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

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WORLD BANK GROUP Water

WORLD BANK GROUP Environment, Natural Resources & Blue Economy

GPS Global Program on Sustainability

GWSP Global Water Security & Sanitation Partnership

WAVES

Australian National University

• Outline of presentation

Introduction
- Overall objective
- Rationale
- The challenge

Valuation in CWON

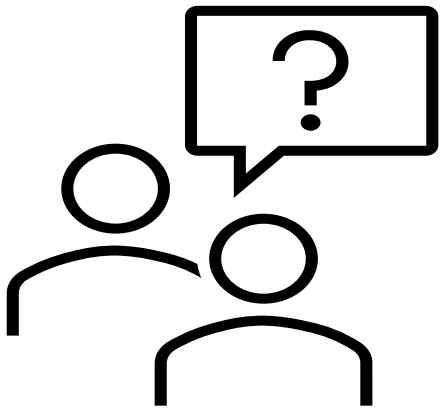
Water accounting

Data sources and methods

Options
- Assets-by-asset
- Use-by-use
- Service-by-service

Questions to London Group

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?

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INTRODUCTION

Overall objective

Assess the feasibility of valuing water as a natural capital asset in at least 150 countries for possible inclusion in the Changing Wealth of Nations

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The rationale for water valuation

- Water using increasing due to the growing population and economy.
- Water availability changing due to climate change, groundwater overuse, 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 for balancing water supply and demand
- Estimating water value and adding it to the wealth of nations would help to make clear the importance of water to the economy and embed water into macroeconomic thinking.

The challenge

"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

UN World Water Development Report: Valuing Water (2021)

Why water is hard to value

1. Water is a heavily regulated resource for which the price charged (if any) often bears little relation to its economic value or even the cost of supply.
2. Water supply often has the characteristics of a natural monopoly
3. Where and when water is scarce, water may be rationed, or restrictions placed on some water uses
4. Property rights are often absent and not always easy to define
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 industries other than the water supply industry and by households

Scope of valuation – water assets

Surface water (“blue” water)

- Rivers, lakes, reservoirs, snow/ice, soil water (used in rainfed agriculture

Groundwater

- Non-renewable water (“fossil” groundwater)
- Renewable water (recharging aquifers)

Soil water (“green” water)

- Used in rainfed agriculture

Excluded water sources

- Seas and oceans (e.g. for desalination)
- Reuse water (“grey” water)

Similar but different asset and flow classifications in the SNA, Central Framework and Ecosystem Accounting

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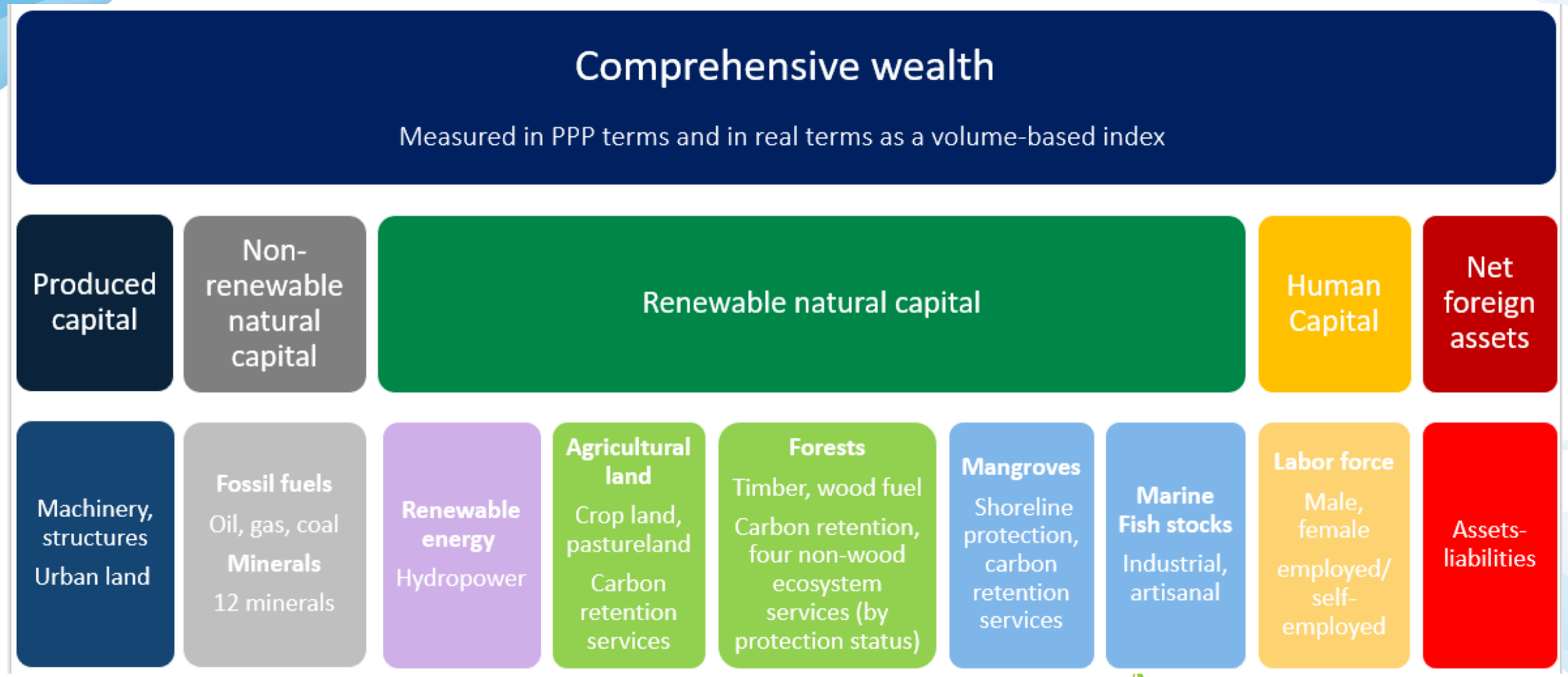
VALUATION IN CWON

•Assets include in CWON



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Water accounting organizes information

Integrating the environment and the economic

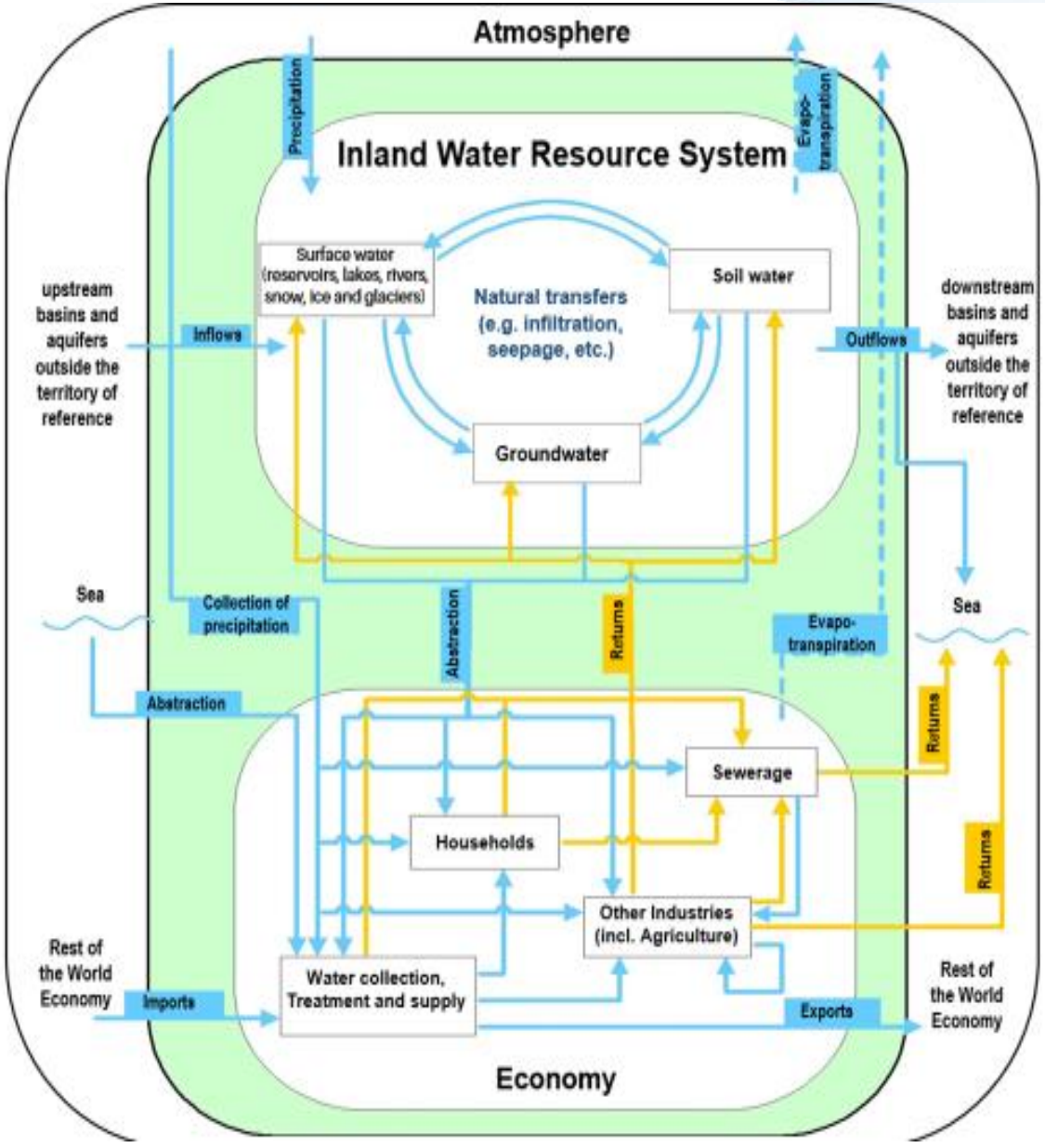
Stocks and flows

- Surface, ground and soil water
- Water quality and pollution
- Water supply and sewerage infrastructure

Water supply and use

- Water supply and wastewater treatment industri
- Agriculture and other industries
- Households

Physical and monetary measures



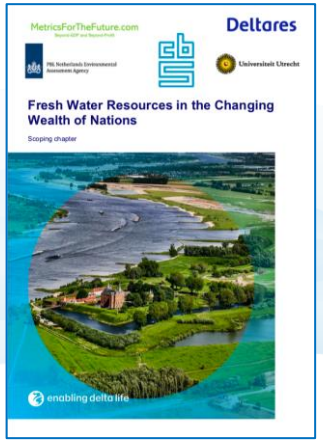
Water valuation review by Kind et al 2020

Identification of global databases and hydrological models

Table 1: Overview of the identified databases

	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 • Ground-water abstracted • Fresh water abstracted as the proportion of renewable water	• 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 fresh-water resources • Annual water withdrawals • Water stress Index • Modelled water availability and use for current and future climate conditions	• Sectoral water abstracted • Net freshwater supplied • Renewable fresh water resources	• Renewable fresh water resources • Water scarcity • Aridity • Water depletion • Baseline water stress • Access to safe drinking water • Future water discharge and water stress	• Proportion of population using: • drinking water services • sanitation services • piped drinking water sources • sanitation facilities connected to sewer networks
	OECD / Eurostat Joint Question-naire 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 Question-naire • AQUASTAT			• OECD • CGIAR • WRI • WaterGAP • UN IGRAC • UNICEF / WHO • Various scientific publications	• National Statistical Institutes

Model	Water demand / use	Water abstractions	Replenishment of groundwater	Quantification of groundwater resources	Reservoirs	Spatial resolution	Reference
WaterGAP3	Yes	Yes, distinction between ground and surface water	Yes	Approximation	Yes, with regulation routine	5 arc min / ~10 km	Flörke et al.,2013
PCR-GLOBWB	Yes	Yes, distinction between ground and surface water	Yes	Approximation	Yes, with regulation routine	5 arc min / ~10 km	Sutanudjaja et al., 2018
LISFLOOD	No	Not implemented for all demands globally	Yes	Approximation	Yes, simple weir + downstream ecological demand	0.1 degrees / ~10 km	Van Der Knijff et al., 2010
W3RA	No	Not implemented for all demands globally	Yes	Approximation	No	5 arc min / ~10 km	van Dijk et al., 2014
H08	Yes	Yes, distinction between ground and surface water	Yes	Approximation	Yes, with regulation routine	0.5 degrees	Hanasaki et al., 2018
HYPE	Yes	Yes, distinction between ground and surface water	Yes	Approximation	Yes, regulated	catchments	Lindström et al., 2010
VIC	No	Not implemented for all demands globally	Yes	Approximation	Yes, simple weir	1 km	Liang et al., 1994
MODFLOW[1]	No	Not implemented for all demands Globally	Yes	Absolute Volumes	Natural lakes	10 km	De Graaf et al., 2015

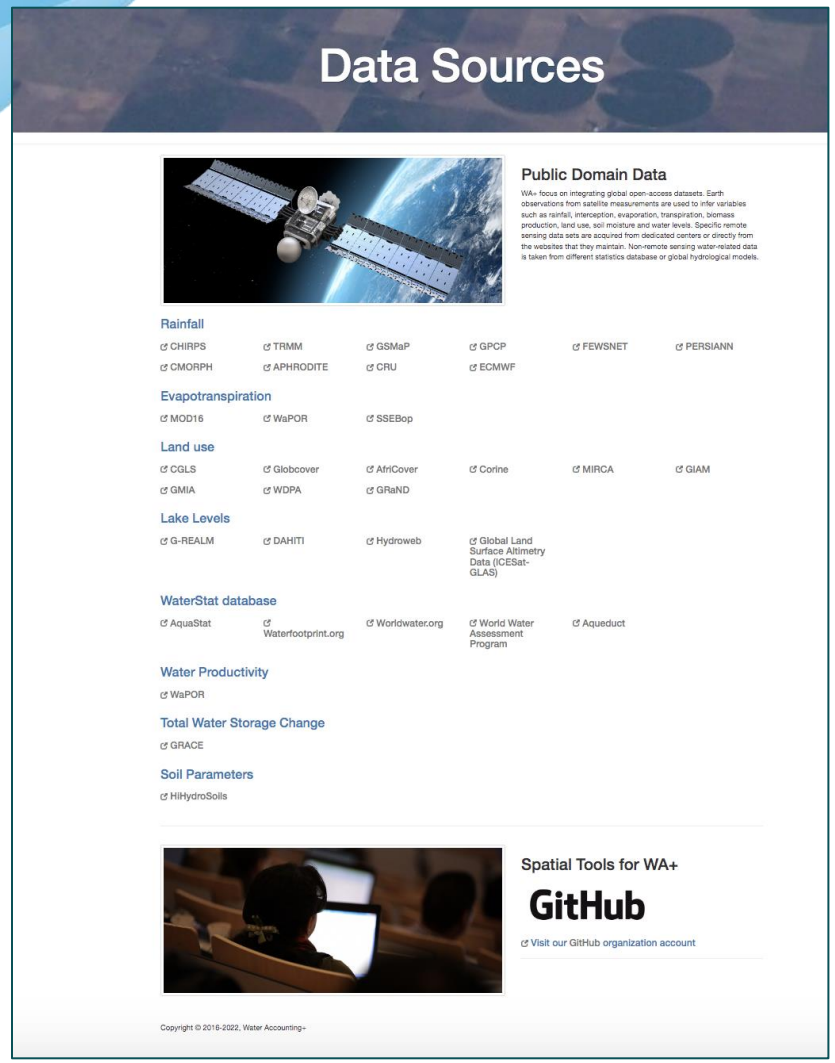


Kind et al. 2020

Updated data from Water GP and FAO

• Other data sources and models

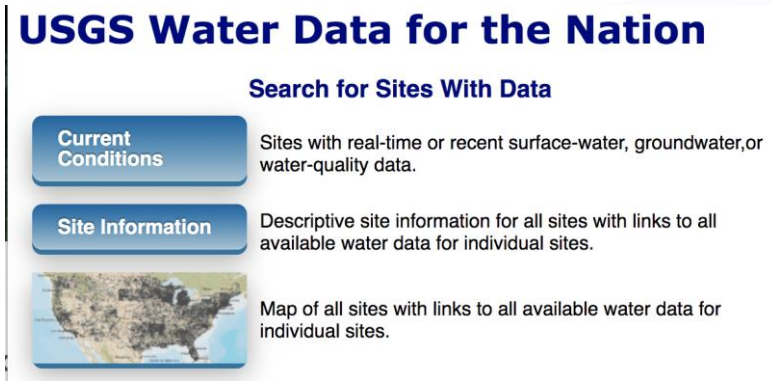
International and national



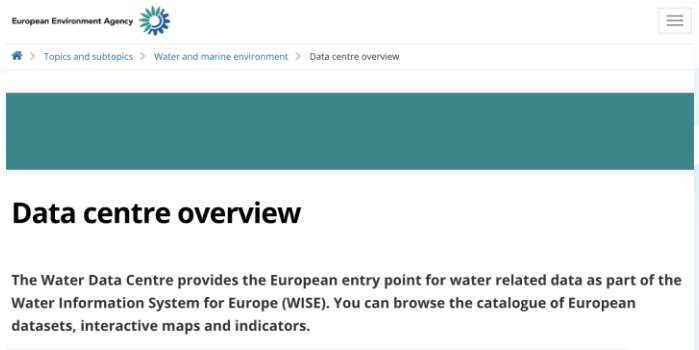
- https://www.wateraccounting.org/data_sources.html

ARIES for SEEA

https://seea.un.org/content/aries-for-seea



https://waterdata.usgs.gov/nwis?



https://www.eea.europa.eu/themes/water/dc

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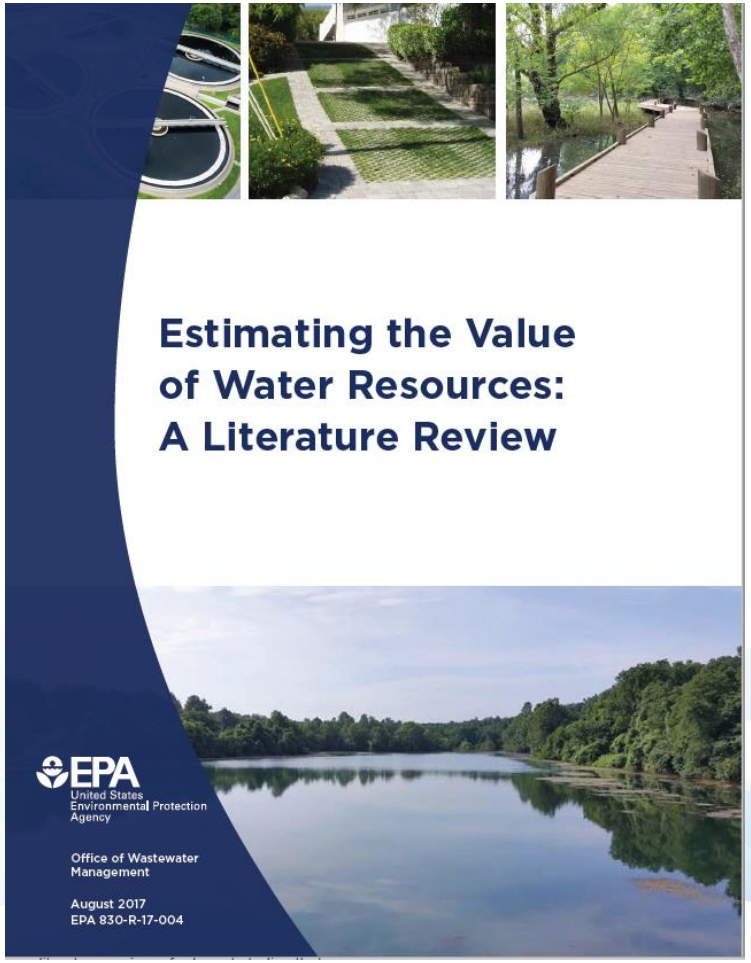
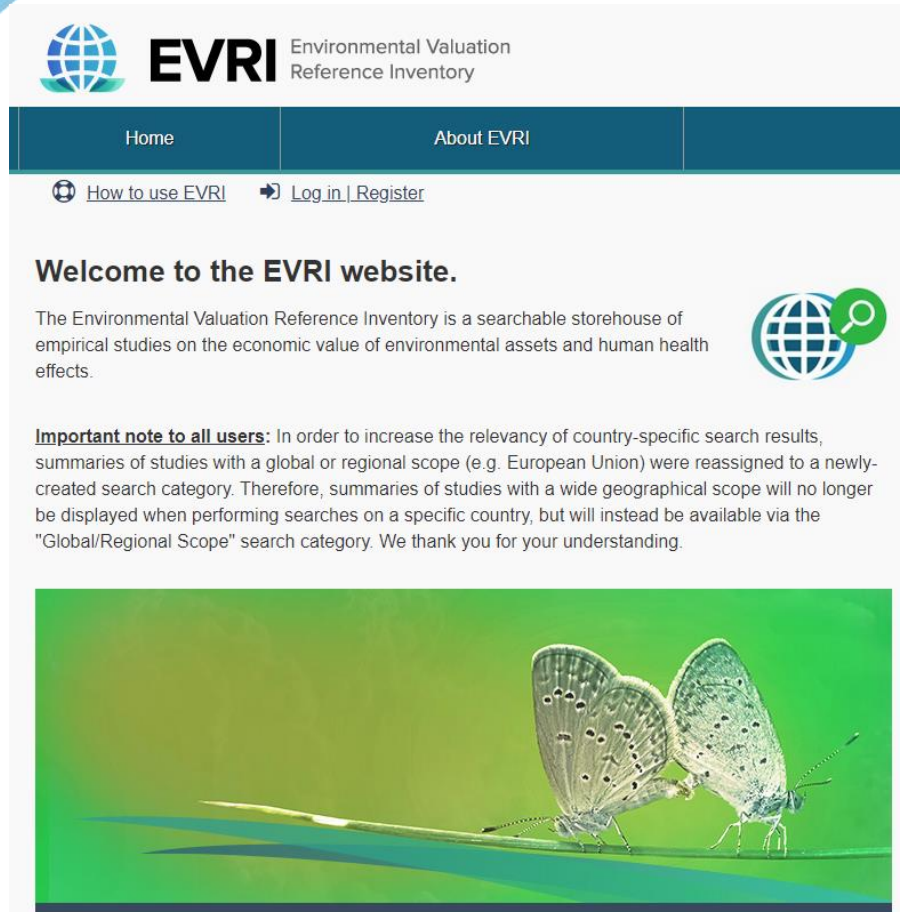
Academic studies of water valuation

- Massive literature
- 2657 articles identified via Scopus search
- Several reviews of water valuation
- Need to identify approaches consistent with exchange values
- Determine the data available to support valuation
- Price x quantity = value
- Quality of water
- Price a function of many things (e.g. relative scarcity and demand)

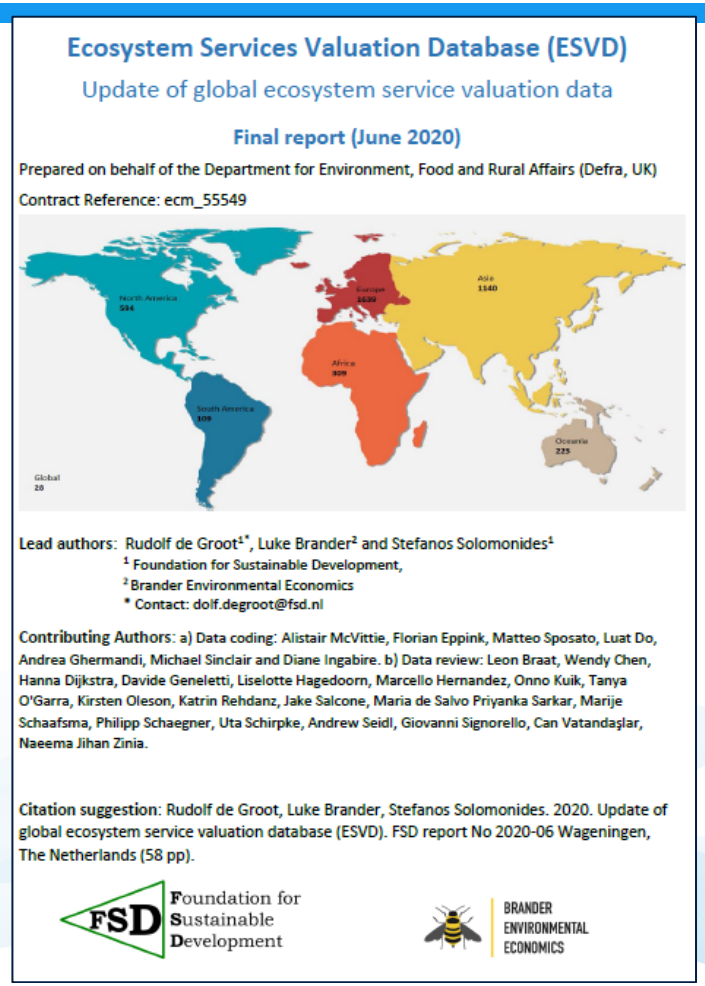


https://www.epa.gov/sites/default/files/2018-10/documents/estimating_value_of_water_lit_review.pdf

• Data bases for environmental valuation



https://www.evri.ca/



https://www.es-partnership.org/wp-content/uploads/2020/08/ESVD_Global-Update-FINAL-Report-June-2020.pdf

ASSET-BY-ASSET

Water assets and the national accounts

Surface water subject to purchase, extraction and use in production as part of ‘water resources’ (along with groundwater).

‘Water associated with land’:

- “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.)
- Soil water

A ‘permit to use a natural resource’

- tradable water rights.

Water rights

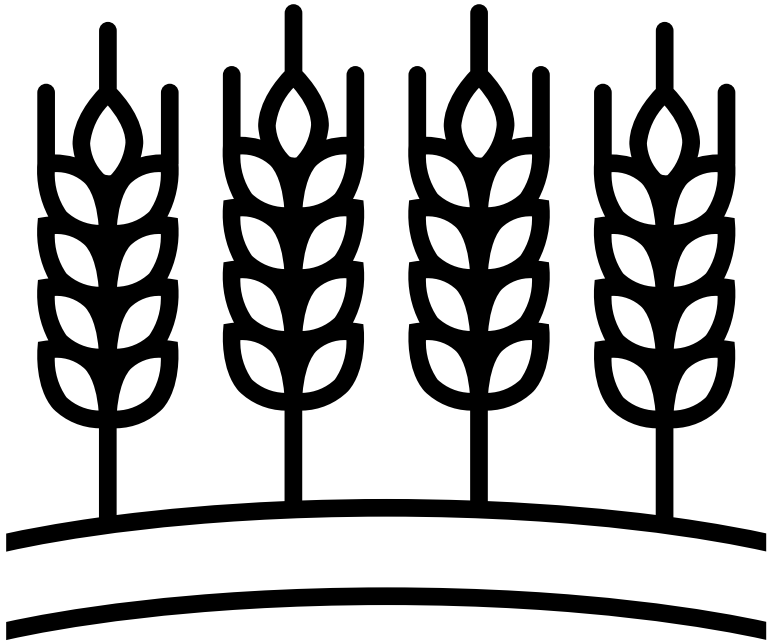
Part of broader governance

Countries with formal tradable water rights

- Australia
- Chile
- Iran
- United Kingdom
- United States

Tradition or informal access rights in many counties

Land value

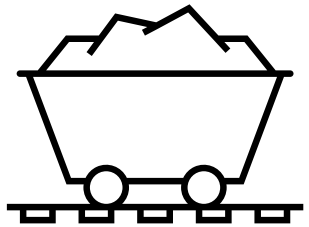


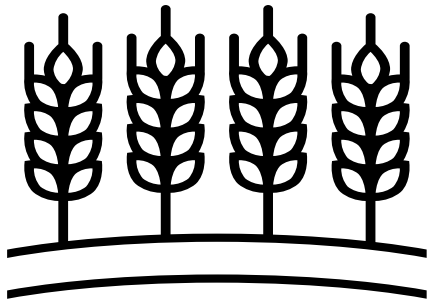
The value of the water available to land in the soil or water resources (surface or ground) is embedded in the value of land

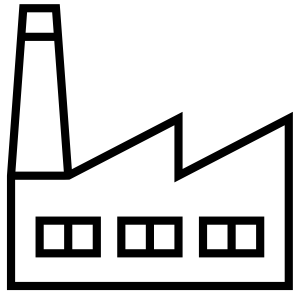
- Hedonic pricing could be used
- Data intensive

USE-BY-USE

Use by industries and households







Industries

- Water supply
- Agriculture
- Mining
- Manufacturing
- Etc

Households

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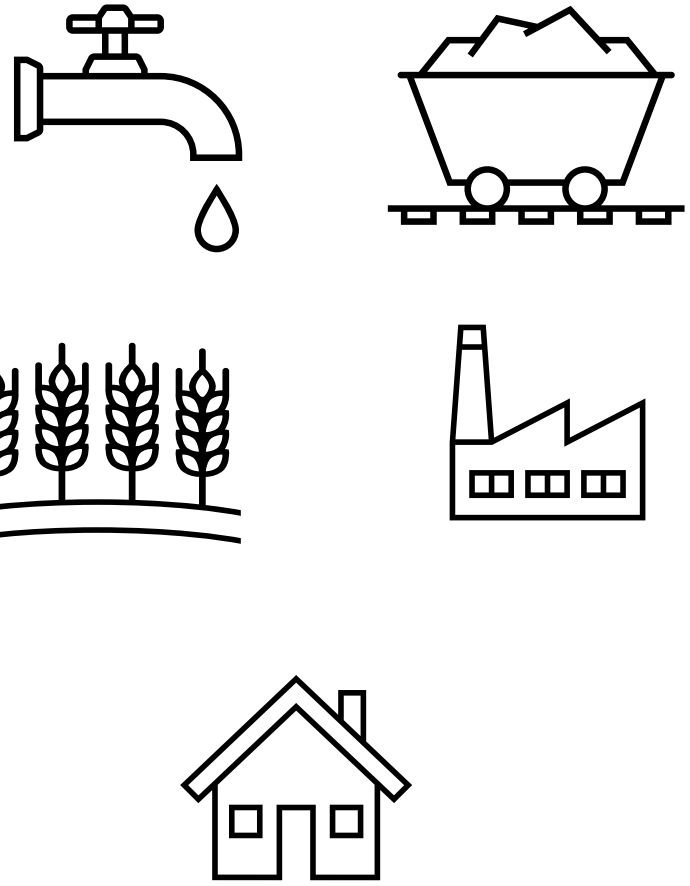
Need to know value of production and consumption



Capital costs

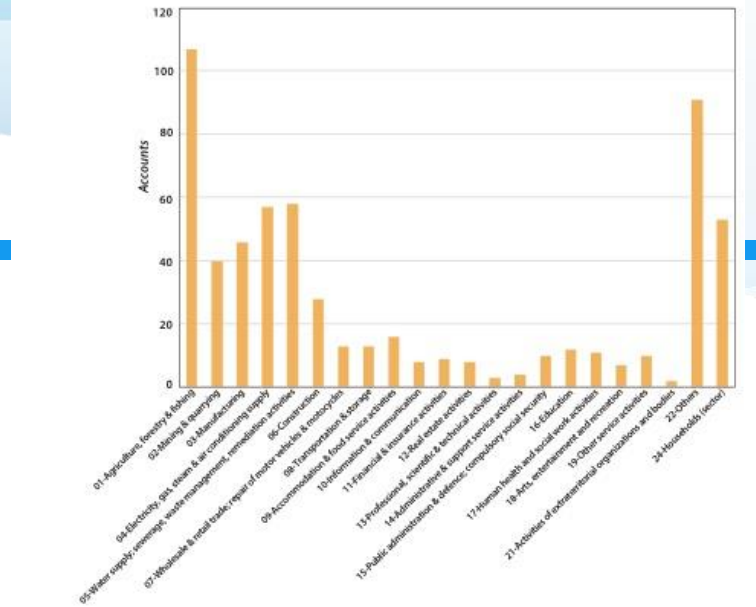
- Plant and equipment
- Running costs
- E.g. energy, fertilizer and transport
- Labor
- Value of sales
- Part of the profit contains the value of water
- Water suppliers
- Price constrained and negative rents
- Households
- own account production
- Much of this economic data comes from the national accounts

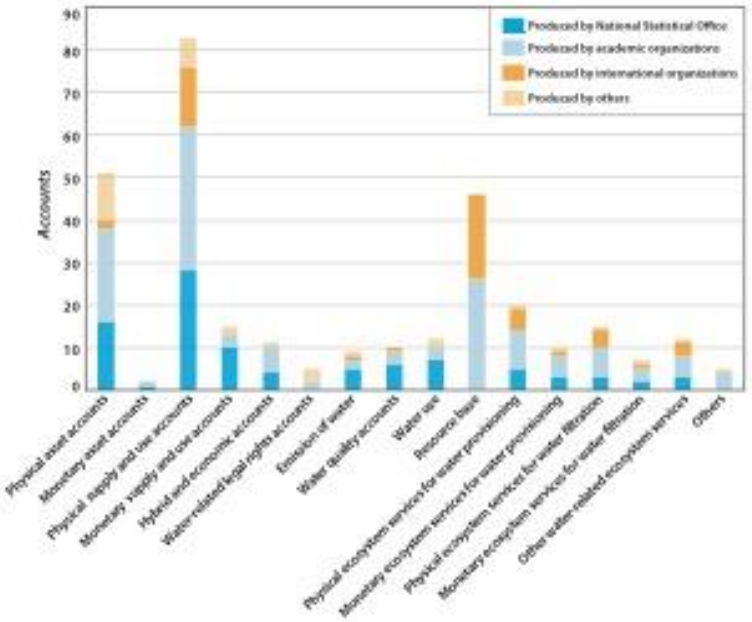
Water use from water accounts

67 countries have water accounts

But . . .

- Mostly “one-off” studies
- Limited time series
- Lack of industry detail
- Few produce monetary supply and use table





Vardon, M. J., Thi Ha Lien Le, Martinez-Lagunes, R., Pule, O. P., Schenau, S., May, S., and Grafton, R., 2023. Water accounts and water accounting. Technical Report of the Global Commission on the Economics of Water, Paris.

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(ECOSYSTEM) SERVICE-BY SERVICE

• Ecosystem service approach

- Global ecosystem service models (e.g. ARIES, InVest) for physical volume of water provisioning
- Other hydrological models are also available for different aspects of water (e.g. AQUASTAT, SWAT)
- Need to determine use of ecosystem services (when, where and by who)
- Need a price for the volume of water provisioning service used
- Price will vary by location (uses, users, scarcity, demand, quality, etc.)

Ecosystem services related to water

- SEEA Ecosystem Accounting services(pp. 131 to 133)
- Provisioning services
- Water supply
- Regulating and maintenance services
- Soil and sediment retention
- Water purification
- Water flow regulation
- Flood control
- Nursery and population habitat services
- Cultural services
- Recreation
- Visual amenity
- Spiritual, artistic and symbolic services

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ARIES for SEEA – water supply ecosystem service

Physical volume for th
water supply ecosysten
service (m^3)

- Uses approach of Fasil et al 2016
- Can be done fine spatial level
- For CWON country level is only needed

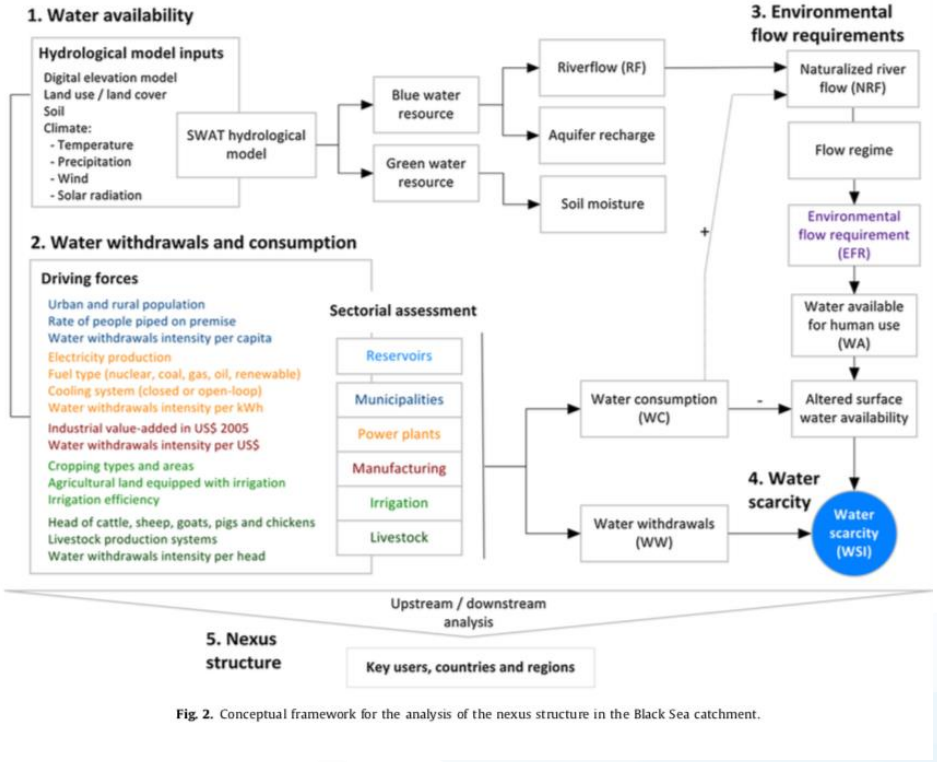
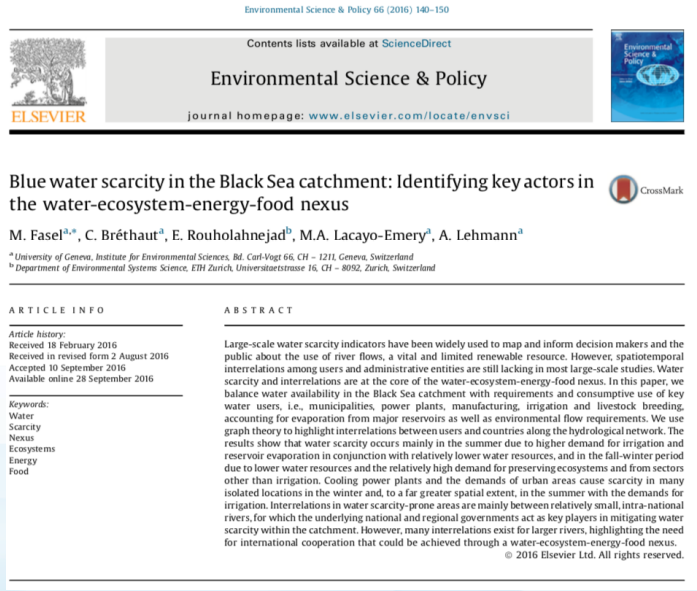


Fig. 2. Conceptual framework for the analysis of the nexus structure in the Black Sea catchment.



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Blue water scarcity in the Black Sea catchment: Identifying key actors in the water-ecosystem-energy-food nexus

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ABSTRACT

Large-scale water scarcity indicators have been widely used to map and inform decision makers and the public about the use of river flows, a vital and limited renewable resource. However, spatiotemporal interrelations among users and administrative entities are still lacking in most large-scale studies. Water scarcity and interrelations are at the core of the water-ecosystem-energy-food nexus. In this paper, we balance water availability in the Black Sea catchment with requirements and consumptive use of key water users, i.e., municipalities, power plants, manufacturing, irrigation and livestock breeding, accounting for evaporation from major reservoirs as well as environmental flow requirements. We use graph theory to highlight interrelations between users and countries along the hydrological network. The results show that water scarcity occurs mainly in the summer due to higher demand for irrigation and reservoir evaporation in conjunction with relatively lower water resources, and in the fall-winter period due to lower water resources and the relatively high demand for preserving ecosystems and from sectors other than irrigation. Cooling power plants and the demands of urban areas cause scarcity in many isolated locations in the winter and, to a far greater spatial extent, in the summer with the demands for irrigation. Interrelations in water scarcity-prone areas are mainly between relatively small, intra-national rivers, for which the underlying national and regional governments act as key players in mitigating water scarcity within the catchment. However, many interrelations exist for larger rivers, highlighting the need for international cooperation that could be achieved through a water-ecosystem-energy-food nexus.

http://dx.doi.org/10.1016/j.envsci.2016.09.004

Water price: global meta analysis

Siikamäki et al. (2021)

- 32 water-related ES
- 18 water quantity (supply) and quality
- Likely overlap of value of water supply and water filtration ES as defined in SEEA

(Study is being updated)

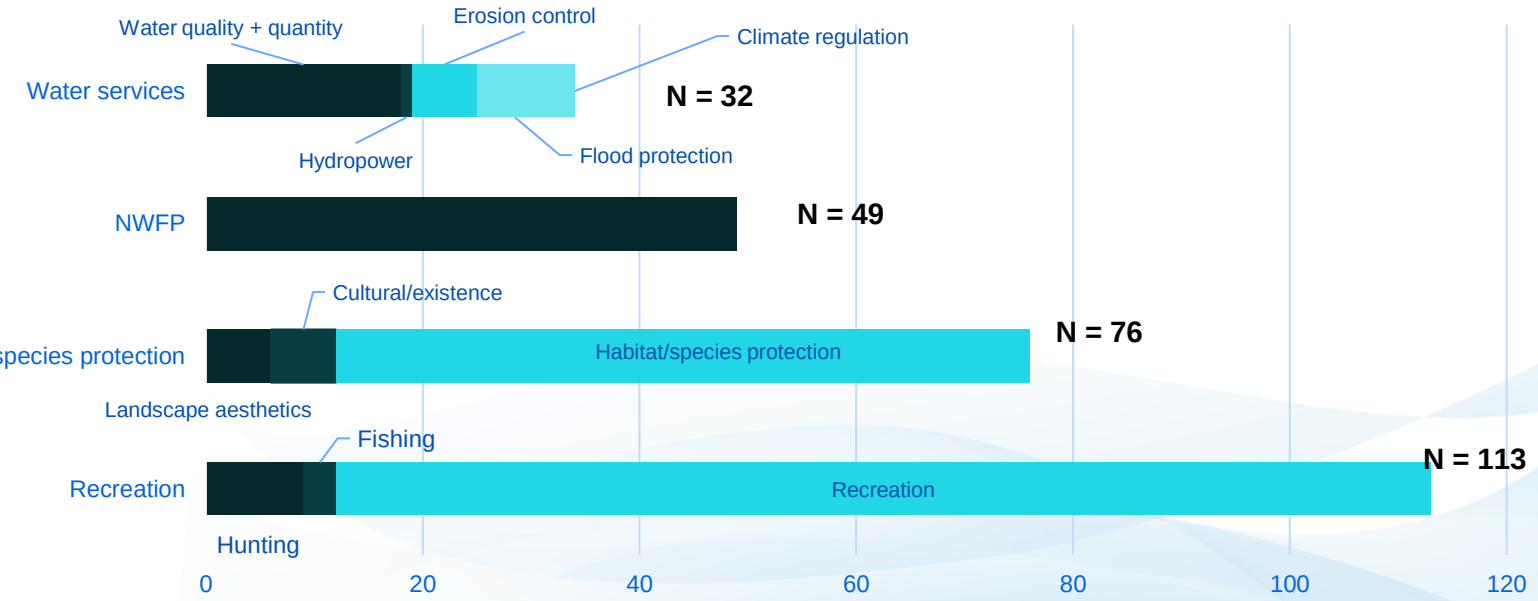
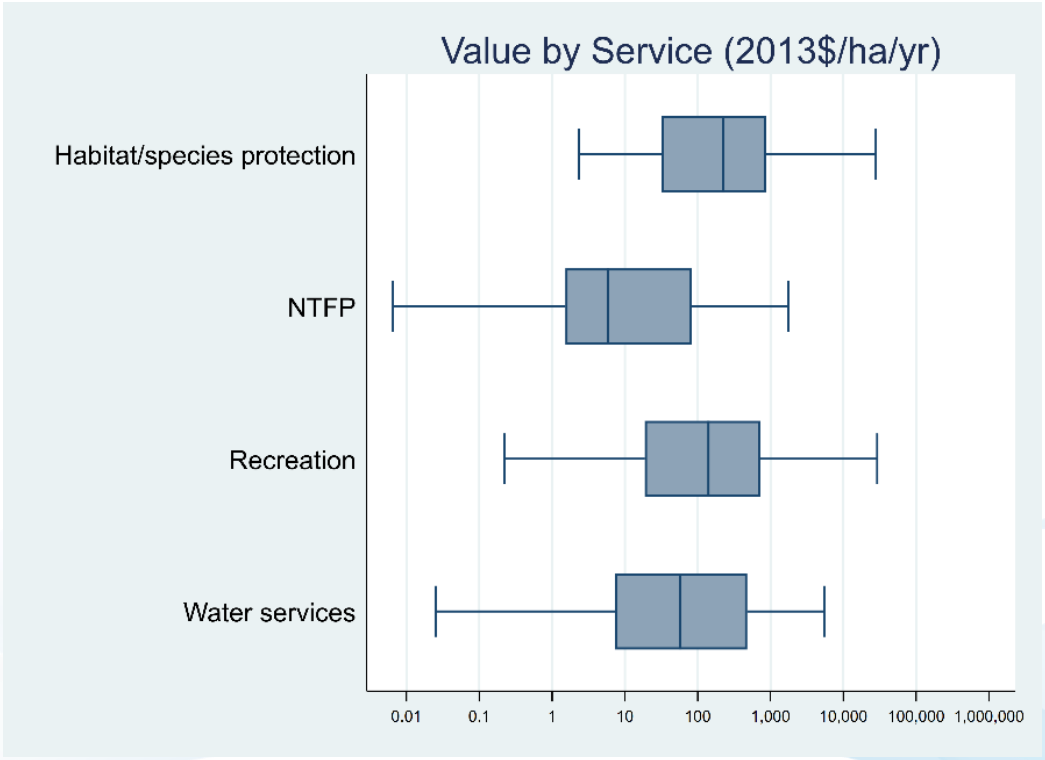


Figure 2 Siikamäki et al. (2021)

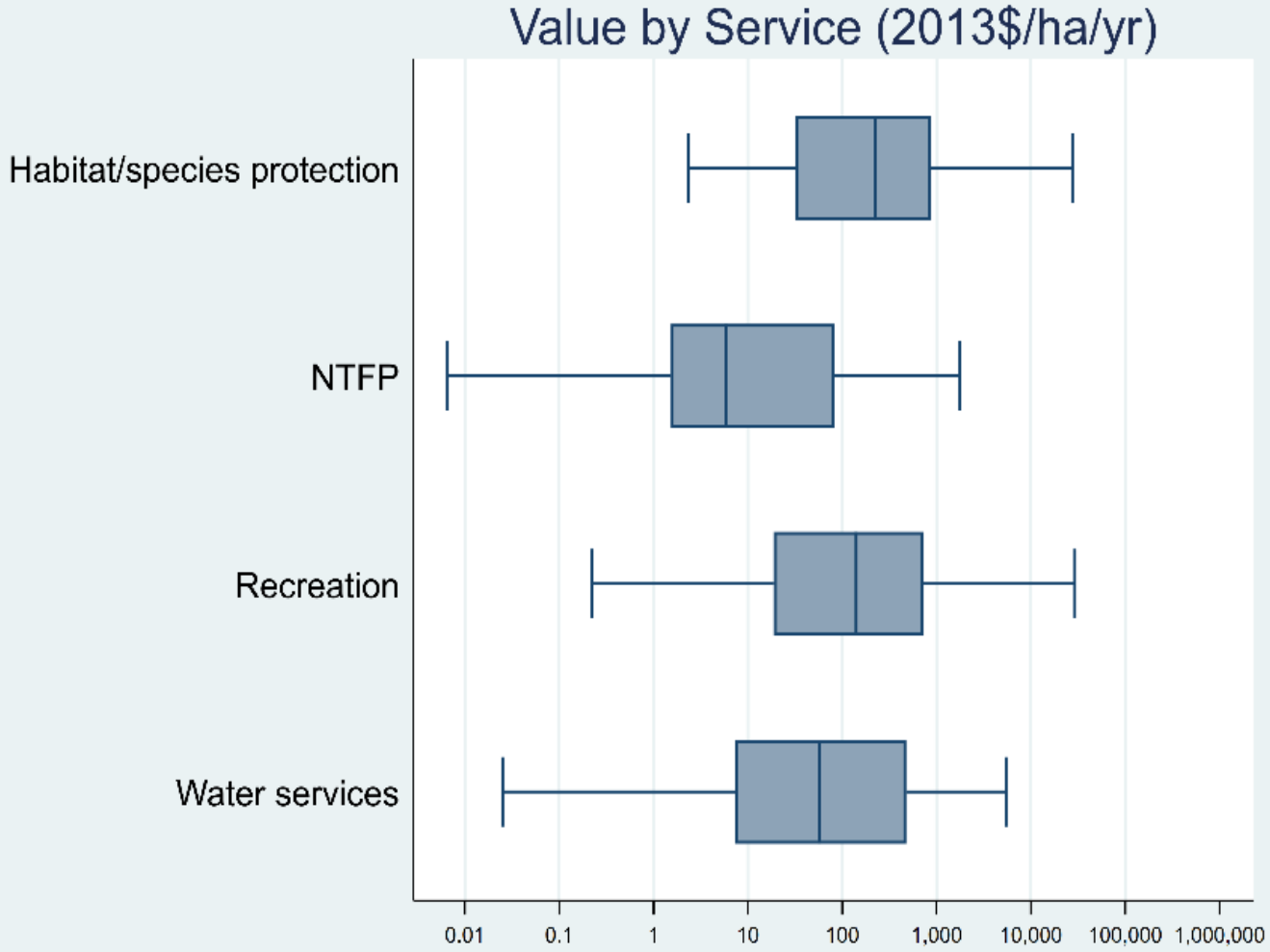
Study locations and values for forest ecosystem services



Figures 4 and 5 Siikamäki et al. (2021)

Water value by service and country

a) Recreation



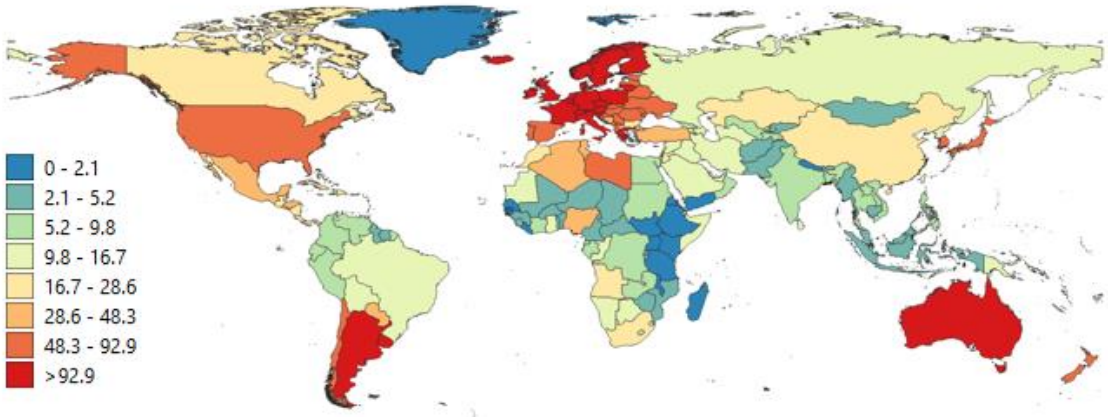
Value range is large

- 0.1 to nearly 10,000 $/ha

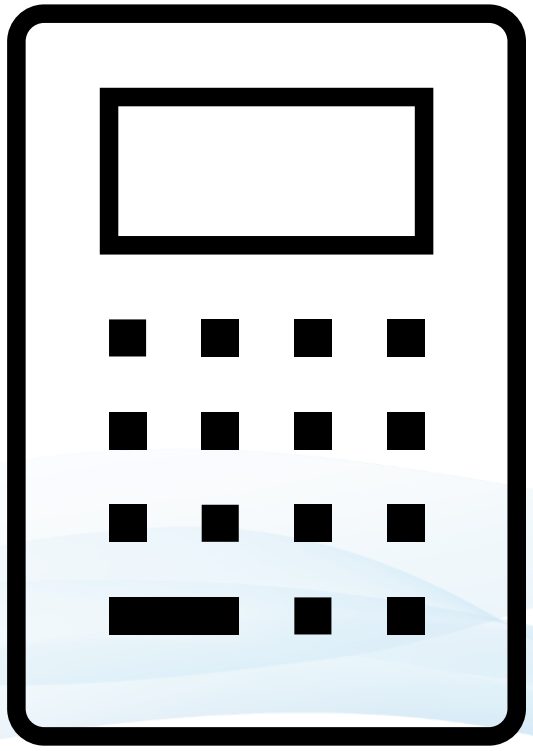
Value distribution

- Value higher in Europe than Africa

d) Water services



• Apply price x quantity and use NPV



150 countries

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ACCOUNTING CHOICES

Chains of service flows

Many combinations are possible

Forest (Asset)

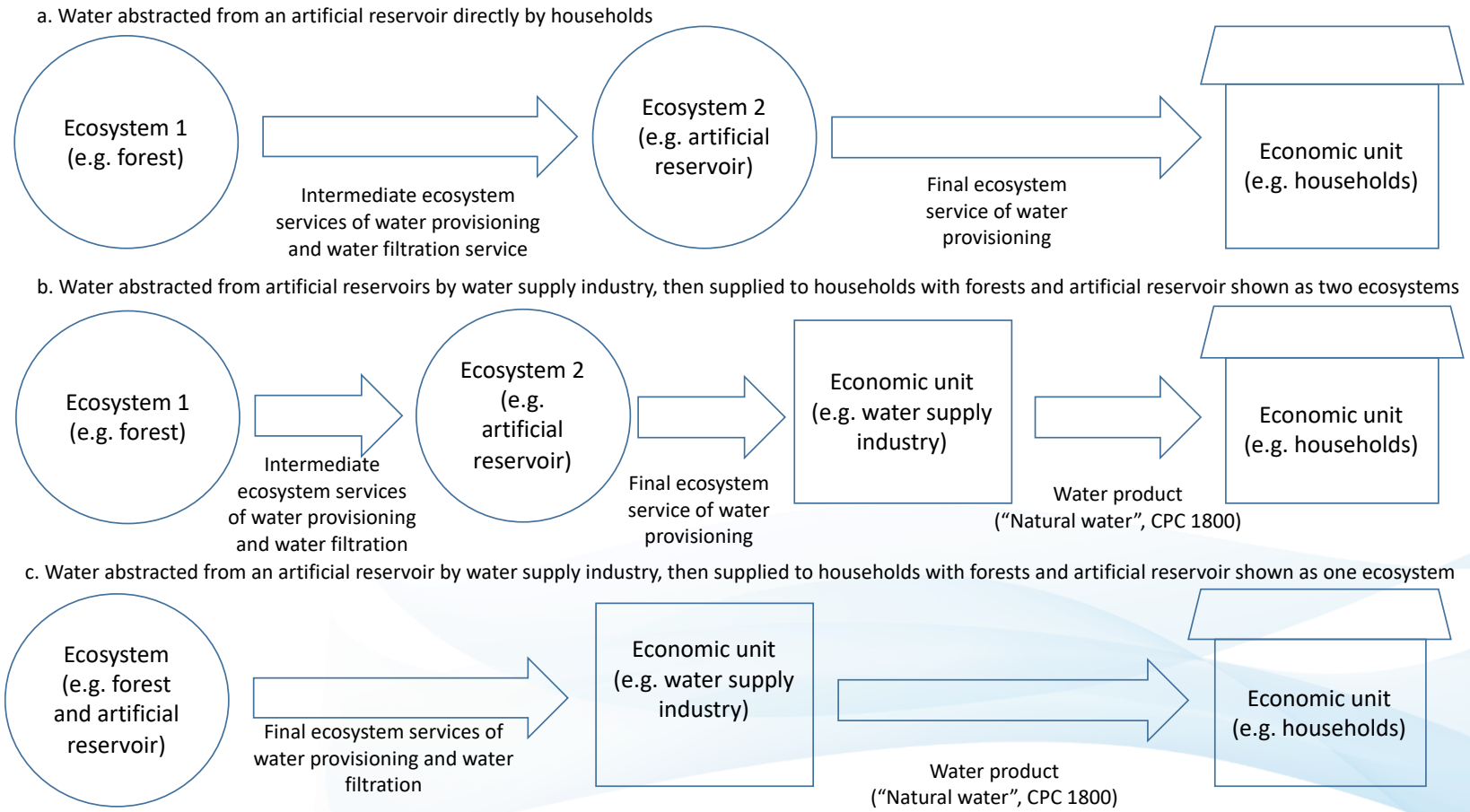
- Supply of water filtration service
- Supply of water provisioning service

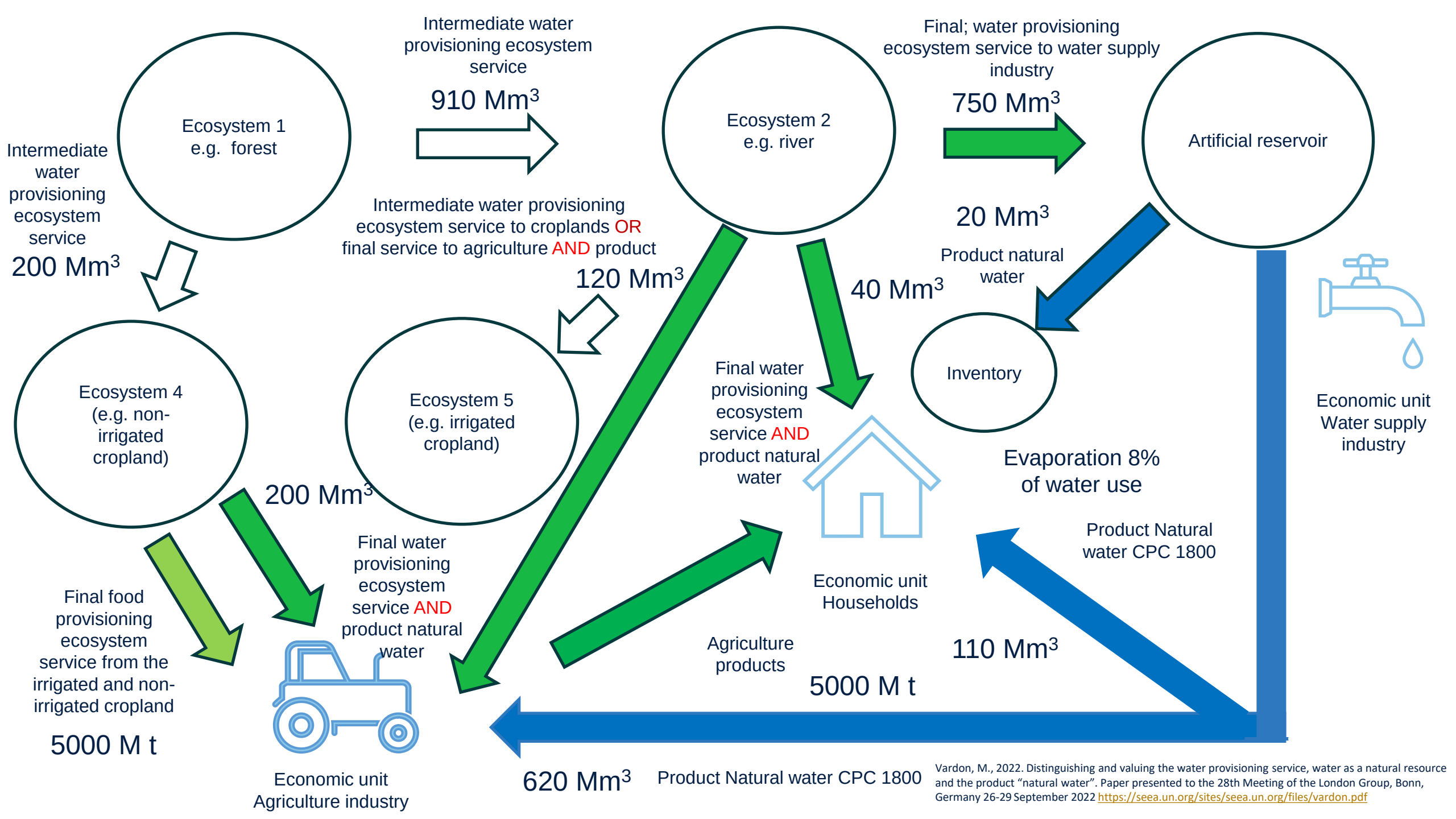
Agricultural land (Asset)

- Intermediate use of water provisioning service
- Final supply of food provision service

Artificial reservoirs (Asset)

- Use of final water provisioning service
- Supply of water product (CPC1800)





Vardon, M., 2022. Distinguishing and valuing the water provisioning service, water as a natural resource and the product "natural water". Paper presented to the 28th Meeting of the London Group, Bonn, Germany 26-29 September 2022 https://seea.un.org/sites/seea.un.org/files/vardon.pdf

Overlap of water resources with other forms of natural capital in CWON

	Final ecosystem service	Intermediate ecosystem service(s)	Notes
Renewable			
Agricultural land (cropland and pasture)	Food provisioning	Water supply Water filtration	Value of water supply and filtration embedded in value of harvested crops and livestock (SEEA EA) Value of soil water embedded in land (SNA)
Forests (timber, non-timber forest products and ecosystem services)	Timber and non-timber forest products provisioning Water supply Water filtration	Water supply Water filtration	Value of water supply and filtration embedded in value of timber Value of water filtration embedded in water supply
Protected areas	Water supply Water filtration Cultural and recreational services	Water filtration Water supply	
Mangroves	Protection of coastal assets, including water sources (quality and quantity)		This is the value of mangroves to water supply Note: Marine fisheries not shown

CONCLUSIONS

Service-by-service is most feasible now

Hard but

- Global hydrological models can provide volume
- Global meta-analysis can provide price

Going forward do more than one way

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THANK YOU

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