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Accounting for Water and Water Ecosystem Services in the UK

Paul Ekins, Silvia Ferrini and Joe Grice

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DISCUSSION PAPER

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Abstract

Water is a fundamental resource for human life and life more generally. It, and the ecosystem services it provides, are under increasing pressure from human production and consumption activities. Such pressures, and their relationship to economic activities, can be tracked and monitored through water accounting through the UN-agreed System of Environmental-Economic Accounting (SEEA). This paper describes how this is done. The SEEA (Ecosystem Accounting) advises the creation of five accounts: extent, condition and ecosystem flow – all in physical terms – and ecosystem condition and stock – in monetary terms. The information in the asset and flow accounts may be expressed in supply-and-use tables in physical and monetary terms, which allows their articulation with the System of National Accounts (SNA). The paper discusses the European and UK experience of compiling water accounts and finds that it is patchy and in considerable need of further development in order to realise the accounting approach set out in the SEEA. It concludes with some thoughts about the relevance of this approach to water and broader environmental management in the UK.

Keywords: Water, water accounting, water ecosystem services, System of Environmental-Economic Accounting (SEEA), supply-use tables, water policy

JEL classification: Q25, Q56

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Accounting for Water and Water Ecosystem Services in the UK

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Note: The views in this paper are those of the authors and do not necessarily reflect the views of the ONS or any other organisation. In addition, it should be noted that this paper does not take account of the proposals or recommendations of the process that is updating the 2008 System of National Accounts (SNA 2025, see https://unstats.un.org/unsd/nationalaccount/towards2025.asp).

Abstract

Water is a fundamental resource for human life and life more generally. It, and the ecosystem services it provides, are under increasing pressure from human production and consumption activities. Such pressures, and their relationship to economic activities, can be tracked and monitored through water accounting through the UN-agreed System of Environmental-Economic Accounting (SEEA). This paper describes how this is done. The SEEA (Ecosystem Accounting) advises the creation of five accounts: extent, condition and ecosystem flow – all in physical terms – and ecosystem condition and stock – in monetary terms. The information in the asset and flow accounts may be expressed in supply-and-use tables in physical and monetary terms, which allows their articulation with the System of National Accounts (SNA). The paper discusses the European and UK experience of compiling water accounts and finds that it is patchy and in considerable need of further development in order to realise the accounting approach set out in the SEEA. It concludes with some thoughts about the relevance of this approach to water and broader environmental management in the UK.

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Introduction

Water has played a pivotal role in the historical development and settlement of human civilizations. In fact, water remains a critical resource for human survival, economic growth, and environmental health. Water management and distribution have made significant progress over time although improving efficiency in water usage is still a key issue for many industries.

Although water is a textbook renewable resource, water is one of several 'planetary boundaries' that are at risk, as a result of which humans might experience severe consequences for health, agriculture, industry, and ecosystems (Rockström et al., 2009; Richardson et al., 2024; Global Commission on the Economics of Water, 2024). UNESCO (2021) reports that one in ten people access unsafe water worldwide and Jacobsen et al. (2024) highlight that western societies are facing emerging water risks due to pollution (e.g. nitrates, PFAS - per- and polyfluoroalkyl substances). Furthermore, innovation and technologies can heavily rely on water availability (e.g. https://www.forbes.com/sites/cindygordon/2024/02/25/ai-is-accelerating-the-loss-of-our-scarcest-natural-resource-water/; https://oecd.ai/en/wonk/how-much-water-does-ai-consume), which may not be adequately available under standard water management approaches.

Despite these risks, efforts aimed at the global mapping, accounting and economic valuing of Water Ecosystem Services (WES) are still few (Vardon et al. 2023, Vardon et al. 2025), limiting the evidence that governments and decision-makers can access to design sustainable water management pathways. Yet, in principle, robust water accounting could strengthen the social understanding and management of water resources and WES, and could support the measurement and monitoring of SDGs and prioritize interventions in water-stressed regions.

In the UK there are targets for 'clean and plentiful water' as part of the UK Government's 25-Year Environment Plan, with annual monitoring of the targets part of the responsibility of the Office for Environmental Protection (OEP). Once adequately developed, natural capital accounting could play a key role in helping the OEP discharge this responsibility, as discussed further below.

This review outlines the development of economic and environmental accounting at the international level, and describes how this has been applied to water at the global and European levels. It then discusses the progress with such accounting in the UK and how this might help to inform UK policy making in this area.

International Economic and Environmental Accounting

Development.of.the.System.of.Environmental.Economic.Accounting.(SEEA)

Countries have sought to keep track of their economic development through national accounts since the 1940s and 1950s, with the UN Statistical Commission publishing the first System of National Accounts in 1953. In the decades that followed the SNA was subject to continual revision and development, with new versions of the SNA published in 1968, 1993 and 2008[1]. The next revision is due in 2025. With this development has come much increased complexity: the 1953 SNA consisted of 48 pages; the latest 2025 SNA draft comes to well over a thousand.

[1] https://unstats.un.org/unsd/nationalaccount/hsna.asp#:~:text=The%201953%20SNA%20was%20published,the%20flows%20in%20the%20economy.

As the awareness of the importance of the environment and environmental resources grew during the 1970s and 1980s, countries began to consider how to account for them, and how to relate environmental and resource accounts to their economic accounts. The first version of the UN System of Environmental-Economic Accounting (SEEA) was published in 1993 (SEEA-1993), on an interim basis as not all countries agreed with some of its aspects. A further version was published in 2003 (SEEA-2003), but it was not until 2012 that the SEEA - Central Framework (SEEA-CF) became an internationally agreed statistical standard.

SEEA-CF "brings together, in a single measurement system, information on water, minerals, energy, timber, fish, soil, land and ecosystems, pollution and waste, etc."[2], so that its main focus is on assets (stocks) and the physical flows that arise from them.

Both SNA national accounts and the SEEA accounts are of integrated stock flow form. That is, they embrace both stocks – produced capital and natural capital respectively – and flows – GDP and its components, ecosystems and ecosystem services, again respectively. These accounts ensure such stocks and flows are recorded consistently. The change in the stock is essentially the investment in the capital less the depreciation thereof, adjusted for revaluations.

Both the stocks and flows are of policy relevance. What is happening to stocks gives key information about sustainability. Is enough being invested in produced capital and natural capital to maintain a sustainable position? What is happening to flows – gross value added for the national accounts and ecosystem services in the natural capital accounts – communicates what benefits humanity is receiving from produced and natural assets and how successfully these assets are being exploited to produce such valuable services.

The SNA and the SEEA are designed to be consistent. It is not just that the SEEA accounts give perspective on domains not covered by the SNA but they do so in a way which is mutually consistent and without overlap or duplication. So the result is not just two views of economic reality. Together, they give a wider but wholly consistent account of developments. Although it is crucial to mention that a further harmonization between SNA and the two SEEA frameworks (Central Framework and Ecosystem Account) is still ongoing due to the future revision of SNA and SEEA CF due in 2025 (e.g. Fermia et al 2024, La Notte et al. 2024).

SEEA-CF does not cover ecosystem services (ECSs) whereas SEEA-EA focuses on ecosystems and ECSs, a concept that emerged in 1997, and was central to the Millennium Ecosystem Assessment of 2005. In 2010, The Economics of Ecosystems and Biodiversity (TEEB) initiative defined ecosystem services as "the direct and indirect contributions of ecosystems to human wellbeing" (TEEB, 2010) and proposed a classification, but in 2013 the Common International Classification for Ecosystem Services (CICES) emerged to coherently cover more ecosystem services (about 55) than those identified in the TEEB (22). This newer classification of ecosystem services represents the basis for the EU natural capital initiatives discussed below. The study and classification of ecosystem services has become central to disciplines in natural science and environmental economics (Martin-Ortega et al., 2015).

Work began to incorporate ecosystem services in the SEEA, and the SEEA Experimental Ecosystem Accounts (SEEA-EEA) were published in 2013. Following further discussions and development, the SEEA-Ecosystem Accounts (SEEA-EA) were finally agreed internationally and published in 2021. The SEEA guidelines standardise how to monitor and assess ecosystems and

[2] https://seea.un.org/content/seea-central-framework

ecosystem services in biophysical terms. They also underline the value of monetising these estimates, so as to allow comparison across the accounts.

Water.in.SEEA

SEEA-2003 contained the first attempt to develop harmonised methodologies for water accounts, and this effort was further developed in subsequent years, culminating in the adoption in 2012 by the UN Statistical Commission of the System.of.Environmental_Economic.Accounting. for.Water.(SEEA-Water). In order to support the implementation of water accounting in 2017 the UN Statistical Division (UNSD) published SEEA: Technical Note on Water Accounting (SEEA-Water 2017) on the implementation of water accounting following the SEEA-CF.

The core documents for this application SEEA to the UK are SEEA-CF (2012), SEEA-Water (2012), SEEA-Water (2017) and SEEA-EA (2021). Although, these documents have paved the way to improve water management strategies, efforts are still needed to "clarify[ing] the status and relationship [between SEEA Water, SNA, SEEA CF and SEEA EA] providing more guidance on valuation and values, and linking these directly to water policy and management". (Vardon et al 2024, p.39)

Figure 1 shows the core flows and boundaries in the SEEA approach to water accounting.

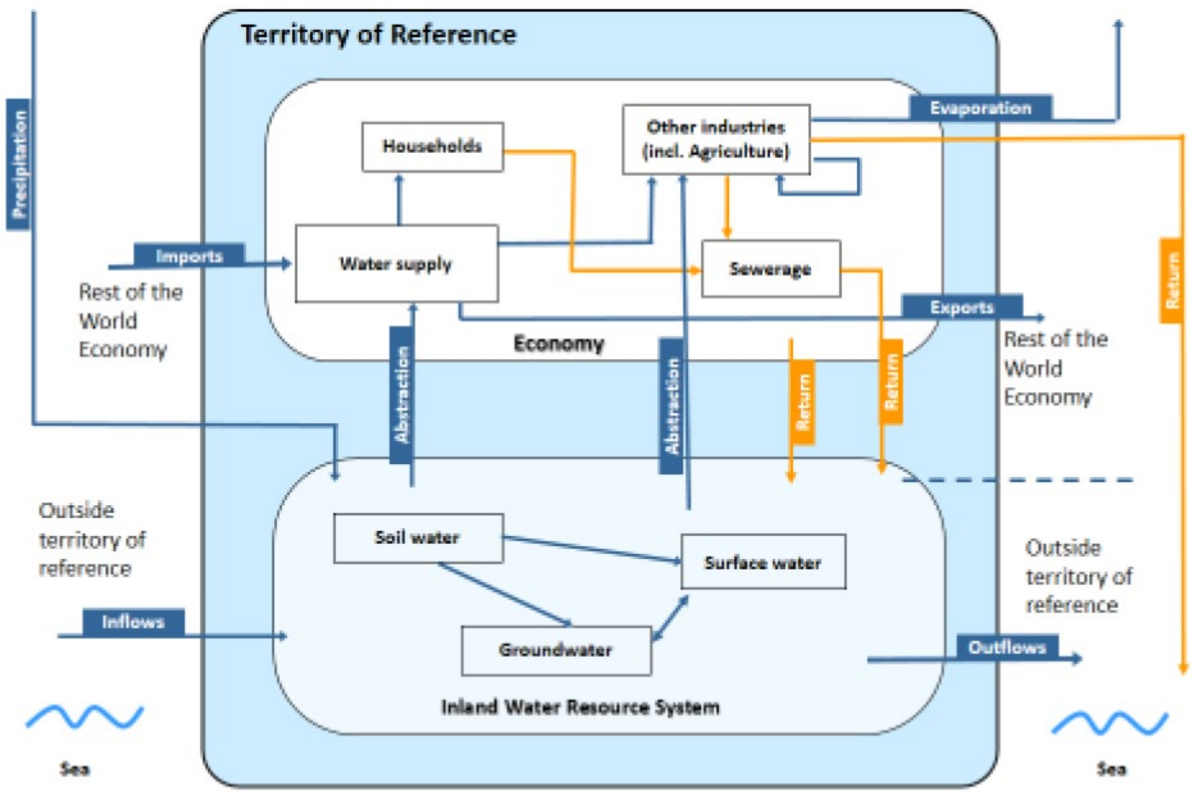

Figure 1: Flows of water within the Inland Water Resource System and between this and the Economy in the SEEA approach to water accounting

Source: SEEA-Water (2017), Figure 1, p.6

A rather more complex version, but arguably one more useful for water accounting, was produced by Vardon et al. (2023).

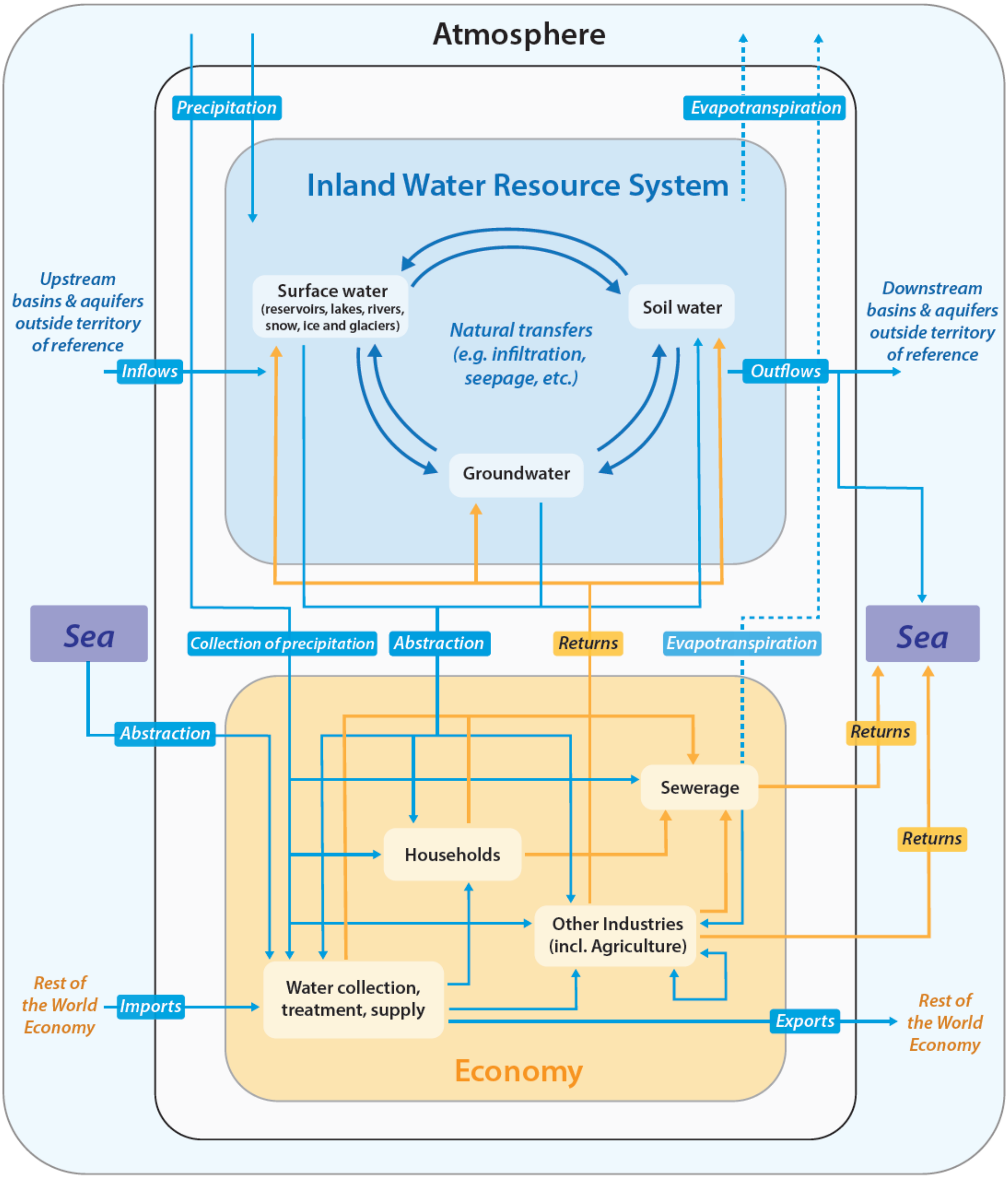

Figure 2: The scope of water accounting

Source: Vardon et al. 2023, Figure 4.1, p.17

On the basis of Figures 1 and 2, SEEA-Water (2012, para. 1.15) says that it includes "as part of its standard presentation, information on the following:

(a) Stocks and flows of water resources within the environment;
(b) Pressures imposed on the environment by the economy in terms of water abstraction and emissions added to wastewater and released into the environment or removed from wastewater;
(c) The supply of water and its use as an input in the production process and by households;

(d) The reuse of water within the economy;
(e) The costs of collection, purification, distribution and treatment of water, as well as the service charges paid by its users;
(f.) The financing of these costs, that is, who is to pay for the water supply and sanitation services;
(g) The payment of permits for access to abstract water or to use it as a sink for the discharge of wastewater;
(h) The hydraulic stock in place, as well as investments in hydraulic infrastructure made during the accounting period."

Following agreement on the SEEA-EA (2021), it also now includes:

- Water quality and water pollution.
- The economic valuation of water resources.

Water.accounts.in.SEEA

SEEA-CF (2012) presents asset accounting principles and SEEA-Water (2012) delineates supply and use tables for water resources. Both documents are intended to allow articulation with the standard SNA and should follow coherent and comprehensive accounting rules to describe the relationship between nature-economy and society. This implies that opening and closing stock information are needed as well as its use/allocation to different economic sectors including water export/import. Therefore, the supply and use tables report the volume of water which flows: (i) from environment to economic sectors, (ii) between economic units and (iii) from economic sectors back to environment.

SEEA-Water (2017) recommends, on the basis of the conceptual framework of Figure 1, and the SEEA-CF, the construction of three Core Accounts: a Physical Supply and Use Table (PSUT), a Monetary Supply and Use Table (MSUT), which gives money values to the physical entries, and a Physical Asset Account, which relates the annual water flows in the PSUT to the stocks which give rise to them (Final Stock = Initial Stock + (Inflows – Outflows)). These all arise from implementation of water accounting according to the SEEA-CF.

In the later SEEA Ecosystem Accounts (SEEA-EA, 2021), the logical connections between the stock and flow accounts were expressed as in Figure 3. This requires stock accounts for ecosystem extent and condition, which give rise to flows of ecosystem services, to be expressed in both physical and monetary terms. The monetary service flows, over an appropriate time and with an appropriate discount rate, permits the calculation of the corresponding monetary stock value.

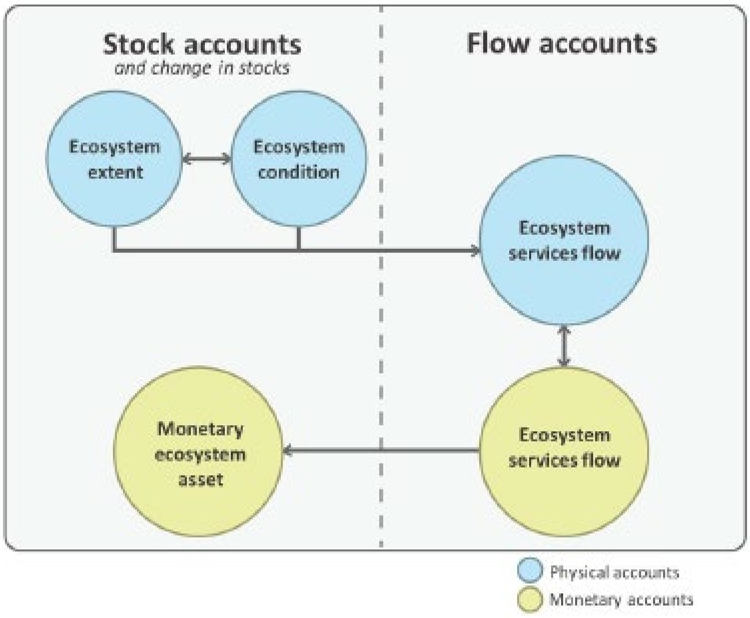

Figure 3: Stock and flow accounts in the SEEA-EA (2021), Figure 2.2, p.32.

This characterisation of stocks and flows leads to SEEA-EA recommending the compilation of five linked accounts:

Ecosystem extent account – physical terms
Ecosystem condition account – physical terms
Ecosystem services flow account – physical terms
Ecosystem services flow account – monetary terms
Monetary ecosystem account – monetary terms

Source: SEEA-EA (2021), Table 2.1, p.32

The rationale for these different accounts may be summarised as follows.

a) The extent accounts give information about the current amount of the natural asset, in physical terms. This is clearly relevant to any discussion of sustainability.

b) The ecosystem condition account is of policy relevance in its own right. It can also be combined with the extent account to calculate the volume of ecosystem services (ECSs) currently generated, in volume terms.

c) Since the SNA and the SEEA aim to be consistent, the volume of this ecosystem services flow can then be brought alongside the volume measures in conventional GDP. The value of this step is greatly increased when the ECS flow accounts are expressed as a supply/use table. That allows a full account of how the natural asset is used throughout the economy and how, to the extent it is not being used up by intermediate consumption in the production process, it provides final services to consumers.

d) Monetising this physical supply/use table allows disparate physical quantities to be added together to generate a value of each ECS, which can be added together to produce an aggregate value. Again, based on the consistency of the SNA and SEEA, they can be added to GDP in monetary terms to give a genuinely consistent “green GDP”. This gives the wider view of economic reality that we were looking for data-driven decision-making approaches. An example of this can be found in Di Gennaro et al (2025) where Italian genuine savings are expanded to account for the water purification and flood control services along with poverty indicators.

e) Finally, the aggregate ECSs in monetary terms can be capitalised to give a stock of natural assets valued in monetary terms. This is the stock measure that can serve as the starting point for consideration of sustainability.

Vardon (2023) combines both the accounting recommendations of SEEA-Water (2017), based on SEEA-CF, with those of SEEA-EA (2021) as set out above, and, importantly, adds water emissions accounts, so that his recommended list of accounts is:

- Physical asset accounts
- Physical flow accounts – supply and use tables
- Monetary supply and use tables
- Ecosystem accounts containing water-related ecosystem services (stock and flow, physical and monetary)
- Water emissions accounts

While the accounts at national level have value for the overall assessment, perhaps at least as important for management and policy purposes are regional accounts, especially for water, which ideally should be managed at catchment level, on the basis of, data permitting, catchment area accounts.

Before considering this further, the experience of water accounting in other European countries is briefly explored.

European Water Accounting Initiatives

Before the UNSD guidelines, the European Union (EU) promoted a number of directives to improve water quality and its management strategies (e.g. Water Framework Directive 2000/60/EC, Nitrate Directive 91/676) and since 2012 has established a number of initiatives to assess and protect the environment.

In 2011, the target 2 of the EU Biodiversity 2020 required Member States to assess and map ecosystem services and prepare accounting measurement by 2020. At the time, UK (then a Member State of the EU) was already publishing the second UK National Ecosystem Assessment and the Natural Capital Committee was established in 2012.

The EU intention was to support Member States in preparing their natural capital accounting assessment and in 2012 it started the Knowledge Innovation Project (KIP) to develop an Integrated system for Natural Capital and ecosystem services Accounting (KIP INCA). KIP INCA is a joint effort between Eurostat (the Statistical Office of the European Communities), the EU Joint Research Centre (JRC), the Directorate-General for Environment and the Directorate-General for Research and Innovation of the European Commission, and the European Environment Agency to support accounting initiatives in EU.

KIP INCA has been developed in phases as follows:

- 2012-2016 technical committees composed by JRC member and Eurostat were created to understand the aim and complexity of monitoring the interlinks of economic sectors and ecosystems
- 2016-2020. KIP INCA built the first EU Mapping and Assessment of Ecosystems and Services (MAES) and JRC developed a series of Ecosystem Service Supply and Use Accounts for different Ecosystem Types.
- After 2020. Through KIP INCA, a tool in an open-source platform has been developed to help Member States produce digitalized accounts (Buchhorn et al., 2022). The intention is to provide guidance in compiling and standardising accounts as established by the revision of EU Regulation 691/2011.

JRC and Eurostat collaborated to develop the procedure to compile the accounts and the European Environment Agency mainly worked on extend accounts and condition indicators. Other important players in the first two phases of the KIP INCA were DG Environment and DG Research and Development as recipients of the accounts and important policy partners to streamline the structuring of the accounts.

The EU has a programme of publishing Natural Capital Accounts incorporating ecosystem services, but it is noticeable that the only proposed publication relating to water ecosystem services is on flood regulation.

In parallel with water accounting, initiatives have been undertaken to progress EU water management. Thus, in 2014, the European Commission established the working group on water balances and water resources management which resulted in the publication of the Guidance on Water Balances (European Commission, 2015). In the same period, the analytical Water Accounting Plus (WA+) framework, supported by UNESCO-IHE, The International Water Management Institute (IWMI) and FAO (Karimi et al 2013) was launched to collect open-access data from earth observation measurements, hydrological modelling and global GIS datasets of specific water and environmental parameters (www.wateraccounting.org). These initiatives strengthen the biophysical measurement of water resources and ecosystem services. At the same time, they offered alternative frameworks to SEEA to assess water resources, although they can be mapped onto SEEA (Vardon et al., 2025).

Individual EU Member States presented their revisions of water accounts between 2018-2023 improving their previous accounts mainly developed following the SEEA CF. For example, in 1995 Germany started the water satellite account and in 2023 they re-organized it in biophysical supply and use tables as well as in asset accounts. Furthermore, national hydrological data and models were collected, modelled and organized to populate the accounting table. In the same period, a national questionnaire for more than 120 economic sectors integrating the OECD/EU (1985) water questionnaire was distributed to economic agents to define dependency and water uses. Finally, Germany automated the reporting procedure developing a routine in Statistical data Analysis Software (SAS). Similarly, Netherlands published in 2022 its latest water account and automated the process using the software R. A similar development path can be also reported for Denmark. Spain and Greece instead report sub-regional water accounts whereas Italy published a set of ecosystem services following SEEA EA where the water provision service was assessed using the economic water tariff of 1.29 €/m^3 for potable uses and an average value between 0.04 and 0.07 €/m^3 for irrigation (Capriolo et al 2020). As confirmed in Vardon et al (2025), Netherland (NL) presents the most advanced set of accounts. The Netherlands not only reported a water asset account in biophysical and monetary terms (following SEEA CF), but they also produce a natural capital report following SEEA EA including a set of water ecosystem services. The UK followed a slightly different approach, publishing in 2011 and 2014 its National Ecosystem Assessment focused on identifying the key natural assets and economic services. Schaafsma et al. (2015) synthetize the lesson learned for water ecosystem services and their management challenges. In the same period the UK ONS set out a roadmap for accounting initiatives and the different outputs are synthesised in the natural capital overview document (ONS, 2024).

Classification of Ecosystems and Water Ecosystem Services

Water Ecosystem Services (WES) contribute to the achievement of at least five Sustainable Development Goals (SDGs 6,8,13,15,3). The Millennium Ecosystem Assessment (MEA, 2015) used a typology of four fundamental ecosystem services (provisioning, regulating, supporting and cultural), which map well onto the description (by Brauman et al. (2007) and Brauman (2015)) of hydrologic ecosystem services (those deriving from terrestrial freshwater, e.g. rivers, lakes): water supply, water damage mitigation, the provision of spiritual and aesthetic services (religious, educational and tourism values) and services supporting ecosystems themselves. Figure 4 adds detail to this WES typology, identifies the main stakeholders who manage or benefit from them, and lists some of the ways in which these ES can be given a monetary value for accounting or other purposes.

It may be noted from Figure 4 that the SEEA-CF water account primarily records provisioning services, whereas most of other WES need to be assessed following the SEEA-EA. This helps to avoid double counting but attention is still needed to avoid this. For example, water provided to leisure centres is normally recorded as provisioning, but it can also appear under recreational cultural services. It is therefore crucial to carefully map WES and accounting boundaries before selecting the economic valuation methods.

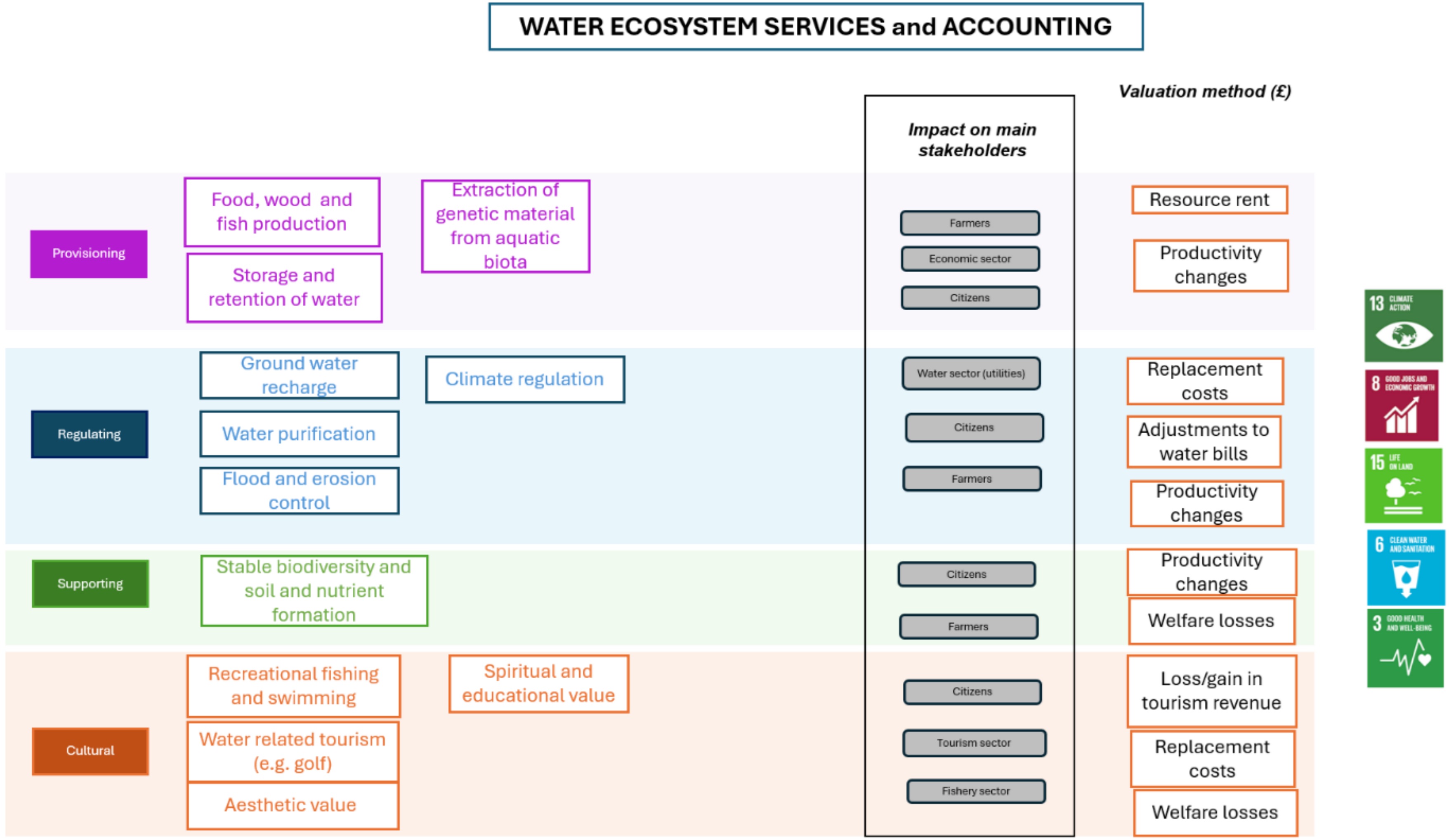

Figure 4: Classification of WES (adapted from Capon and Bunn, 2015)

UK Natural Capital Accounts related to water

Referring back to Figure 3, the first of the stock accounts is ecosystem extent which can only refer to the quantity of water uses following the SEEA CF or by ecosystems (or habitats, in some nomenclatures) in line with the SEEA EA. ONS has considered and sought to relate to each other, three different classifications: those from SEEA-EEA/EA[3], the Countryside Survey and the UK National Ecosystem Assessment (NEA).

In respect of water ecosystems the differences are as shown in Table 1:

SEEA-EEA	Countryside Survey (CS)	UK NEA
Open wetlands	Fen, marsh, swamp	Freshwater
	Bog	
Inland water bodies	Standing open waters	
	Rivers and streams	

Table 1: Different classifications of ecosystems/habitats in ONS Natural Capital Accounts (NCA) (https://www.ons.gov.uk/economy/environmentalaccounts/articles/uknaturalcapitallandcoverintheuk/2015-03-17)

Using the SEEA framework, ONS has calculated the changes in water ecosystems between 1998 and 2007 as follows:

Thousand hectares	**Opening stock 1998**	**Additions to stock**	**Reductions to stock**	**Net change**	**Closing stock 2007**
Open wetlands	2,812	211	-223	-12	2,800
Inland water bodies	307	9	-2.7	7*	314

Table 2: Extent of UK water ecosystems and change over 1998-2007, (https://www.ons.gov.uk/economy/environmentalaccounts/articles/uknaturalcapitallandcoverintheuk/2015-03-17, Table 4)

These accounts were extended from 2000-2010 in Khan, Powell and Harwood (2013)[4], as shown in Table 3. Comparing the data in Tables 2 and 3, it is clear that 'Freshwater' in the latter corresponds broadly to 'Inland water bodies' in the former, though the precise relation between the two is not clear, illustrating the difficulties with aligning classifications.

Thousand hectares	Opening stock, 2000	Net additions	Closing stock, 2010
Freshwater	212	37	249

Table 3: Physical asset account for land use in the UK, 2000-2010 (Khan et al., 2013, Table 2)

[3] The SEEA-EEA (Experimental Ecosystem Accounts, published in 2014, https://seea.un.org/content/seea-experimental-ecosystem-accounting-1), Table 2.1 lists 'Provisional land cover/ecosystem functional unit classes' (LCEU). The LCEU were renamed Ecosystem Assets (EA) in SEEA-EA, and the land cover classification shifted to the IUCN Global Ecosystem Typology (IUCN GET). The ONS has its own extent classification, as will be seen.

[4] As reported in https://www.ons.gov.uk/economy/environmentalaccounts/articles/uknaturalcapitallandcoverintheuk/2015-03-17

In 2021 the extent of the UK Freshwater, wetlands and floodplains ecosystems was 1,420,422 ha[5], a net change from 1990 of 353,010 ha, or 33%[6]. Total water use in the UK in 2022, all assumed to come from Freshwater, wetlands and floodplains was 6,625 million cubic metres, a considerable reduction since 2002, as shown in Figure 5.

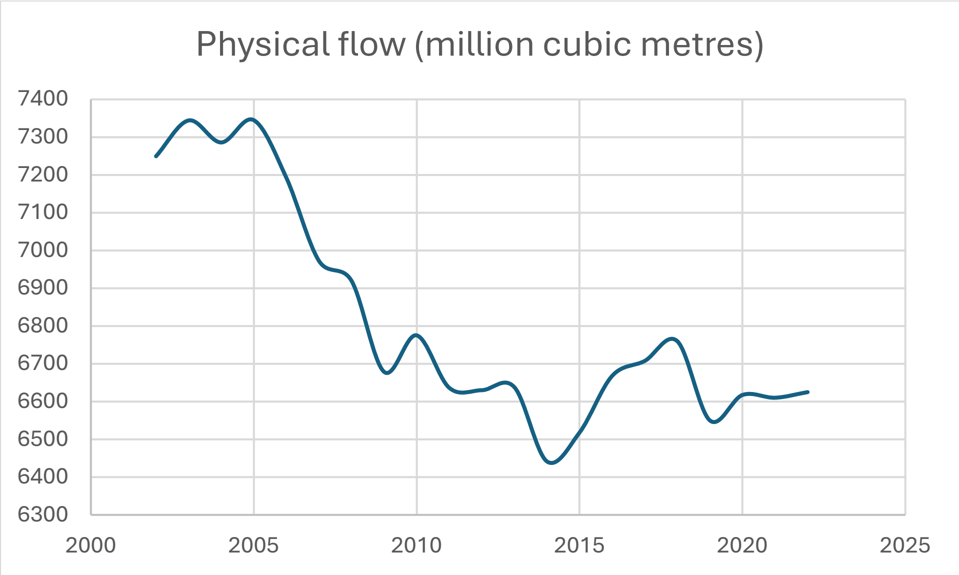

Figure 5: Quantity of water used in the UK, 2002-2021
Source: Table 2,
https://www.ons.gov.uk/economy/environmentalaccounts/datasets/uknaturalcapitalaccounts2023

Ecosystem.condition

The second physical aspect of the stock account in Figure 2 is ecosystem condition. This is reported in the 2023 UK Natural Capital Accounts for the Freshwater, wetlands and floodplains ecosystems.

Ecosystem condition is a complex concept and can only effectively be measured through a number of indicators. Under the European Union's Water Framework Directive the condition of freshwaters was measured by around 30 indicators in three categories (biological, chemical, and 'condition'). Table 4 shows the kind of ecological condition data that was published by the ONS in 2017.

Type	Indicator	Indicator signalling improvement or deterioration in condition between 2008 and 2015
Chemical	Ammonium Levels	Improvement
	Biomedical Oxygen Demand	Improvement
River Flow	Exceptionally high annual flow	No Trend

[5] Table 1,
https://www.ons.gov.uk/economy/environmentalaccounts/datasets/uknaturalcapitalaccounts2023
[6] Author calculations from data in
https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/uknaturalcapitalaccounts/2023#extent-of-habitats-in-the-uk

	Exceptionally low flow	Little/no change
Biodiversity	Water and Wetland Birds index	Deterioration
WFD status for rivers and canals	Percentage of rivers and canals in good or excellent condition	Little/no change
	Percentage of rivers and canals in poor or bad condition	Deterioration
WFD status for lakes	Percentage of lakes in good or excellent condition	Deterioration
	Percentage of lakes in poor or bad condition	Deterioration

Table 4: Freshwater ecosystem conditions under the WFD, 2017
Source of data: European Environment Agency, Joint Nature Conservation Committee, Natural Environment Research Council and Defra. ONS (2017) https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/uknaturalcapital/landandhabitatecosystemaccounts

The 2023 release of ONS condition data did not continue this data series but reported other relevant information. Different information is available for the four constituent countries of the UK and for varying time periods.

Table 5 shows the issues chosen, the indicators used, the date of the latest data, the Table or Figure number in the 'Freshwater, wetlands and floodplains' section of the Natural Capital Accounts (2023 release), and the data source. Much of the data in these condition accounts is also quite old.

Issue	Indicators	Dates of data reported	Table/figure in the NCA; data source
Fen, marsh, swamp Bog	pH Carbon concentrate (g C/kg)] Loss of ignition (%) Soil bulk density	1978, 1998, 2007 (1998 only for soil bulk density)	Table 22; UK CEH (CS)
Water quality (high, good, moderate, poor, bad)	Percentage of UK surface water bodies awarded each status for rivers and canals Percentage of UK surface water bodies awarded each status for lakes	Annual, 2009-2020	Table 23 Table 24; JNCC, EA, NRW, SEPA, DAERA NI
Compositional species indicators for freshwater, wetlands and floodplains: Bees, bats and birds	Bees (average bees per km walk) Bats (index) Birds (index)	Annual, 2010-2020 Annual, 1999-2020 Annual (1975-2020)	Figure 14; BeeWalk, JNCC, Bat Cons Trust

Compositional state indicator: Freshwater salmonids	Salmon and trout caught in rivers in Great Britain	Annual, 1994-2020	Figure 15; EA, NRW, Scot Gov
Structural state indicator: Invasive species	Number of non-native freshwater species	Annual, 1960-2019	Figure 16; JNCC
Landscape level indicators for freshwater, wetlands and floodplain	Habitat connectivity (Scotland) River naturalness (England) Hydromorphological impact ratio categories for Welsh areas Water environment condition (Scotland)	2017 2014 2007-2008 2020	Table 25; NatureScot, Nat England Table 26; NRW SEPA
Ancillary indicators for freshwater, wetland and floodplain	Pollution incidents from sewerage Protected wetland sites (Scotland) Area of protected sites in England by condition Number of protected sites in Wales by condition	2011, 2019 2007,-10,-15,-18,-20 2018, 2022 2020	Source NA Table 27; NatureScot Table 28; Nat England Table 29; NRW

Table 5: Freshwater indicators in the NCA's Habitat and Condition Accounts, 2023 (https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/habitatextentandconditionnaturalcapitaluk/2022#freshwater-wetlands-and-floodplain)

Accounts.of.emissions.to.water

A fundamental determinant of ecosystem condition are the various emissions to water that may pollute it and reduce its ability to supply ecosystem services. ONS does not report systematically on these emissions. The House of Lords Library has an interesting publication on sewage pollution in England's water (House of Lords Library, 2022), which spells out the problem but has no systematic data. Ofwat publishes annual Water Company Performance reports, which do not mention sewage pollution explicitly, but report on 'pollution incidents', which presumably cover this. In 2022-23, the companies which exceeded their commitments on pollution incidents were Anglian Water, Dŵr Cymru, South West Water, Southern Water, Thames Water, and Wessex Water (Ofwat, 2023). These reports give no systematic data over time, which makes them in their current form of limited use for the building of consistent accounts and indicators.

Sewage pollution is mentioned in the ONS Natural Capital Condition Accounts, but only in the following summary way: "**Pollution incidents from sewerage:** Pollution by discharges or escapes of contaminants into rivers are recorded by the water companies. The number of pollution incidents has decreased by 34% in Great Britain between 2011 (3,316 pollution incidents) and 2019 (2,194 incidents)." (https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/habitatextentandconditionnaturalcapitaluk/2022). Given the current public interest in sewage discharges to surface and coastal waters, it would seem important to bring this data up to date.

Clearly emissions of sewage to water courses are only one of the many kinds of emissions to inland water resources. Others include fertilisers from fields, and run off from roads and other hard surfaces. It would seem important from a policy perspective to construct far more comprehensive and systematic emission accounts.

Physical.supply.and.use.tables.(SUTs)

Figure 6 shows the general schema for how physical SUTs engage with the monetary SUTs that are a standard feature of national economic accounting. The scheme is consistent with SEEA EA reporting rules.

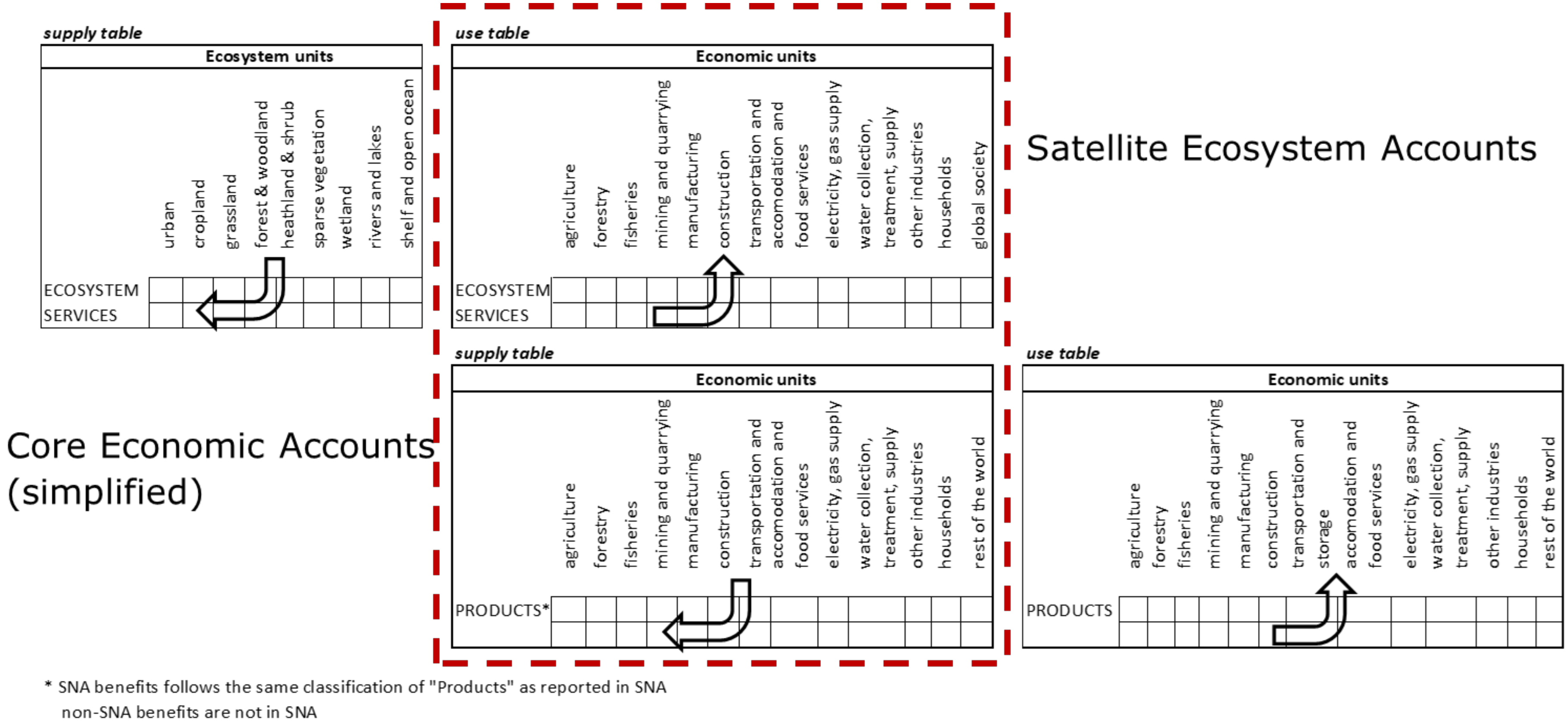

Figure 6: The relationship between Satellite Ecosystem Accounts and Core National (Economic) Accounts
Source: La Notte et al., 2020

Figure 6 shows that ecosystem units, also called habitat types, supply ecosystem services (the top left panel, in physical units). These ecosystem services are used.by economic sectors, and the use tables can be constructed in both physical terms (not shown in Figure 5) and, after appropriate valuation, in monetary terms (top central panel in Figure 5). Economic sectors supply products (bottom central panel). The products are used by other economic sectors and final demand (SNA accounts) (La Notte et al., 2020).

Tables 6a and 6b show an illustrative example of physical supply and use tables (PSUT) from SEEA Water (2017), relating the flows of water from the environment to the main industries (with ISIC 36, water collection, treatment and supply, and ISIC 37, sewerage, being particularly important for water), households, and flows from and to the rest of the world and the environment. As always in such tables, the Total Supply and Total Use must be equal.

The five main sections of each of the supply and use tables are:

Supply.table¿Sources of abstracted water (flows from the environment); the supply of water for distribution (by ISIC 36,) and own use (mainly by the agriculture and electricity sectors); supply of wastewater (mainly for treatment); return flows of water (from economic sectors to inland water resources and other sources); and evaporation of water.

Use.table¿Use of sources of abstracted water by economic sectors; use of distributed water (mainly by households) and own use (same as in the supply table); wastewater received (mainly by ISIC 37, sewerage); return flows of water to the environment (total as in the supply tables); and evaporation of water (total as in the supply table).

PHYSICAL SUPPLY TABLE	Industries (by ISIC) Agriculture, Forestry & Fishery (ISIC A)	Mining and Quarrying (ISIC B)	Manufacturing (ISIC C)	Electricity, gas, steam & air conditioning supply (ISIC D)	Water collection, treatment & supply (ISIC 36)	Sewerage (ISIC 37)	Other Industries	Total Industry	House-holds	Flows from the Rest of the World (Imports)	Flows from the Environment	TOTAL SUPPLY
1. Sources of Abstracted Water:												
Inland Water Resources											967	**967**
of which: Surface water											441	**441**
of which: Groundwater											476	**476**
Other Water Sources											202	**202**
TOTAL SUPPLY ABSTRACTED WATER											**1 169**	**1 169**
2. Water:												
For distribution	0	0	0	0	378	0	0	**378**		0		**378**
For own use	108	34	80	404	14	100	2	**743**				**743**
3. Wastewater and reused water:												
Wastewater to treatment	18	35	82	6	1	0	49	**191**	236			**427**
Own treatment of wastewater	0	0	0	0	0	0	0	**0**	0			**0**
Reused water produced (for distribution)	0	3	7	0	0	43	0	**53**	0			**53**
TOTAL WASTEWATER AND REUSED WATER	18	38	89	6	1	43	49	**244**	236			**479**
4. Return flows of water:												
To inland water resources	65	7	16	300	47	228	1	**664**	5			**668**
To other sources	0	2	5	100	0	256	0	**363**	0			**363**
TOTAL RETURN FLOWS	65	9	21	400	47	484	1	**1 026**	5			**1 031**
of which: losses in distribution	0	0	0	0	47	0	0	**47**	0			**47**
5. Evaporation of abstracted water, transpiration and water incorporated into products:												
TOTAL WATER EVAPORATED, TRANSPIRED AND INCORPORATED INTO PRODUCTS	76	13	30	3	2	1	4	**128**	10			**138**
6. TOTAL SUPPLY	**268**	**94**	**220**	**812**	**443**	**627**	**56**	**2 520**	**250**	**0**	**1 169**	**3 939**

Table 6a: A Physical Supply Table for Water Accounting
Source: SEEA, 2017, Core Account 1

PHYSICAL USE TABLE	Industries (by ISIC)								House-holds	Accumu-lation	Flows to the Rest of the World (Exports)	Flows to the Environment	TOTAL USE
	Agriculture, Forestry & Fishery (ISIC A)	Mining and Quarrying (ISIC B)	Manufactur-ing (ISIC C)	Electricity, gas, steam & air conditioning supply (ISIC D)	Water collection, treatment & supply (ISIC 36)	Sewerage (ISIC 37)	Other Industries	**Total Industry**					
1. Sources of Abstracted Water:													
Inland Water Resources	108	34	80	304	437	0	2	**967**					**967**
of which: Surface water	55	24	56	301	5	0	0	**441**					**441**
of which: Groundwater	3	10	24	3	433	0	2	**476**					**476**
Other Water Sources	0	0	0	100	2	100	0	**202**					**202**
TOTAL USE ABSTRACTED WATER	108	34	80	404	440	100	2	**1 169**					**1 169**
2. Water (use):													
Use of distributed water	39	14	32	4	0	0	51	**139**	240		0		**378**
Own use of abstracted water	108	34	80	404	3	100	2	**733**	11				**743**
3. Wastewater and reused water:													
Wastewater received from other units					0	427		**427**			0		**427**
Own treatment of wastewater	0	0	0	0	0	0	0	**0**	0				**0**
Re-used water (distributed reuse)	12	12	28	0	0	0	0	**53**	0				**53**
TOTAL WASTEWATER AND REUSED WATER	12	12	28	0	0	427	0	**479**	0		0		**479**
4. Return flows of water:													
To inland water resources												668	**668**
To other sources												363	**363**
TOTAL RETURN FLOWS												1 031	**1 031**
5. Evaporation of abstracted water, transpiration and water incorporated into products:													
TOTAL WATER EVAPORATED, TRANSPIRED AND INCORPORATED INTO PRODUCTS										10		128	**138**
6. TOTAL USE	**268**	**94**	**220**	**812**	**443**	**627**	**56**	**2 520**	**250**	**10**	**0**	**1 159**	**3 939**

Table 6b: A Physical Use Table for Water Accounting
Source: SEEA, 2017, Core Account 1

Vardon et al. (2024) and La Notte (2024) stress the importance to integrate and increase consistency between SEEA Water, CF and EA SUTs particularly to provide information relevant for decision-making and reduce confusion among practitioners.

Policy relevance of water accounts

The ultimate purpose of environmental economic accounts is to provide information that is relevant for well-based decision making about the management of water supply and of the condition of water and water ecosystems. Policymakers at both central and local levels of government are key decision-makers in this respect. But the same information can also underpin well-informed decision-making by others, such as water companies and water consumers. Reliable information also facilitates informed public debate regarding this key economic and environmental asset.

To put the indicators discussed above in a policy context , it is worth noting the statutory policy targets and objectives for England which the government has agreed under its 25-Year Environment Plan, and updated in 2023.

"**Clean and plentiful water**

We will achieve clean and plentiful water by improving at least three quarters of our waters to be close to their natural state as soon as is practicable by:

- reducing the damaging abstraction of water from rivers and groundwater, ensuring that by 2021 the proportion of water bodies with enough water to support environmental standards increases from 82% to 90% for surface water bodies and from 72% to 77% for groundwater bodies
- reaching or exceeding objectives for rivers, lakes, coastal and ground waters that are specially protected, whether for biodiversity or drinking water as per our River Basin Management Plans
- supporting OFWAT's ambitions on leakage, minimising the amount of water lost through leakage year on year, with water companies expected to reduce leakage by at least an average of 15% by 2025
- minimising by 2030 the harmful bacteria in our designated bathing waters and continuing to improve the cleanliness of our waters; we will make sure that potential bathers are warned of any short-term pollution risks." (https://www.gov.uk/government/publications/25-year-environment-plan/25-year-environment-plan-our-targets-at-a-glance)

The Office for Environmental Protection (OEP) assesses each year the progress of the UK Government towards meeting these environmental targets. Its Progress Report 2024 (https://www.theoep.org.uk/report/government-remains-largely-track-meet-its-environmental-ambitions-finds-oep-annual-progress) found that "Government remains largely off track to meets its environmental ambitions and must speed up and scale up its efforts in order to achieve them". The OEP's Summary Assessment of the 'Clean and plentiful water' topic area is shown in Figure 6:

Past trends	Water pollution is still problematic. While the water industry has reduced pollution loads from wastewater treatment discharges, pollution incidents are not reducing. The ecological status and potential of water bodies in England has remained largely static.	**Trends show a mixed picture**
Progress	The scale and pace of effort does not prioritise all major pressures. For example, whilst sewer overflows and sewage treatment are receiving attention, detailed and specific plans to address wider pollution sources, other pressures and reductions in water use are not demonstrably adequate.	**Mixed**
Overall prospects of meeting ambitions, targets and commitments	The scale and pace of delivery of actions is not aligned with the objective to achieve good ecological status or potential by 2027. The River Basin Management Plans indicate low confidence in achieving this.	**Largely off track**
Robustness	The assessment has primarily used publicly available monitoring data and evidence along with expert judgement. It has also been informed by our current, ongoing scrutiny of the implementation of the Water Framework Directive Regulations.	

Figure 6: OEP's 2024 Summary Assessment of the UK Government's progress towards meeting its targets and objectives in relation to 'Clean and plentiful water' (Table 4.1, p.58, OEP 2024)

Clearly the OEP has its own monitoring and assessment process, but water accounts constructed according to the SEEA frameworks could be a fundamental tool to help the government to manage both water quantity and water quality.

Conclusion

Water is a fundamental resource under increasing pressure in the UK due to population growth, housing developments, and climate change. At the same time, UK has monitored and mapped ecosystems, services and water quality since 2000 and a wealth of data and expertise has been developed in these years. Therefore, water accounts constructed according to the SEEA frameworks, when adequately developed, could be a fundamental tool to help the government and other decision makers to manage both water quantity and water quality.

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