Water valuation at a global scale: how can we add water to the wealth of the nations using the SNA and SEEA?

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Questions to London Group

The purpose of this document is to outline potential approaches to value water for 150 or more countries. This is to determine how water could be added to the list of natural capitals included in the World Bank's Changing Wealth of Nations database.

To help determine the best way to estimate the value of water, we would appreciate comments or answers to the following questions:

1. Do you agree that the most feasible approach to value water value in the short term is using ecosystem service flows based on SEEA Ecosystem Accounting?
2. Are there approaches to water valuation other than those considered in the report?
3. Are there environmental or economic data sources and methods or tools other than those identified in the report?
4. How could the problem of double counting the value of natural capital based on ecosystem service flows be addressed? For example, the value of a forest might be based partly on the value of the water-related ecosystem services of water supply and water filtration and renewable energy includes hydropower which uses water.
5. To what extent do you think including water value in estimates of national wealth would:
    - Encourage uptake of the System of Environmental-Economic Accounting?
    - Be useful to national economic or environmental policy and management?

[1] https://www.worldbank.org/en/publication/changing-wealth-of-nations

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1. Introduction

"What is water worth? There is no easy answer to this deceptively simple question. On the one hand, water is infinitely valuable – without it, life would not exist. On the other, water is taken for granted – it is wasted every single day."

Audrey Azoulay, Director-General of UNESCO

This quote from the Foreword to the *World Water Development: Valuing Water* (UN 2021) captures both the challenge of water valuation and a key motivation for water valuation. The underlying logic is that if we value water, then water may be used more carefully and not wasted.

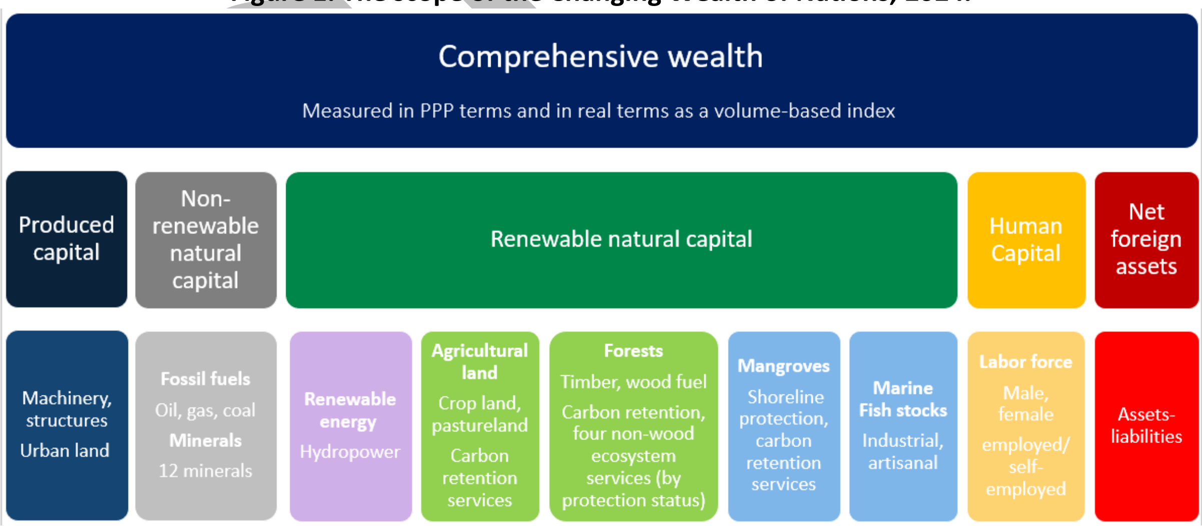
The use of water in human activity is increasing around the world due to the growing population and economy. Compounding the problem of increased water use is that the availability of water is changing due to climate change, historical overuse of groundwater, and declining water quality. Understanding the uses and values of water and how these are changing over time should lead to more effective water policy and management. Estimating water value and adding it to *The Changing Wealth of Nations (CWON)* would help to make clear the importance of water to the economy and embed water into macroeconomic thinking.

The CWON aims to account for the wealth of nations by providing comparable monetary measures of natural capital and other asset classes, grounded in the balance sheet approach of the System of National Accounts (SNA) and its extension, the System of Environmental-Economic Accounting (SEEA).

2. Background

Several natural capital assets are already included in CWON (Figure 1). The CWON's wealth accounts are designed to provide comparable monetary measures of natural capital and other asset classes, grounded in the balance sheet approach of the System of National Accounts (SNA) and its extension, the System of Environmental-Economic Accounting (SEEA).

Figure 1. The scope of the Changing Wealth of Nations, 2024.



The natural capital assets used in CWON are equivalent to the environmental assets defined in the SEEA Central Framework (See Section 2). In the SEEA Central Framework environmental assets are defined as "*the naturally occurring living and non-living components of the Earth, together constituting the biophysical environment, which may provide benefits to humanity*" (SEEA Central Framework, para. 2.17).

2.1 Water valuation

Water valuation is contentious (e.g., Schmidt 2019, d'Odorico et al. 2020) and arises because of the characteristics of water and its use in the economy (UN 2012a&b, Young 1996, Fenichel et al. 2016, Grafton et al. 2020, Wheeler et al. 2023). Key characteristics include:

1. *Water is a heavily regulated product* for which the price charged (if any) often bears little relation to its economic value or even the cost of supply. This situation is more common in water-scarce low-income countries where water may be supplied to some users at no charge. Such practices occur in part because the natural characteristics of water inhibit the emergence of competitive markets that establish economic value.
2. *Water supply often has the characteristics of a natural monopoly* because water storage and distribution have economies of scale.
3. *Where and when water is scarce the water may be rationed* or there are restrictions on particular types of uses (e.g. parks and gardens are not permitted to use water).
4. *Property rights*, essential for competitive markets, *are often absent* and not always easy to define when the uses of water exhibit characteristics of a public good (e.g., flood mitigation), a collective good (e.g., a sink for wastes), or when water is subject to multiple and/or sequential uses (e.g., first hydropower and then irrigation).
5. *Water is a "bulky" commodity* with its weight-to-value ratio very low, inhibiting the development of markets beyond local areas.
6. *Large amounts of water are abstracted for own use by sectors other than those under ISIC Division 36* (water collection, treatment, and supply), such as agriculture, mining, and energy (See Section 1.3 for definitions of industries and sectors). Water abstraction for own use, while theoretically in the scope of the SNA in practice it is not. As such own use of water is not necessarily recorded as an input to production, hence, the use of water by an industry and the value of water to an industry may be underestimated. For example, the value of water's contribution to agricultural production and agriculture land, is not explicit but is embedded in the operating surplus of the agricultural industry and the value of land.

Because of these factors, the observed values of water, and in particular the water supplied by the water supply industry which is usually done "at cost" is not a true representation of exchange values and the net present approach commonly used for natural resources in the SNA is not possible. As such, alternative valuation methods are needed.

3. Water valuation options for CWON

The valuation of water assets for the CWON can be approached from at least three perspectives: (1) asset-by-asset, (2) use-by-use, and (3) ecosystem service by ecosystem service (or service-by-service) Further details on these approaches follow.

3.1 Asset-by-asset

This approach is based on the SNA.

The direct value of water assets is not usually observed in markets. However, while the water assets themselves are not traded, their value can be determined through the value of rights associated with water. For example, water rights are a "*permit to use a natural resource*" within the SNA (paragraph 17.324), and are distinct from the value of land (Comisari and Vardon 2013). A "*permit to use a natural resource*" is a type of financial asset in the SNA (paragraph 3.36)

While a financial asset, in the SNA the value of the water rights traded can be taken to represent the value of the physical water asset that underpins the financial asset. While some countries and regions have tradeable water rights – for example, Australia, Chile, Iran, South Africa, and parts of the USA (UN 2021) – the use of these for valuing water is not feasible for countries without water rights, which is most countries. There is also concern about the functioning of some markets for water rights (Garrick et al 2020). As such the use of water rights to value water assets is not feasible in the short term, except for the few countries with water rights.

Land is traded in most, if not all, countries. The SNA includes "*Water associated with land*" as part of the asset "land" and relates to "*any inland waters (reservoirs, lakes, rivers, etc.) over which ownership rights can be exercised and that can, therefore, be the subject of transactions between institutional units*" (2008 SNA, paragraph 10.175.). While not specifically mentioned, soil water is also part of the land in the context of the SNA, and soil water can only be accessed via land, for example by the growing of rain-fed crops (Comisari and Vardon 2012). Hedonic pricing could be used to decompose the value of land into the value of water and land. This has been done at local levels (e.g., Moore et al. 2020). However, the amount of data needed for hedonic pricing is large. The information needed would be on the price of land traded, the total area of land able to be traded[2], the physical characteristics of the land including the level of rainfall, the value of economic production on the land and other economic factors such as proximity to transport infrastructure.

The data for this would need to be obtained for each country and would have to be built "bottom-up". The data requirements for this represent a significant barrier to estimating the value of water assets using hedonic pricing and hence this approach to valuing water assets is unsuitable for large scale valuation (i.e. of water assets in 150 or more countries).

3.2 Use-by-use

This approach is based on the SEEA Central Framework.

The use-by-use approach is a bottom-up approach. It would be done country-by-country using assessments of water use by different industries – agriculture, mining, manufacturing, energy, water supply, education, health, etc. – with water as one input to production. In this, the value of the water used is embedded in the value added by each industry, rather than just the price paid per unit volume used (which may be zero in the case of the use of "green" water in rain-fed agriculture). The use-by-use approach requires information from the SNA on industry value added and intermediate consumption, and the amount and source of water used by each industry and the households. SEEA water supply and use tables of the SEEA provide this information. However, these are only available for a handful of countries at the level of detail needed for this approach (Vardon et al. 2023). Because of this, a use-by-use approach based on SEEA water supply and use tables is not feasible for 150 countries at this time.

A partial estimate based on the use of water in agriculture would be possible, with the use of global hydrological models, information on the value of agricultural commodities produced, and the costs associated with this production. This approach is like that already used to value agricultural land in CWON. If a partial estimate of the value of agricultural water use was made, then the value of this would probably need to be deducted from the value of agricultural land to prevent double-counting.

3.3 Service-by-service

This approach is based on SEEA Ecosystem Accounting.

Ecosystem services come from ecosystem assets. Ecosystem assets, and their relationship to natural resources as defined in the SEEA Central Framework and are shown in Annex 1. The water-related ecosystem services listed in the SEEA Ecosystem Accounting are:

[2] Note all land can be traded. For example the area of land in national parks.

- **Water supply services** reflect the combined ecosystem contributions of water flow regulation, water purification, and other ecosystem services to the supply of water of appropriate quality to users for various uses including household consumption.
- **Water purification (water quality regulation) services** are the ecosystem contributions to the restoration and maintenance of the chemical condition of surface water and groundwater bodies through the breakdown or removal of nutrients and other pollutants by ecosystem components that mitigate the harmful effects of the pollutants on human use or health.
- **Water regulation (baseline flow maintenance) services** are the ecosystem contributions to the regulation of river flows and groundwater and lake water tables. They are derived from the ability of ecosystems to absorb and store water, and gradually release water during dry seasons or periods through evapotranspiration and hence secure a regular flow of water.
- **Water flow regulation (peak flow mitigation services)** are the ecosystem contributions to the regulation of river flows and groundwater and lake water tables. They are derived from the ability of ecosystems to absorb and store water, and hence mitigate the effects of flood and other extreme water-related events. Peak flow mitigation services will be supplied together with river flood mitigation services in providing the benefit of flood protection. This is a final ecosystem service.
- **Flood control (river flood mitigation) services** are the ecosystem contributions to the regulation of river flows and groundwater and lake water tables. They are derived from the ability of ecosystems to absorb and store water, and hence mitigate the effects of floods and other extreme water-related events. Peak flow mitigation services will be supplied together with river flood mitigation services in providing the benefit of flood protection.
- **Nursery population and habitat maintenance services** are the ecosystem contributions necessary for sustaining populations of species that economic units ultimately use or enjoy either through the maintenance of habitats (e.g., for nurseries or migration) or the protection of natural gene pools. This service may be an input to several different ecosystem services including biomass provision and recreation-related services (e.g., for fish harvested from rivers or lakes).
- **Recreation-related services** are the ecosystem contributions, through the biophysical characteristics and qualities of ecosystems, that enable people to use and enjoy the environment through direct, in-situ, physical, and experiential interactions with the environment. This includes services to both locals and non-locals, i.e., tourists, (e.g., canoeing on a river).
- **Visual amenity services** are the ecosystem contributions to local living conditions, through the biophysical characteristics and qualities of ecosystems that provide sensory benefits, especially visual (e.g., views of a river or snow, ice, and glaciers). This service combines with other ecosystem services, including recreation-related services and noise attenuation services to underpin amenity values.
- **Spiritual, artistic, and symbolic services** are the ecosystem contributions, through the biophysical characteristics and qualities of ecosystems, that are recognized by people for their cultural, historical, aesthetic, sacred, or religious significance. These services may underpin people's cultural identity and may inspire people to express themselves through various artistic media.

The water supply service is directly liked to water-related ecosystem assets (rivers, lakes, artificial reservoirs). An intermediate service of water purification contributes to value of the final ecosystem service of water supply but is not necessarily supplied by the water-related ecosystem assets. For example, a water filtration service is provided by forests. The value of other water-related ecosystem services could also be included but are not considered further in this paper.

A service-by-service approach is already used in CWON. Siikamäki et al. (2023) produced an estimate for the value of forests using ecosystem services using prices derived from a meta-analysis. The report included the value of four water-related ecosystem services: (1) climate regulation, (2) erosion control, (3) flood protection, (4) hydropower and (5) water services in the value of forests, and represents a service-by-service approach. These services were aligned with the reference list of services in the SEEA Ecosystem Accounting and related methods.

The assessment of forest value by Siikamäki et al. (2023) identified a total of 47 papers including four water-related ecosystem services, with 27 papers on water-related services, which includes water supply and water purification (filtration). Some of the studies used the contingent valuation method, which by themselves are not consistent with the concept of exchange value, but when these values are used an input to the simulated exchange method may be used (NCAVES and MAIA 2022). The estimates in Siikamäki et al. (2023) reviewed the studies that used contingent valuation to ensure they were consistent with the concept of exchange value.

The ecosystem service-by-service approach can be, and in the case of forests has been, used to generate values for the natural capital assets (Siikamäki et al. 2023). This approach could be extended to all other ecosystem assets (i.e., ecosystems beyond forests) including water-related ecosystem assets like surface water and groundwater.

A complication with estimating the physical volume of water-related ecosystem serices, is ome popular models, like InVEST, used to estimate the water supply ecosystem service are not fully aligned with the SEEA ecosystem services definition as these estimate the potential supply of water (essentially run-off) not the use of water by industries and sectors.

If an ecosystem service approach is used to value water assets, then the number and type of ecosystem services that contribute to value need to be determined. If the valuation is based on the single ecosystem service of water supply, then it would in theory be equal to the value calculated by the use-by-use approach, since the water supply ecosystem service is equivalent to the amount of water abstracted for use (Vardon 2022). It is important to note that the use of “green” water in agriculture is already included in the value of agricultural land and hence a possible source of double counting. If the valuation of ecosystem services extends to other ecosystem services, for example recreation-related services, then the value of the water assets will be greater than the use-by-use approach as more factors are contributing to water value.

3.4 Double counting

Whatever approach to the valuation of water assets is taken there is likely to be double counting of value within the natural capital assets.

The double counting of the value of water assets would occur in the valuation of forests, agricultural land, and renewable energy. The forest valuation explicitly includes the value of water-related ecosystem services (Siikamäki et al. 2023), while the value of water is embedded in the value of agricultural products used to value agricultural land (Gerber et al. 2020). The value of soil water used for agricultural production is also included in the value of land in the balance sheet of the SNA. The valuation of renewable energy, which is planned to be included in the next CWON, will also include the value of water in the generation of hydroelectricity.

Another source of double counting would arise if an ecosystem service approach is adopted and the final and intermediate ecosystem services are not distinguished. It is usual for the final ecosystem service of water supply to use the intermediate service of water purification, which could result in double counting.

4. Data sources. methods and tools

A range of data sources, methods and tools have been identified that could be used to estimate water value.

4.1 Valuation methods

The SEEA Ecosystem Accounting provides a list of five valuation methods of the value of natural resources and ecosystem services that are consistent with exchange values (UN et al. 2021). These methods are, in the order of preference, methods where the price is:

1. directly observable
2. obtained from markets for similar goods and services
3. embodied in a market transaction
4. based on revealed expenditures (costs) for related goods and services,
5. based on expected expenditures or markets

The first valuation method is problematic for several reasons (UN, 2012a). Firstly, water is an essential good, so while water is transacted in markets, the price of distributed water for drinking ("potable water" or "tap water") or industry use (e.g., irrigated agriculture) is almost always subsidized. Secondly, water supply authorities are mostly state-owned enterprises not seeking to maximize profit but to provide an essential service. It is usual for the water to be provided "at cost", that is the payments made reflect only the capital and running costs, and no payment is made for the water (e.g., Wheeler et al. 2023). In many cases, water is provided for use at less than cost. This results in zero or negative resource rents, implying no value (e.g., Obst et al. 2016). While the methods based on observable prices are problematic, the observed values can at least be recorded, and this has been done by several countries and presented in SEEA-Water monetary supply use tables (e.g., for Australia, Netherlands, and Zambia).

For many countries, and in particular, in low- and middle-income countries, water is "self-supplied". That is, rather than water being supplied to people and industries (including agriculture) via a water distribution network, people and industries extract water from wells, rivers, and lakes or collect rainwater in tanks and dams. This is own account production and while theoretically in the scope of the SNA (Section 1.3) and water abstraction may be regulated by formal (e.g., water licensing of well and bores) or informal means, in practice it is not usually recorded in the SNA.

Because the observed prices are distorted and own account production may be missing, alternative methods for water valuation are required. The need for such methods is recognized in the SEEA Ecosystem and such methods for water-related ecosystem services are outlined by NCAVES and MAIA (2022). For the water provisioning and water purification services, at least four methods are possible:

1. **Productivity change**. For water provisioning, this is done using partial and general equilibrium models and looking at the impacts of a reduction in the supply of water to the output in different sectors of the economy (e.g., Calzadilla et al. 2013, Roson and Damania 2016; Mul et al. 2020).
2. **Replacement cost methods**. For water provisioning, this is where a source of water is valued based on the cost of obtaining the water from the next lowest cost source (adjusted for water quality) (e.g., Edens and Graveland 2013, Keith et al. 2017). An example would be using the cost of providing water through desalination. For water purification, this would be the capital (i.e., infrastructure) and running costs of purifying water to the same level of water quality (e.g., La Notte et al. 2012, Schenau et al. 2022)
3. **Value of water rights.** For water provisioning, this is where they are separately identified (from land values), and trading in water rights takes place such that a market is established. These rights are financial assets and may be connected to a permanent right to abstract water or year allocation of water (Comisari and Vardon 2013)
4. **Avoided damage costs**. For water purification, this is the reduction in water purification and treatment costs that arises from having the ecosystem service.

The damage to human health from water pollution (hence lack of water purification service) is another potential approach that has been used in accounting (e.g., Angeles and Peskin 1998) and in accordance with the notion of exchange values (i.e., it is a type of avoided loss).

There are a range of source and online databases for the valuation of ecosystem services and water. For example, a review of water valuation literature (EPA 2017), Valuing Water Database[3], the TEEB Valuation Database[4], and the Ecosystem Services Valuation Database[5]. These sources can be investigated and any studies on water valuation could be used in a meta-analysis building on the work of Siikamäki et al. (2023).

4.2 Global data sources and tools

With ready-made country level information unavailable for most countries on water assets, water use and water-related ecosystem services, then global data and methods need to be investigated. These data sources and methods could be applied to the use-by-use or service-by-service approaches.

Kind et al. (2020) examined the feasibility of valuing water using the currently available global water databases and hydrological models for estimating the physical quantities of water. A list of global water databases and hydrological models is found in Table 2. Since the review by Kind et al (2020), additional data sources and methods have become available, including an upgrade of the WA+ platform (Box 1), the development of ARIES for SEEA[6] (Box 2), and updates to IBNET (World Bank 2022). Further investigation is needed to determine the suitability and these data sources and models for the use-by-use or service-by-service approaches. Once the physical quantities of water are estimated, a price needs to be applied (see Section 4.1).

Box 1 Water Accounting Plus

Water accounting plus (WA+) is an open-access platform developed for basin-level water accounting (Karimi et al. 2013). The framework was developed by the IHE Delft Institute for Water Education, the International Water Management Institute, and the UN Food and Agricultural Organisation. The WA+ combines remotely sensed data with global data sets and ground measurements to produce standardized tables, graphs, indicators, and maps.

The WA+ framework is primarily depletion water accounting that tracks water consumption. It has, however, much in common with the SEEA and is focused on basin-level hydrological processes. The abstraction (withdrawal) of water for use in the economy is recorded, with the amount of water used recorded by land use category and measured by tracking evaporation in space and time. In this water is shown as abstracted and consumed by agriculture, industry, and domestic users. Industry may be equated with all industries other than agriculture used in the SEEA and domestic is equivalent to the household sector. The framework does not directly link to related economic data, but the data sources and methods can, and are, used to construct SEEA-based accounts and in particular the asset account and to estimate the use of soil water by agriculture.

A key feature of WA+ is that it is an integrated modeling system, providing a framework along with data and methods that enable the framework to be populated. The framework comes with a glossary[7], supported by a range of online material and references[8], and an open-access online course.[9]

[3] https://ceowatermandate.org/resources/valuing-water-database-2019/
[4] https://teebweb.org/publications/other/teeb-valuation-database/
[5] https://www.esvd.net/
[6] https://seea.un.org/content/aries-for-seea
[7] https://wateraccounting.un-ihe.org/wa-definitions-glossary
[8] https://wateraccounting.un-ihe.org/publications-0
[9] https://wateraccounting.un-ihe.org/capacity-building

Table 2. Global water databases and hydrological models

	AQUASTAT	EUROSTAT	OECD. Stat	WISE	WRR	UNSD	Water Risk Filter	WASH
Publisher	FAO	European Commission	OECD	EEA	WRI	UN	WWF	UNICEF/WHO
Geographic coverage	Global	Europe	Global	Europe	Global	Global	Global	Global
Spatial resolution	National/ Regional	National/State/ RBD	National	National, RBD, Sub-unit	Regional, National	National	Sub-basins	National
Time coverage	1958-2017	1970-2016	1970-2016	2002-2012	1959-2011 + future projections	1990-2016	2000 – present + future projections	1950-2019
Relevant variables	• Sectoral surface water abstracted • Groundwater abstracted • Fresh water abstracted as the proportion of	• Sectoral surface water abstractions • Fresh groundwater abstracted • Renewable freshwater resources	• Renewable freshwater resources • Total water abstractions • Return flow • Water use	• Sectoral water abstractions • Water use per supply category and economic sector	• Renewable freshwater resources • Annual water withdrawals • Water stress Index • Modelled water availability and use for	• Sectoral water abstracted • Net freshwater supplied • Renewable freshwater resources	• Renewable freshwater resources • Water scarcity • Aridity • Water depletion • Baseline water stress	• Proportion of population using: • drinking water services • sanitation services • piped drinking

	AQUASTAT	EUROSTAT	OECD. Stat	WISE	WRR	UNSD	Water Risk Filter	WASH
	renewable water • Renewable freshwater water resources				current and future climate conditions		• Access to safe drinking water • Future water discharge and water stress	water sources • sanitation facilities connected to sewer networks
Main data sources	• National Statistical Institutes • Modelled values • Eurostat/ UNSD/OECD	• OECD/Eurostat Joint Questionnaire • National Statistical Institutes • Agricultural institutes • Universities	• OECD / Eurostat Joint Questionnaire • National Statistical Institutes • AQUASTAT	• Obligated National WFD reports of EEA member countries and cooperating countries	• AQUASTAT / PCR-GLOBWB and other sources	• National Statistical Institutes • UNSD/UNEP Questionnaire • AQUASTAT	• OECD • CGIAR • WRI • WaterGAP • UN IGRAC • UNICEF / WHO • Various scientific publications	• National Statistical Institutes

Source: Kind et al. 2021

Box 2 ARIES for SEEA

Artificial Intelligence for Environment and Sustainability (ARIES) was developed by the Basque Centre for Climate Change (BC3) and is an application using a suite of models for estimating ecosystem services based on available data and open-source software (k.LAB[10]). ARIES for SEEA was developed in a partnership between the UN and BC3 and provides a user interface to compile SEEA-based ecosystem accounts. The ARIES application specifically considers the users (or beneficiaries) of ecosystem services which sets it apart from other ecosystem service models like InVEST[11], which do not use a definition of ecosystem services compatible with SEEA. The ARIES for SEEA application can produce accounts and related maps for ecosystem extent, ecosystem condition, and selected ecosystem services. The ecosystem services currently available in ARIES for SEEA are crop provisioning, climate regulation, and soil erosion control. Crop provisioning and climate regulation and both available in physical and monetary terms, while only a physical estimate of erosion control is available. Nature-based tourism is planned to be added soon. The addition of the water supply ecosystem service in physical terms is currently being investigated based on the approach of Fasel et al. (2016) (Ken Bagstad, pers. com). ARIES for SEEA uses the global ecosystem[12] and land cover classifications recommended in SEEA Ecosystem Accounts.

5. Conclusion

This report confirms the findings of past research – there are theoretical and practical challenges to estimating water value. We know that water is valuable, but it is difficult to monetize water assets. In this the prices paid for water are distorted, the methods for water valuation are many and reflect different concepts of value, while data deficiencies and model assumptions mean that estimates of value will be uncertain.

While there are challenges, three approaches for estimating water value consistent with the value of the other natural capital assets in the CWON were identified: (1) asset-by-asset, (2) use-by-use, and (3) service-by-service. These correspond to the approaches in SNA, SEEA Central Framework, and SEEA Ecosystem Accounting respectively.

The service-by-service approach is the most feasible at the scale required. This approach relies on incomplete environmental and economic data, a meta-analysis of valuation studies, and global models using many assumptions probably resulting in low-quality estimates. New data sources and models are in development and expected to be available in the near future which should lead to higher quality estimates. The use-by-use approach is possible but problematic. Data are only available for a small number of countries and uses (agriculture, hydroelectricity, households) at this stage. Going forward, the increasing adoption of SEEA by countries should make this approach more feasible. The asset-by-asset approach, which uses the value of tradable water rights or separates the water value from land value (e.g., hedonic pricing), is currently not possible due to a lack of information.

6. Next steps

To move forward with water valuation at a global scale, a combination of the use-by-use bottom-up and service-by-service top-down approaches could be used to generate estimates for discussion. This would stimulate interest in the broader natural capital, water, and accounting communities by providing experimental estimates of water value as well as case studies to help understand the regional variation in water value. This would aid the:

[10] https://integratedmodelling.org/hub/#/register
[11] Integrated Valuation of Ecosystem Services and Trade-offs https://naturalcapitalproject.stanford.edu/software/invest
[12] IUCN Global Ecosystem Typology https://portals.iucn.org/library/node/49250

- **Discovery of additional data sources and methods for water valuation** to assist with estimates based on the three approaches identified in this report. International agencies, countries and research organizations hold a wealth of data and methods and not all of these have been identified.
- **Identification of other possible approaches to water valuation** not considered in this report.
- **Development of partnerships** to leverage the use of existing knowledge, identify data gaps and deficiencies, and seek additional resources for improving data sources for estimating the value of water in a systematic and comprehensive manner.
- **Promote the collection of data and methodological innovation** to enable reliable estimates of water value to be regularly produced.

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Annex 1. Comparison of the asset classifications in SEEA Central Frame, SEEA Water and SEEA Ecosystem Accounting

SEEA Central Framework and SEEA Water	SEEA Ecosystem Accounting	Notes for determining the scope and definitions of water assets for valuation
Surface water • Rivers and streams • Lakes • Artificial reservoirs • Snow, ice and glaciers	Freshwater • F1 Rivers and streams • F2 Lakes • F3 Artificial reservoirs[13] • T6 Polar-alpine (cryogenic)	Direct correspondence between SEEA Water, SEEA Central Framework and SEEA Ecosystem Accounting
Groundwater	• SF1 Subterranean freshwater • SF1 Anthropocentric subterranean freshwater • FM1 Semi-confined transitional waters	SEEA Ecosystem Accounting sub-divides groundwater into three classes. In the SEEA Water and SEEA Central Framework groundwater includes all of these sources and could be similarly divided.
Soil water	• Water use in rainfed agricultural and cultivated forest ecosystems	The SEEA Water and Central Framework only identifies soil water, which is found in all ecosystem types with soil. However, in practice the use of soil water is only estimated for rain-fed agricultural ecosystems. The use of soil water can be shown by the ecosystem types used in the SEEA Ecosystem Accounting.
	Transitional • TF1Palustrine wetlands • MFT1 Brackish tidal systems	The SEEA Water and Central Framework does not explicitly recognize these assets although water assets consist *"of fresh and brackish water in inland water bodies, including groundwater and soil water"* (SEEA Central Framework para 5.474) and these would likely be recorded as abstractions from surface water (i.e. lakes)
Seas and oceans	Marine • M1 Marine shelf • M2 Pelagic ocean waters • M3 Deep sea floors	The SEEA Water included seas and oceans as a source of water for desalinization and cooling water as well as a receiving return flows from the economy and river outflows. The ocean accounts described in SEEA Ecosystem Accounting do not consider marine ecosystems as a possible source of water.

[13] Artificial reservoirs include all human built water storages, from rainwater collection and small farm dams through to large artificial reservoirs (e.g., Hoover Dam, Kariba Dam, and Bhakra Nangal Dam)