangible). 2. Account 121 "Rights to use natural resources " (intangible)	It determines sub-accounts for recording of bodies in the accounting system depending on the type of resource ownership or use

Hence, a classification of water resources, made at the intersection of environmental, legal and economic criteria, enables for incorporating natural bodies into the economic accounting system. This interdisciplinary approach is designed to address water as a resource with dual nature: an eco-systemic good and an economic asset. Its detailing helps enhance the accuracy of accounting, optimize water use and take effective management decisions in keeping with legal requirements and sustainable development standards.

Water resources are interpreted by the international statistics as physical stocks, but also as a component in the regular monitoring of sustainable development, food security, energy resilience, and adaptation to climate change. Comprehensive accounting systems built for this purpose in countries and regions include quantitative and qualitative characteristics of water. An essential component of this accounting is the assessment of renewable fresh waters: river discharge, air precipitations, underground aquifers. For instance, the average global quantity of renewable water, according to UN, amounts to nearly 42–45 thousand km^3 per year [19], but it is too unevenly distributed: higher than 80,000 m^3 per capita in Canada vs less than 10 m^3 in Kuwait [29]. These data are found in international databases of FAO AQUASTAT, World Bank and UN Water.

Apart from the water consumption, greatly important is the estimate of water stress, showing the tensions in water use: a country using more than 25% of the available water resource is regarded as water-stressed, and a country using more than 40% of them is the one with a high level of stress burden. In some regions, Middle East and South Asia in particular, this figure exceeds 80% [27].

The international practice also involves statistical accounting of water quality: the inclusion of nitrates, phosphates, heavy metals, bacterial or virus pollution. According to UN, nearly one third of the rivers across the globe are classified as polluted, significantly reducing the quantity of usable water. A strong emphasis is placed on the indicators of access to water supply and sanitation services: as of 2020, nearly 2 billion of persons had no access to safe water, and 3.6 billion persons had no access to sanitation [29]. These indicators included in UN SDGs are subject to annual monitoring on line of SDG 6 [27].

The international statistics of water resources reveal water-related challenges, with some raising special concern, namely:

1) the increasing demand for water, caused by demographic pressure, urbanization and economic development, especially in developing countries;

2) the degrading quality of water: pollution of rivers, lakes and underground waters, caused by

agriculture, industrial discharges and ineffective sanitation;

3) the increasing frequency and intensity of extreme weather phenomena (droughts, floods) resulting from climate change, which makes water supply less predictable;

4) competition between sectors (agrarian, energy, municipal), aggravating the problem of equitable distribution of resources, especially amidst a limited supply.

These challenges require a holistic approach to accounting, governance and politics pertaining to water resources.

Conclusions. Water resources have crucial importance for national and global economy, being a necessary condition for operation of key sectors and life activity support. Nowadays, when the global humanity faces the ever more acute challenges – the growing demand for water, water scarcity, pollution of water sources and climate change – issues of rational management of water resources are gaining special importance. These challenges cannot be addressed without reliable, comprehensive and regular statistical information enabling for the assessment of the real condition of water resources, their use and environmental risks.

International practices have produced a robust methodological toolkit for statistical accounting of water. In particular, UN standards SEEA-Water and IRWS enable for incorporating environmental and economic dimensions of water use in an integrated national accounts system. Classifications of water by type, renewability, source and purpose help create a multidimensional landscape of water resources, required for in-depth analyses, decision-making and cross-country comparisons.

However, the modern theory emphasizes that the water accounting is not a merely technical procedure for data collection, but an important component in the global governance process. The concepts of water stress, virtual water, water footprint, shared management and full value of water could have a significant impact on setting policies and indicators used nowadays by governments and international organizations. The abovementioned demonstrates that statistical accounting and classification of water resources are basic components of water security, social equity, and sustainable development. Hence, the development of statistical accounting of water resources has to rely upon international standards, local community engagement, data openness and interdisciplinary approach. This will ensure an effective governance of water ecosystems amidst the increasing global instability and limited natural resources.

Further studies will be focused on improvements in the statistical accounting of water resources.

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Статистичний облік і класифікація водних ресурсів

У статті досліджується роль статистичного обліку та класифікації водних ресурсів у забезпеченні сталого розвитку, екологічної рівноваги та економічної безпеки. Вода є не лише базовим елементом природного середовища, а й критичним чинником економічної діяльності, що визначає функціонування таких ключових секторів, як сільське господарство, промисловість, енергетика та міська інфраструктура. В умовах глобальних викликів – дефіциту прісної води, погіршення її якості, кліматичних змін і зростання водного стресу – особливого значення набуває створення системи достовірного статистичного обліку, яка дозволяє кількісно й якісно оцінювати стан водних ресурсів, рівень їх використання, ефективність управління та ризики деградації.

У роботі проаналізовано основні міжнародні підходи до статистичного обліку води, зокрема системи SEEA-Water та IRWS, які забезпечують інтеграцію гідрологічних і економічних показників у єдину систему національних рахунків. Окрему увагу приділено концептуальним засадам оцінки водних ресурсів як економічного активу, зокрема поняттям "водний стрес", "віртуальна вода", "водний слід", "повна вартість води" та "поліцентричне управління".

Обґрунтовано необхідність розвитку комплексної системи індикаторів сталого водокористування, що охоплює показники водоємності, дефіциту, рівня забруднення та надійності водопостачання. Такий підхід дозволяє не лише відстежувати динаміку змін у використанні води, а й підтримувати прийняття обґрунтованих управлінських рішень на національному та міжнародному рівнях.

Значну частину дослідження присвячено аналізу класифікацій водних ресурсів. Розглянуто міжнародні підходи до класифікації за критеріями поновлюваності, джерела, географії, якості та напрямів економічного використання. Крім того, представлено вітчизняну систему класифікації, яка враховує правовий статус водних об'єктів, форму існування, належність до водного фонду, економічне призначення й особливості бухгалтерського обліку на підприємствах.

Дослідження підкреслює потребу гармонізації національної статистики з міжнародними стандартами, а також інституційної відкритості, залучення громад до обліку та створення єдиної системи моніторингу водних ресурсів як основи для забезпечення водної безпеки та стійкого розвитку.

Ключові слова: *водні ресурси, статистичний облік, водний слід, класифікація водних ресурсів, сталий розвиток, індикатори, управління ресурсами, міжнародні стандарти.*

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