

A full account of water

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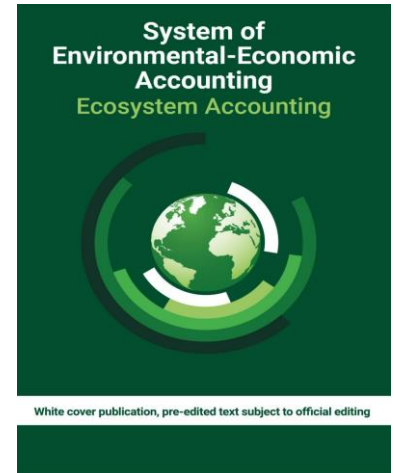
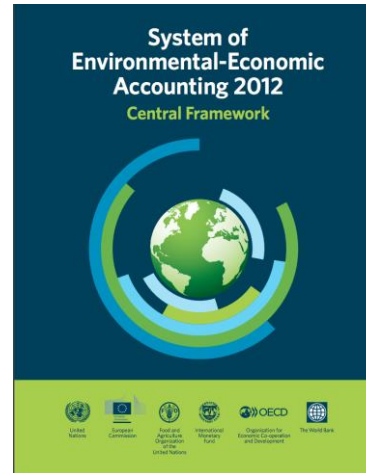
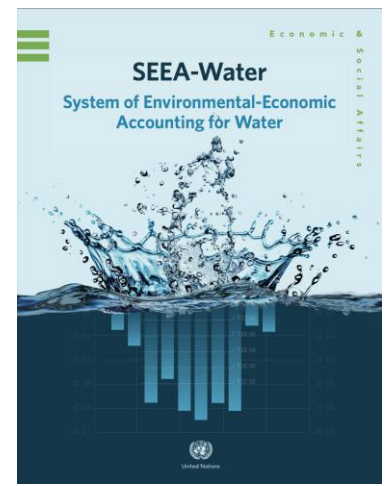
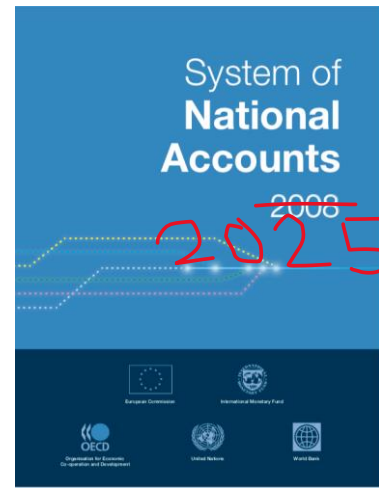
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Outline of presentation

- Questions and recommendations to the London Group
- Terminology
- Reservoir water as a produced asset
- Water quality accounts
- Water valuation
- Water accounting and policy



Recommendations and questions to the London Group



Q1. Do you agree with the recommendations?

Q2. What process would be needed to update SEEA-Water as proposed in Recommendation 9

1. That concordance tables and diagrams for the definitions of water flows and assets in the SEEA-Water, SEEA-CF, and SEEA-EA are added to the Central Framework
2. Water in reservoirs should be treated as a produced asset
3. The water supply use tables in the Central Framework be updated to reflect reservoir water as a produced asset, and to accommodate this:
 - a. The water supply industry is split into water distribution and water storage, and
 - b. The product natural water (CPC 1800) is split into distributed water and stored water
 - c. A column for inventory is added
4. That text is added to Central Framework, clarifying that losses in water distribution and, if accepted that water is a produced asset, losses from evaporation in reservoirs, be treated as use of natural water (CPC 1800) by the water storage industry (a sub-category of the water supply industry).
5. That physical and monetary supply use tables integrating the Central Framework and Ecosystem Accounting are developed along the lines suggested in this paper
6. That the water quality accounts from the SEEA-Water become part of the Central Framework.
7. That the methods from the SEEA Ecosystem Accounting be used to value water abstractions and water assets in the Central Framework.
8. That alternative representations of water values are recognised in the Central Framework update
9. That the SEEA-Water is updated, integrating the relevant parts of the Central Framework and Ecosystem accounting, more guidance on values and valuation, and with material on how water accounting can be used for water policy and management

TERMINOLOGY AND DEFINITIONS



Water terminology and definitions

Lots of terms and definitions in water accounting

- SEEA is not the only water accounting system (but the most dominant)

A glossary of terms

- SEEA-Water (developed by an expert working group)
- International dictionary of hydrology
- etc

SNA, SEEA-CF and SEEA-Water

- Water as a natural resource
- SNA product “natural water” CPC 1800
 - Makes discussions very confusing!
- SNA product bottled waters CPC 2441
 - Important in many low- and middle-income countries

SEEA-EA

- Water as an abiotic flow or ecosystem service
- Many water-related ecosystem services

Accounting identities

- Water consumption (is it net water use?)



<https://unesdoc.unesco.org/ark:/48223/pf0000221862>

SEEA asset classifications

Similar but different

- Complete alignment of surface water (note artificial reservoirs are an ecosystem asset)
- Groundwater split in SEEA-EA (in practice SEEA-CF and SEEA Water often split renewable and non-renewable groundwater)
- Soil water not explicit in SEEA-EA
- Seas and oceans vs more detail in marine

Water in SEEA-CF and SEEA Water recognised in its own right

- SEEA-EA water a part of ecosystems (dominant in surface water)
- Marine ecosystems: is water like air for terrestrial ecosystems?
 - Is the atmosphere an asset?

Recommendation 1. That concordance tables and diagrams for the definitions of water flows and assets in the SEEA-Water, SEEA-CF, and SEEA-EA are added to the Central Framework

SEEA Central Framework and SEEA-Water	SEEA Ecosystem Accounting	Notes for determining the scope and definitions of water assets for valuation
Surface water <ul style="list-style-type: none"> • Rivers and streams • Lakes • Artificial reservoirs • Snow, ice and glaciers 	Freshwater <ul style="list-style-type: none"> • F1 Rivers and streams • F2 Lakes • F3 Artificial reservoirs • T6 Polar-alpine (cryogenic) 	Direct correspondence between SEEA-Water, SEEA Central Framework and SEEA Ecosystem Accounting
Groundwater	<ul style="list-style-type: none"> • SF1 Subterranean freshwater • SF1 Anthropocentric subterranean freshwater • FM1 Semi-confined transitional waters 	SEEA Ecosystem Accounting subdivides groundwater into three classes. In the SEEA-Water and SEEA Central Framework, groundwater includes all these sources and could be similarly divided.
Soil water	<ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • TF1 Palustrine 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 <ul style="list-style-type: none"> • M1 Marine shelf • M2 Pelagic ocean waters • M3 Deep sea floors 	The SEEA-Water included seas and oceans as a source of water for desalination and cooling water as well as 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.

RESERVOIR WATER AS A PRODUCED ASSET



2008 SNA, assets, and production

2008 SNA paragraph 10.8

“An asset is a store of value representing a benefit or series of benefits accruing to the economic owner by holding or using the entity over a period of time. It is a means of carrying forward value from one accounting period to another. All assets in the SNA are economic assets.”

2008 SNA paragraph 10.9

“Produced assets are non-financial assets that have come into existence as outputs from production processes that fall within the production boundary of the SNA” and “Non-produced assets are non-financial assets that have come into existence in ways other than through processes of production.”

2008 SNA paragraph 6.2

“Production is an activity, carried out under the responsibility, control and management of an institutional unit, that uses inputs of labour, capital, and goods and services to produce outputs of goods and services.”

2008 SNA paragraph 10.12

“produced assets that consist of goods and services, which came into existence in the current period or in an earlier period, and that are held for sale, use in production or other use at a later date.”



Reservoir water as a produced asset

2008 SNA Assets (paragraph 10.8)

- Water is held in reservoirs and supplied or held over time with benefits accruing to the economic owner. The water volume and water value is carried forward from one accounting period to another. ✓

2008 SNA Produced asset (paragraph 10.9)

- Reservoir water (natural water CPC 1800) is an output of production (see below). ✓
- Without human intervention there would be no reservoir water.
- The water has not come into existence, but it would not be in the reservoir without a production process that stores water
- At present production is recognised when water leaves the reservoir (it didn't come into existence at the dam wall)
- **The question is not whether it comes into existence but when it is produced**

2008 SNA Production (paragraph 6.2)

- Production of reservoir water (natural water CPC 1800) is an activity carried out under the responsibility, control and management of an institutional unit (e.g., enterprises and establishments classified to Water Supply Industry ISIC 36), it uses inputs of labour (dam operation and maintenance), capital (e.g. dam walls), and goods and services (electricity, concrete, chemicals) to produce outputs of goods and services (i.e. natural water CPC 1800). ✓

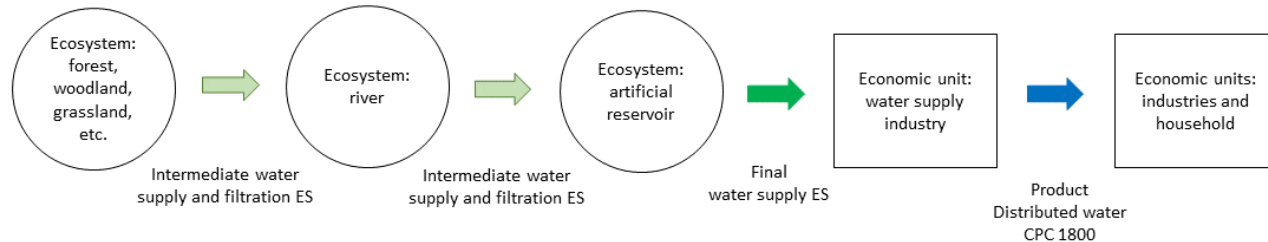
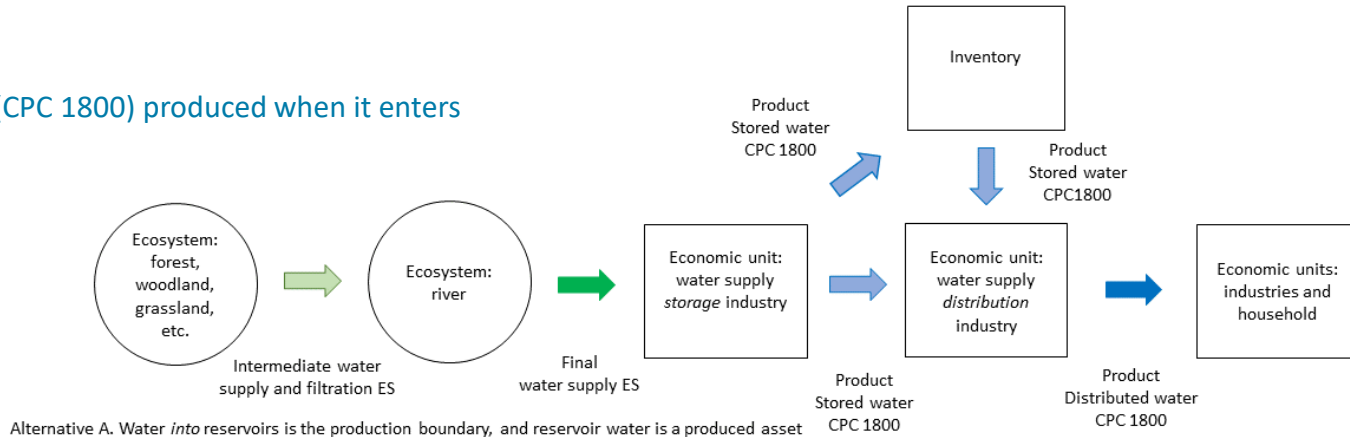
2008 SNA Produced assets (paragraph) 10.12

- Reservoir water is produced in the current period (inflow in current year) or in an earlier period (inflows from previous years) held in storage as an inventory for distribution ✓
- Reservoir water may be distributed or stored for use at a later date

Reservoir water as a produced asset or non-produced asset

Produced asset

- Natural water (CPC 1800) produced when it enters a reservoir



Non-produced asset

- Natural water (CPC 1800) produced when it leaves a reservoir



ACCOUNTING FOR WATER AS A PRODUCED ASSET



Example diagram and table for water as a produced asset

1. Diagram
2. Tables showing entries

A recently published study from Australia

- Chen, Y. & Vardon, M. (2024). Accounting for water-related ecosystem services to provide information for water policy and management: an Australian case study. *Ecosystem Services*.

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Full Length Article

Accounting for water-related ecosystem services to provide information for water policy and management: An Australian case study

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ARTICLE INFO

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System of Environmental-Economic Accounting (SEEA)
Ecosystem accounting
Ecosystem services (ES)
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ABSTRACT
Effective water policy requires good information. The System of Environmental-Economic Accounting (SEEA) requires information on ecosystems and the interactions with the economy. We investigate how accounting for water-related ecosystem services (ES) using SEEA-EA could provide information for water policy and management, using the Integrated Water Resource Management (IWRM) framework and a case study from the Australian Capital Territory (ACT). A policy review and consulting process linking ACT water policies to SEEA-EA identified three key issues: water security, water quality, and soil erosion, which are evident in many parts of the world. Available data and models were used to account for three ES related to these issues: water supply, soil and sediment retention (soil erosion control), and water purification (nutrient retention). Modified estimates varied but were broadly consistent and used to construct ES accounts. The accounts provide comprehensive information linking the ecosystems supplying ES to the use of ES in economic production and consumption. This supports five ACT water policy actions and three of the IWRM Principles. The accounts suggest investment in catchment restoration and management in the Queanbeyan River Catchment to increase ES and improve water supply and quality. The accounts show how much of water is available (IWRM Principle 4) and recognize water as an economic good (IWRM Principle 4) by identifying the uses of water by industry and households. The accounting also enables a participatory approach to water development and management (IWRM Principle 2) by providing stakeholders with information for informed decision-making. Because the policy issues in the case study are common, and IWRM is widely adopted, there is potential to use SEEA-EA for water policy and management globally.

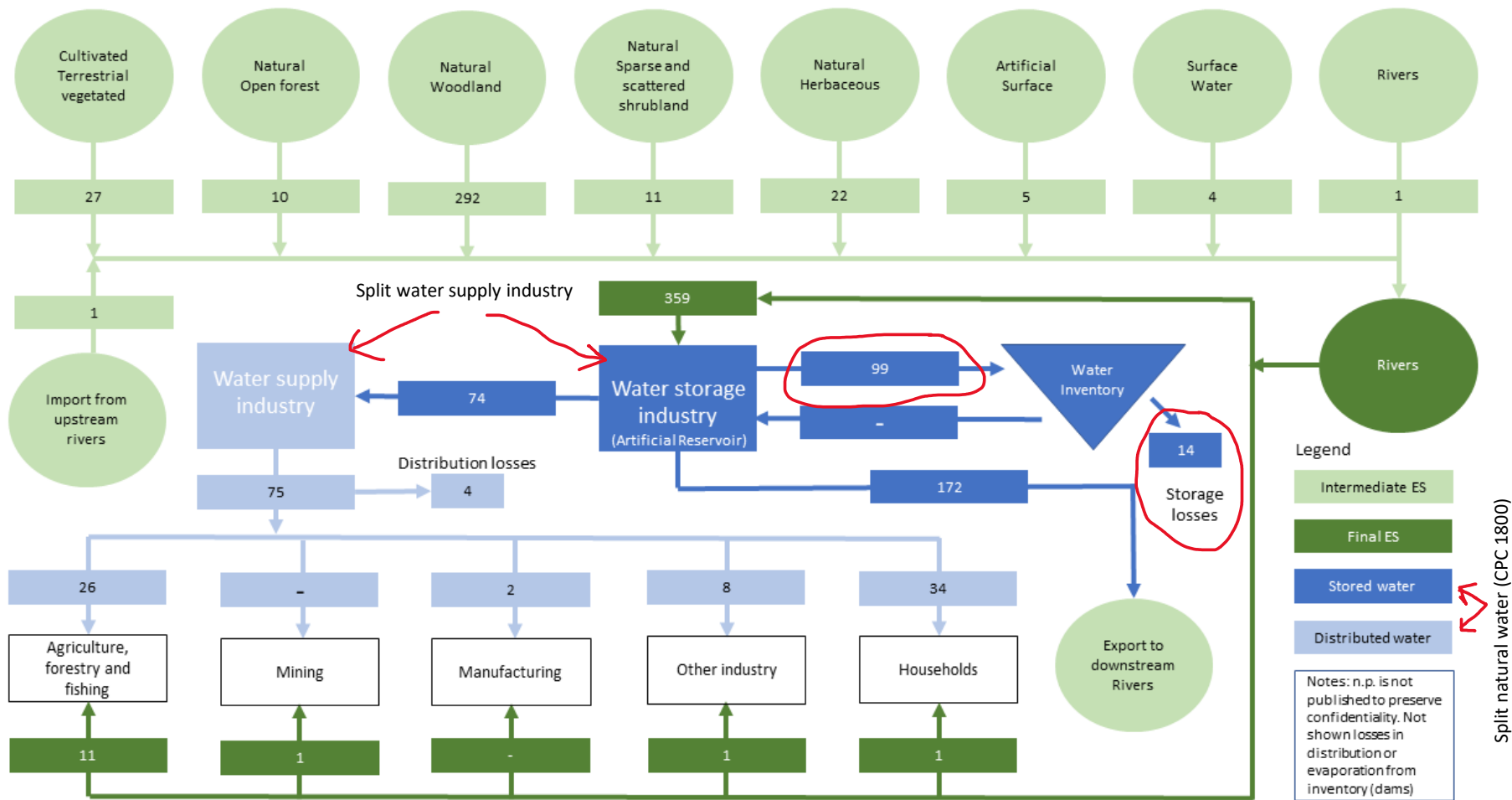
1. Introduction
Effective water policy and management is needed with increasing uncertainty in water supply (Dobson et al., 2001) and a growing water demand as a result of climate change and population growth (Cunill and Liu, 2013). This is reflected in Sustainable Development Goal 6 (SDG 6), to “ensure availability and sustainable management of water and sanitation for all” with targets covering the management issues of water security, sustainable and efficient water supply and use, water quality, and conservation and restoration of water-ecological systems. There is general agreement that reliable and timely data and transparent and evidence-based assessments are needed for policies for sustainable development (e.g., UN, 2013) and this is specifically recognized for water. For example, Principle 5 of the Principles on Water Governance (OECD, 2013) is to “produce, update, and share timely, consistent, comparable and policy-relevant water and water-related data and information, and use it to guide, assess and improve water policy” and Principle 12 is to “promote regular monitoring and evaluation of water policy and governance where appropriate, share the results with the public and make adjustments when needed”. While information is vital for effective water policy and management, it is usually lacking (Ehrlich, 2010; Grafton and Hickey, 2011; Vardon et al., 2022a). This is for several reasons, including that data are not collected or collection is sporadic; collected data are held in multiple agencies and may not be publicly available; data from different agencies, and even within agencies, are often incompatible being based on various theories, standards and methods each developed for a particular purpose (Vardon et al., 2022b). Water accounting can address these issues by organizing existing data in a coherent manner and highlighting data gaps and deficiencies for correction (Vardon et al., 2022a, 2022b; Rajagid et al., 2023). The System of Environmental-Economic Accounting (SEEA) (UN et al., 2012)

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Reservoir water as a produced asset (million m³)



Reservoir water as a produced asset

ES or product	Units	Economy										Environment										Total
		Agriculture, forestry and fishing	Mining	Manufacturing	Water storage industry	Water distribution industry	Other industry	Households	Inventory	Import (supply) / Export (use)	Cultivated terrestrial Vegetated	Natural Open forest	Natural Woodland	Natural Sparse and scattered shrubland	Natural Herbaceous	Bare Surface	Surface Water	Rivers	Import (supply) / Export (use)			
Supply																						
Intermediate ES																						
Water supply	million m3											27	10	292	11	22	5	4	1	1	373	
Final ES																						
Water supply	million m3																					373
Products																						
Stored water	million m3																					359
Distributed water	million m3																					74
Use																						
Intermediate ES																						
Water supply	million m3																					373
Final ES																						
Water supply	million m3	11	1	359			1	1											373			
Products																						
Stored water	million m3																					359
Distributed water	million m3	26		2	14	74	4	8	34	99	172											74

Losses from storage

Losses in distribution

Final ecosystem water supply service supplied to the water storage industry when it enters the reservoir (and to other industries and household when it is abstracted)

Recommendation 3. The water supply use tables in the Central Framework be updated to reflect reservoir water as a produced asset

Recommendation 4. That text is added to Central Framework clarifying treatment of water losses



Recommendations for tables

Recommendation 3.

- The water supply use tables in the Central Framework be updated to reflect reservoir water as a produced asset

Recommendation 4.

- That text is added to Central Framework clarifying treatment of water losses (from storage and in distribution)

Recommendation 5.

- That physical and monetary supply use tables integrating the Central Framework and Ecosystem Accounting are developed

ES or product	Units	Economy									Environment									Total
		Agriculture, forestry and fishing	Mining	Manufacturing	Water storage industry	Water distribution industry	Other industry	Households	Inventory	Import (supply) / Export (use)	Cultivated terrestrial Vegetated	Natural Open forest	Natural Woodland	Natural Sparse and scattered shrubland	Natural Herbaceous	Bare Surface	Surface Water	Rivers	Import (supply) / Export (use)	
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WATER QUALITY ACCOUNTS



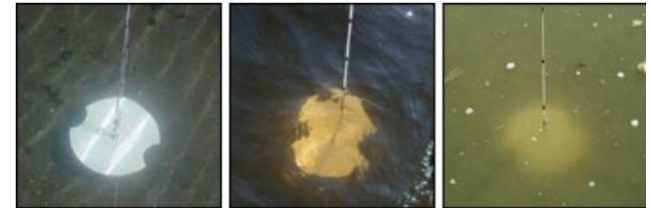
Water quality impacts water availability and ecosystem condition

- Reducing the usable water
- Increasing water treatment costs
- Impacting human health
- Ecological damage



Challenges and Methods in Constructing Water Quality Accounts

- Constructing quality accounts may seem straightforward conceptually.
- Problems exist in defining and measuring water quality classes.
- Water quality is typically defined based on specific concerns (e.g., suitability for drinking water).
- Limited standardisation of concepts, definitions, and aggregation methods for different water concerns.
- Aggregation can occur across:
 - Different pollutants to create an index assessing the collective impact on water resources.
 - Time to account for seasonal variations.
 - Space to derive a unified quality measure across various measurement locations.
- SEEA-EA guidance can be used to describe water quality accounts in the SEEA-CF update.



Use of a Secchi disk for assessing water turbidity. Credit: NASA Earth Observatory using photographs courtesy of the Minnesota Pollution Control Agency.

Relationship to emissions accounts

- Changes in water quality may have multiple causes:
 - Emission of pollutants, linking water quality to water emissions accounts.
 - Self-purification via ecosystem services.
 - Changes in dilution factors due to increased water abstraction.
 - Increased run-off from uncontrolled events or new regulations restricting emissions.
- Pollutants emitted into water resources can be highly toxic, affecting water quality and human health.
- Substances like nitrogen and phosphorus can lead to eutrophication.
- Organic substances can negatively affect the oxygen balance, impacting the ecological status of water bodies.



Water quality accounts - structure

SEEA Standard Table: Quality accounts					
	physical units				
	Quality classes				
	Quality 1	Quality 2	...	Quality n	Total
Opening Stocks					
Changes in stocks					
Closing Stocks					

- Describes the quality of the stocks of water resources
- Structure similar to that of asset accounts
- Included in part 2 of SEEA Water
- Also part of the ecosystem condition accounts (SEEA-EA) for freshwater ecosystems

Recommendation 6. Water quality accounts from the SEEA-Water become part of the Central Framework.



WATER VALUES AND WATER VALUATION



A high-speed photograph of a single water droplet falling into a pool of water. The droplet is suspended in mid-air, just above the surface, and has just made contact, creating a series of concentric ripples that spread outwards. The water is a clear, vibrant blue, and the lighting highlights the droplet's spherical shape and the texture of the ripples.

VALUATION OF WATER

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KEY RECOMMENDATIONS

7. That the methods from the SEEA Ecosystem Accounting be used to value water abstractions and water assets in the Central Framework.
8. That alternative representations of water values are recognised in the Central Framework update.
9. That the SEEA-Water is updated, integrating the relevant parts of the Central Framework and Ecosystem accounting, *more guidance on values and valuation*, and with material on how water accounting can be used for water policy and management.

THE CHALLENGE OF VALUING WATER

- Allocation of benefits difficult
- Multiple:
 - Sources (surface, ground, desalinated)
 - Sourcing (direct, via distributed systems, rainwater collection)
 - Uses (drinking, bathing, watering gardens, own-account ag production)
- Complex ownership & usage rights; multiple beneficiaries
- Interconnected, dynamic water; place-based systems

ECONOMIC VALUE OF WATER

- Focus of SEEA-CF, SEEA-Water (& SEEA EA)
- Exchange value
 - “the values at which goods, services, labour or assets are in fact exchanged or else could be exchanged for cash” (2008 SNA, para 3.118)
 - \$ value *not* value of water to broader society
- Moreover, *price* of water rarely equals exchange value
 - Heavily regulated, monopolistic supply, property rights absent, rationing, bulky

VALUING WATER IN SEEA

- **SEEA-CF** values produced asset Natural Water (CPC 1800) by consumer price or production cost
 - Omits value of water as a natural resource (non-produced asset)
- **SEEA-Water** expands (but does not recommend) valuation techniques for different roles of water in economy

Water's role in economy:

Possible valuation techniques (SEEA-Water p 124):

Water as a final consumer good

Sale and rental of water rights; demand functions from water utility sales; mathematical programming models; alternative cost; contingent valuation

Water as an intermediate input to production

Residual value; change in net income; production function approach; mathematical programming models; sales and rentals of water rights; hedonic pricing; demand functions from water utility sales

Environmental services (waste assimilation)

Cost of actions to prevent damages; benefits from damages averted

Values for recreation, navigation, biodiversity, and water reliability and timing acknowledged but not addressed.

USING VALUATION FROM SEEA-EA

- SEEA-EA values (final ecosystem service) water supply by economic unit
 - SEEA-EA Chs 8, 9, 12 & Technical guidance (NCAVES & MAIA 2022)
 - Examples in NL, Aus, USA, others
- Value must adhere to exchange value concept (no consumer surplus)
 - Consistent with SNA

Recommendation 7: Methods from the SEEA Ecosystem Accounting be used to value water abstractions and water assets in the Central Framework

SEEA-EA RECOMMENDED VALUATION APPROACHES FOR WATER SERVICES

Ecosystem service	Definition	Tier 3 (better)	Tier 2	Tier 2 (less good)
Water supply		Directly observed prices Productivity change	Replacement costs	Residual value
Water purification	Retention and breakdown of nutrients	Directly observed prices	Replacement cost Avoided damages	
Water flow regulation	Baseline flow maintenance Peak flow mitigation	Productivity change Averting behavior	Replacement cost Avoided damages	

Water supply service = "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." (NCAVES & MAIA, p 62)

SEEA-EA RECOMMENDED VALUATION APPROACHES FOR WATER SERVICES

Ecosystem service	Definition	Tier 3 (better)	Tier 2	Tier 2 (less good)
Soil and sediment retention	Soil erosion control	Productivity change	Replacement costs Avoided damages	
Recreation-related	Travel related Local	Simulated exchange value + RUM Hedonic pricing	Consumer expenditure	

TOWARDS VALUING ALL DIMENSIONS OF WATER

- SNA is not designed to measure wellbeing or how economic activity affects the environment
 - “Natural water” valued at price to consumer or cost to consumer
 - No reflection of other roles of water
- SEEA-CF adds pollution and extraction of natural resources
- SEEA-Water outlines valuation methods for multiple economic roles of water
- SEEA-EA adds water-related benefits from ecosystems, partially addressing the economy’s impact on the environment

VALUES OF WATER

- Commodity? Human right? Entity with intrinsic value?
- “Right” valuation depends upon the decision context
 - Put water to its highest economic use – accounting/exchange
 - Identify infrastructure needs – accounting/exchange
 - Weigh costs and benefits – welfare value
 - Protect customary uses – welfare value +
 - Respect water as an entity with intrinsic value – ??
- Many benefits from water cannot be expressed in exchange value (or even monetary) terms



NEED FOR EXTENDING BEYOND EXCHANGE VALUES

- Goal of EA much broader than fitting into SNA
- Compatibility with SNA diminishes utility of accounts for policy analysis (e.g., CBA)
- Exclusion of welfare values limits array of environmental services in accounts
- Technical constraints delay urgent environmental management action

NEED FOR EXTENDING BEYOND EXCHANGE VALUES

Recommendation 8: Alternative representations of water values are recognised in the Central Framework update.

Recommendation 9: The SEEA-Water is updated, integrating the relevant parts of the Central Framework and Ecosystem accounting, *more guidance on values and valuation*, and with material on how water accounting can be used for water policy and management.

INNOVATIONS

- Bridge tables (SEEA-EA Ch 12)
 - Present accounting alongside welfare values
 - Illustrate externalities & ecosystem disservices
- Complementary Accounting Network
 - Non-monetary methods
 - Social, relational, intrinsic values
- Wealth accounting
 - Total (natural, human, productive) capital

KEY RECOMMENDATIONS

5. That physical and *monetary supply and use tables* integrating the CF and EA are developed along the line presented in this paper.
6. ..
7. That the methods from the SEEA Ecosystem Accounting be used to value water abstractions and water assets in the Central Framework.
8. That alternative representations of water values are recognised in the Central Framework update.
9. That the SEEA-Water is updated, integrating the relevant parts of the Central Framework and Ecosystem accounting, *more guidance on values and valuation*, and with material on how water accounting can be used for water policy and management.

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APPLICATIONS OF WATER ACCOUNTING

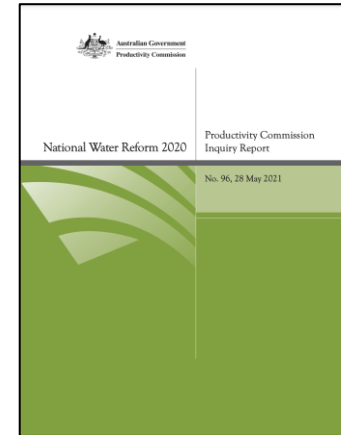
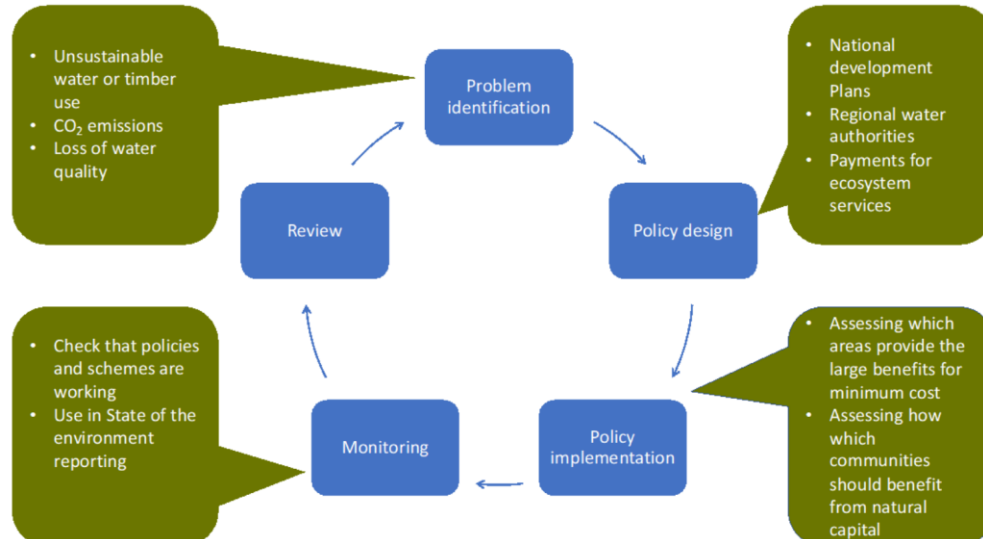


Accounting for water policy and management

Some work but still relatively limited.

Recognised as useful by the Productivity Commission (of Australia) as useful for assessing water reform

Figure 5.1: How NCA can inform integrated landscape management in the policy cycle



<https://www.pc.gov.au/inquiries/completed/water-reform-2020/report/water-reform-2020.pdf>

Meijer, J., Berkhout, E., Hill, C. and Vardon, M., 2020. Integrated landscape management and natural capital accounting: working together for sustainable development. PBL, The Hague. <https://www.pbl.nl/en/publications/integratedlandscape-management-and-natural-capital-accounting-working-together-forsustainable-development>



An update of SEEA Water?

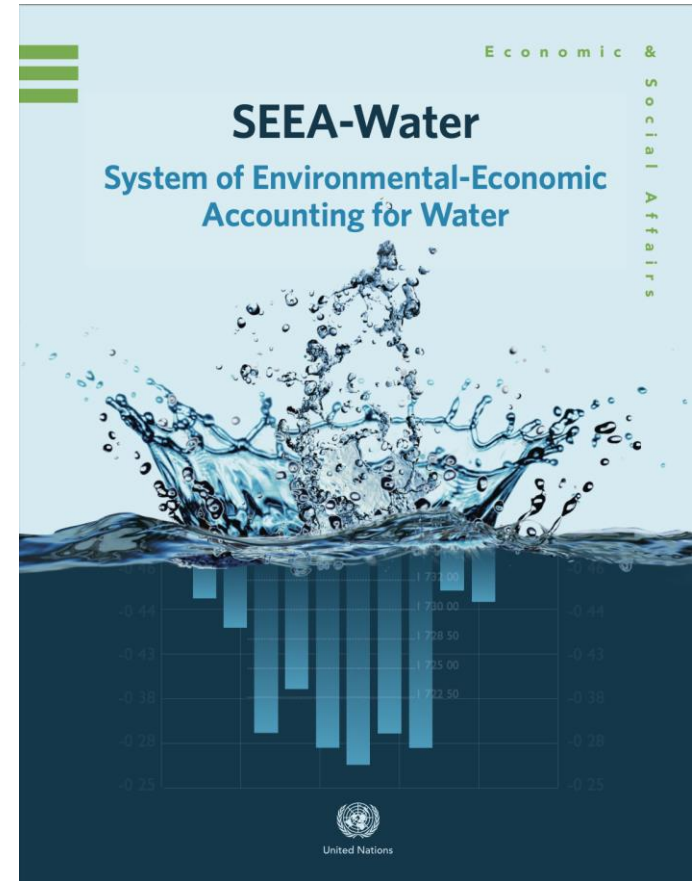
Integrate the SEEA-CF and SEEA-EA

- Harmonise terminology and definitions
- Standardised tables
- Indicators and identities

Add in account production?

Add in applications?

Recommendation 9. That the SEEA-Water is updated



Recommendations and questions to the London Group



Q1. Do you agree with the recommendations?

Q2. What process would be needed to update SEEA-Water as proposed in Recommendation 9

1. That concordance tables and diagrams for the definitions of water flows and assets in the SEEA-Water, SEEA-CF, and SEEA-EA are added to the Central Framework
2. Water in reservoirs should be treated as a produced asset
3. The water supply use tables in the Central Framework be updated to reflect reservoir water as a produced asset, and to accommodate this:
 - a. The water supply industry is split into water distribution and water storage, and
 - b. The product natural water (CPC 1800) is split into distributed water and stored water
 - c. A column for inventory is added
4. That text is added to Central Framework, clarifying that losses in water distribution and, if accepted that water is a produced asset, losses from evaporation in reservoirs, be treated as use of natural water (CPC 1800) by the water storage industry (a sub-category of the water supply industry).
5. That physical and monetary supply use tables integrating the Central Framework and Ecosystem Accounting are developed along the lines suggested in this paper
6. That the water quality accounts from the SEEA-Water become part of the Central Framework.
7. That the methods from the SEEA Ecosystem Accounting be used to value water abstractions and water assets in the Central Framework.
8. That alternative representations of water values are recognised in the Central Framework update
9. That the SEEA-Water is updated, integrating the relevant parts of the Central Framework and Ecosystem accounting, more guidance on values and valuation, and with material on how water accounting can be used for water policy and management

THANK YOU



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