Australian National University

Mapping and Assessment for Integrated Ecosystem Accounting Webinar

Hydrological ecosystem services accounts & SEEA water accounting

Accounting for water and water related ecosystem services using the System of Environment-Economic Accounting

21 June 2021

Australian National University

Steve May
Assistant Director
Australian Bureau of Statistics
steven.may@abs.gov.au

Heather Keith
Senior Research Fellow
Griffith University
h.keith@griffith.edu.au

Michael Vardon
Associate Professor
Australian National University
michael.vardon@anu.edu.au

Yuqing Chen
PhD Candidate
Australian National University
yuqing.chen1@anu.edu.au

Content of presentation

What is environmental-economic accounting and the SEEA?

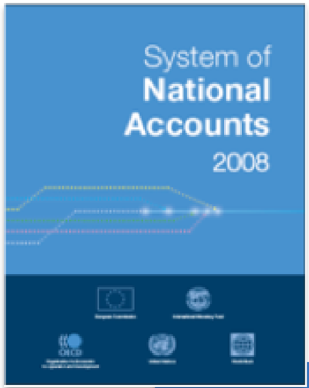
Water accounting

- Asset and flow accounts
- Ecosystem services
- Valuation

Case study

Using environmental-economic accounts

System of Environmental-Economic Accounting (SEEA)



System of National Accounts

- Monetary measures
- Asset and production boundaries set by economics
- Production defined as being capable of being sold in markets
- Assets defined as being owned and capable of being used for economic gain

SEEA Central Framework

- Physical quantity measures added to monetary measures
- Asset boundary expanded
- Assets no longer have to be owned or capable of being used for economic gain

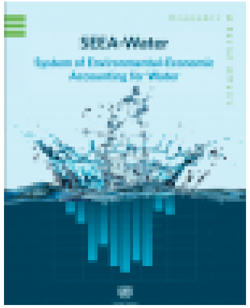
SEEA ~~Experimental~~ Ecosystem

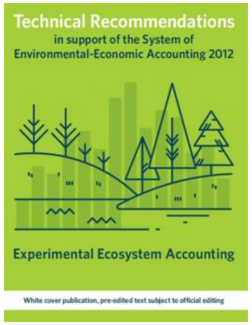
- Physical quality (or condition) measures added
- Production boundary extended
- Production from ecosystems recognized and does not need to be sold in markets

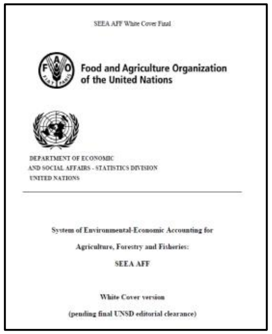
Australian National University

Additional material in support of SEEA

- SEEA Water
- SEEA Energy
- SEEA Applications and Extensions
- SEEA Agriculture Forestry and Fisheries
- Technical Recommendations in support of Experimental Ecosystem Accounting
- International Recommendations for Water Statistics







SEEA-Energy Manual

Draft: English

Three pairs of concepts for environmental accounting

- Stocks are measured at a point in time (e.g. 1 January)
- Flows are measured as a rate (e.g. megalitres per annum, dollars per year)

Stocks and flows

- Physical measures like kilograms, hectares, litres, parts per million
- Monetary measure like $, €, ¥, £, etc.

Physical and monetary measures

Benefits beneficiaries

- Benefits may be in SNA (e.g. in GDP) or non-SNA (e.g. not in GDP)
- Beneficiaries are people of groupings of people (e.g. farmers, government, miners)

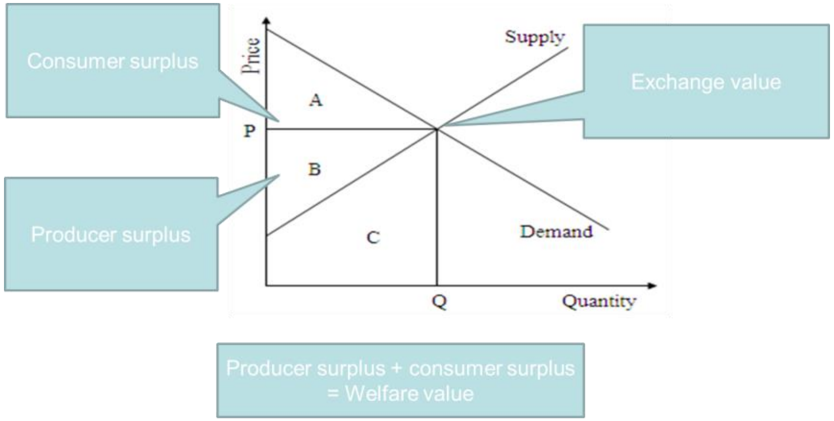
Units, classifications and geographic scope

- Measurement units
  - Use a single unit for each PSUT – joules, cubic metres, tonnes
  - Monetary –current price, constant price, purchase price, producer price
- Classifications
  - Industry classification (ISIC) > ANZSIC
  - Sector classification, Business (financial/non-financial), Government, Not-for-profit (NPISH), Households
  - Classification of natural inputs
  - Central Product Classification (CPC)
  - Standard International Energy product Classification (SIEC)
  - Groups of residuals – waste, wastewater, emissions, etc.
- Geographic scope
  - Start with economic territory/country
  - Record flows based on residence of economic units in the territory
  - Flow not based solely on geographic location

Monetary valuation is important (but controversial)

Economics is the language of decision-making which commonly uses data in monetary terms

- Exchange and welfare values



Value is always context dependent

- Diamonds and water
- Ice and Innuits

Value to who?

- Public and private benefits (and costs)

Why use SEEA?

Incompleteness of current economic accounts

- Don't incorporate many flows between economy and the environment or flows in physical terms
- Do not account effectively for the cost of the use of natural resources
- No clear or common definition of environmental activity

Synthesizes and harmonizes available information and improves data coherence and coordination

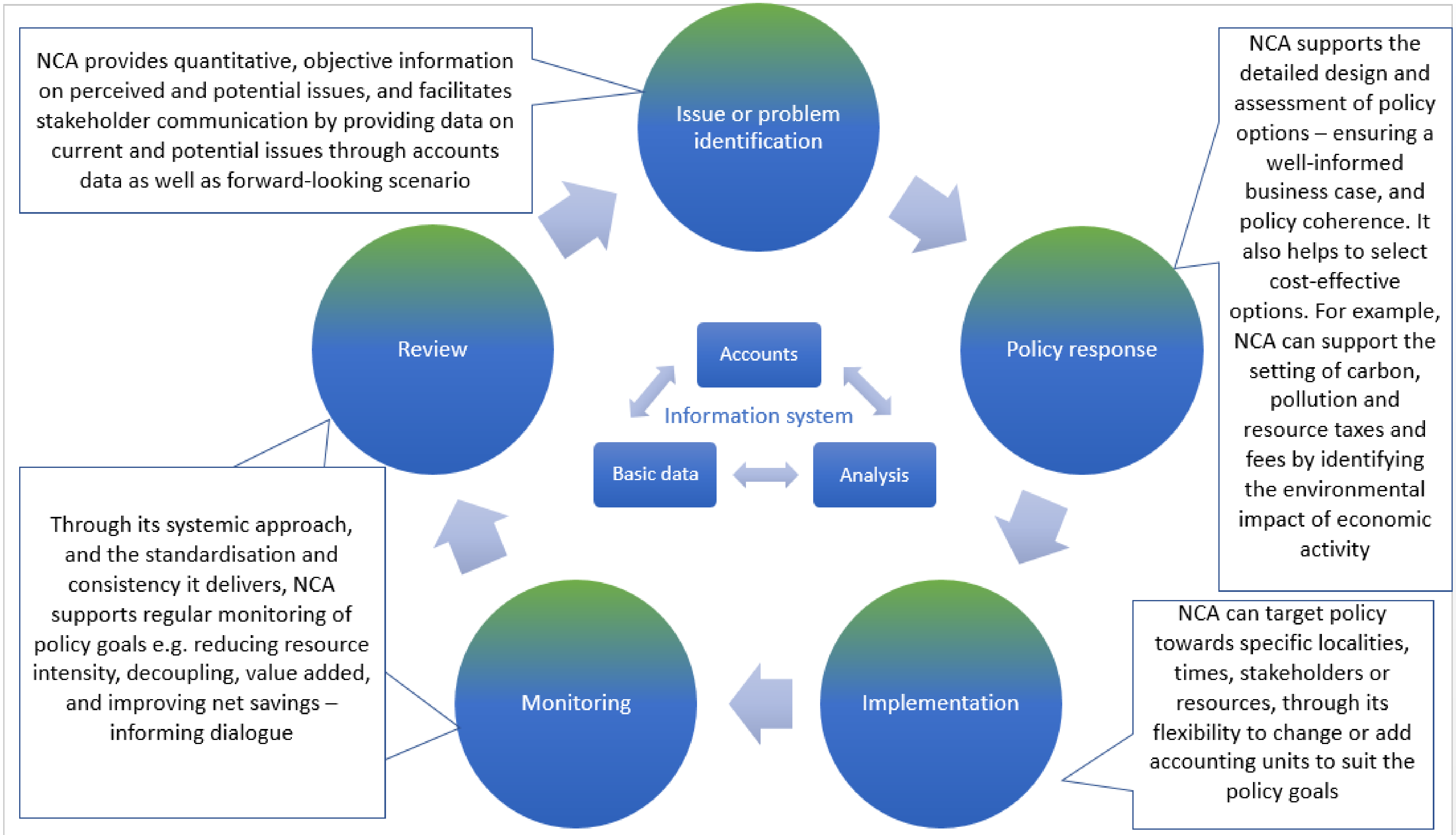
Links to information required for assessing sustainability (SDG, Green Growth, etc.)

Provides a regular suite of integrated information for decision making

- Enabling regular reflection and identification of issues
- Track effectiveness of current policy and management (Accountability)
- Assess policy options and implement policy and management decisions

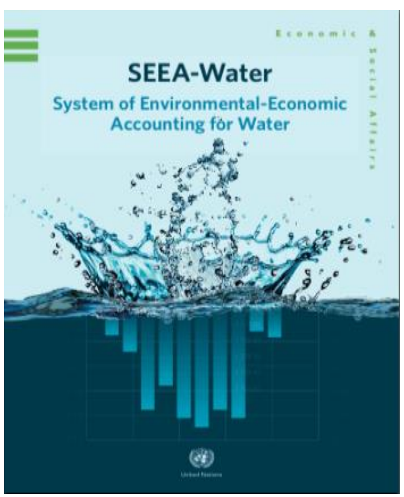
"If you don't measure it, you can't manage it"

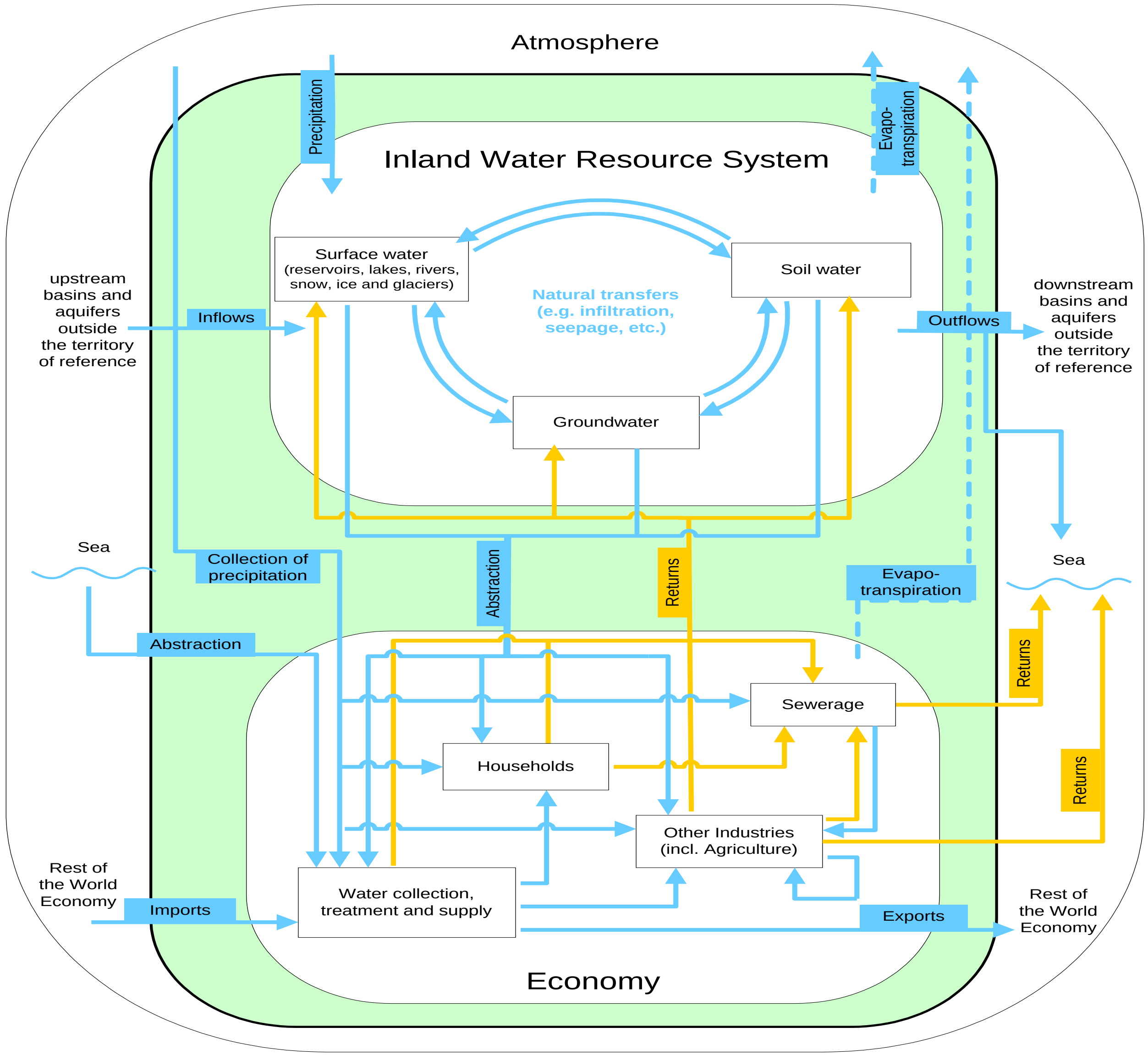
The policy cycle and accounting – more than just monitoring



SEEA-Water

- Stocks and flows
- Economy and environment
- Volume and values

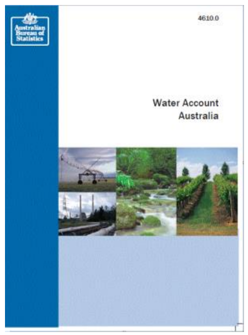


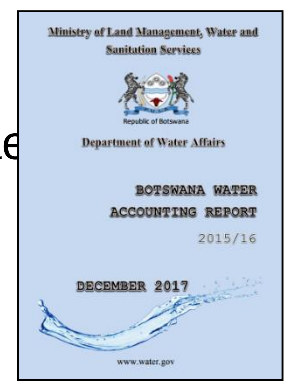


http://unstats.un.org/unsd/envaccounting/seeaw/seeawaterwebversion.pdf

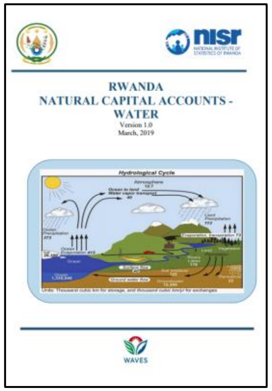
Many countries build water accounts

Andorra
Australia
Austria
Bahamas
Bahrain
Botswana
Brazil
Canada
China
Colombia
Denmark
Dominican Republic
Egypt
France
Germany
Guatemala
HungaryIsrae
Indonesia
IraqItaly
Jordan

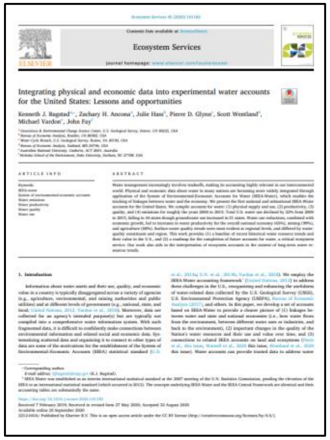


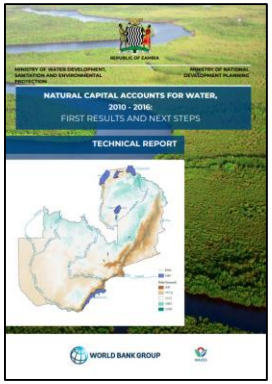


Mexico
Namibia
Netherlands
New Zealand
Oman
Panama
Peru
Philippines
Portugal
Singapore
South Africa
Spain
Sweden
Switzerland
Trinidad and Tobago
Ukraine
Armenia



Estonia
Greece
Lebanon
Mauritius
Madagascar
Norway
Romania
Rwanda
Tunisia
Turkey
United Kingdom
Zambia
USA





SEEA Water Standard Tables
"core tables" in the SEEA Central Framework

1. Physical supply
2. Physical use
3. Gross and net emissions
4. Emissions by ISIC 37
5. Hybrid (Monetary and Physical) supply
6. Hybrid use
7. Hybrid supply and use
8. Hybrid water supply and sewerage for own use
9. Government accounts for water related collective consumption services (Monetary)
10. National expenditure for waste management (Monetary)
11. Financial accounts for waste water management (Monetary)
12. Asset account (Physical)

+ 12 Supplementary tables

Physical asset account for water resources

Table 5.11.2 Physical asset account for water resources (cubic metres)

	Type of water resource						Total
	Surface water				Groundwater	Soil water	
	Artificial reservoirs	Lakes	Rivers and streams	Glaciers, snow and ice			
Opening stock of water resources	1 500	2 700	5 000		100 000	500	109 700
Additions to stock							
Returns	300		53		315		669
Precipitation	124	246	50			23 015	23 435
Inflows from other territories			17 650				17 650
Inflows from other inland water resources	1 054	339	2 487		437	0	4 317
Discoveries of water in aquifers							
Total additions to stock	1 478	585	20 240		752	23 015	46 071
Reductions in stock							
Abstraction	280	20	141		476	50	967
for hydro power generation							
for cooling water							
Evaporation & actual evapotranspiration	80	215	54			21 125	21 474
Outflows to other territores			9 430				9 430
Outflows to the sea			10 000				10 000
Outflows to other inland water resources	1 000	100	1 343		87	1 787	4 317
Total reductions in stock	1 360	335	20 968		563	22 962	46 188
Closing stock of water resources	1 618	2 950	4 272		100 189	553	109 583

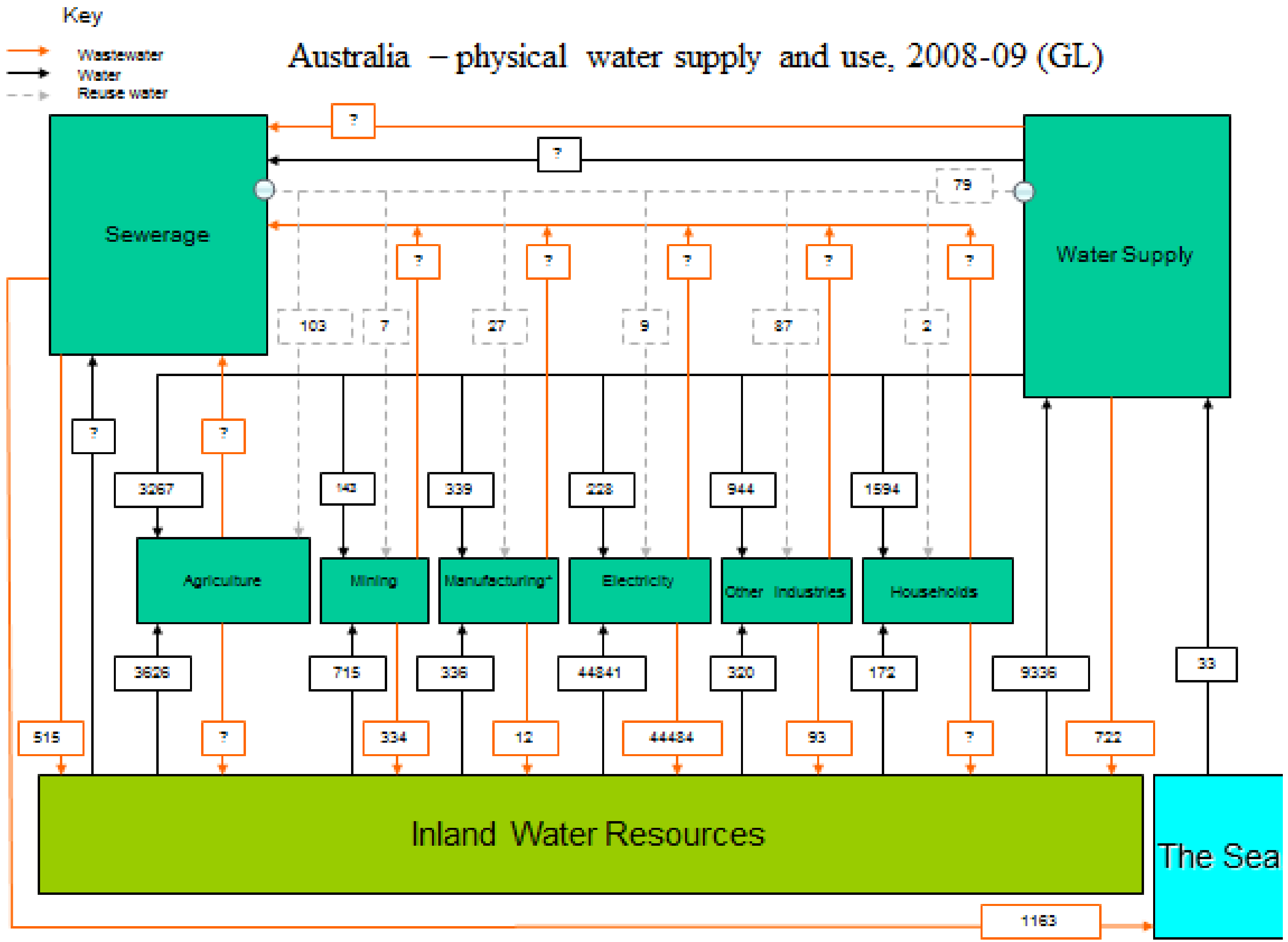
Physical Supply Table for Water

Physical supply table for water										
	Abstraction of water; Production of water; Generation of return flows							Flows from the rest of the world	Flows from the	Total supply
	Agriculture, forestry and fishing	Mining & quarrying, Manufacturing and Construction	Electricity, gas, steam and air conditioning	Water collection, treatment and supply		Sewerage	Other industries	Imports		
				Total (excluding household	Household activity					
Sources of abstracted water										
Inland water resources										
Surface water									440.6	440.6
Groundwater									476.3	476.3
Soil water									50	50
Total									966.9	966.9
Other water sources										
Precipitation									101	101
Sea water									101.1	101.1
Total									202.1	202.1
Total supply abstracted water									1169	1169
Abstracted water										
For distribution				405.6						405.6
For own-use	108.4	114.6	404.2	23	10.8	100.1	2.3			763.4
Wastewater and reused water										
Wastewater										
Wastewater to treatment	17.9	117.6	5.6	1.4	235.5	0	49.1			427.1
Own treatment										0
Reused water produced										
For distribution						42.7				42.7
For own use		10								10
Return flows of water										
To inland water resources										
Surface water			300		0.5	52.5	0.2			352.7
Ground water	65	23.5		47.3	4.1	175	0.5			311.3
Soil water										0
Total	65	23.5	300	47.3	4.6	227.5	0.7			664
To other sources		5.9	100		0.2	256.3				362.2
Total Return flows	65	29.4	400	47.3	4.8	483.8	0.7			1026.2
Evaporation of abstracted water, transpiration and water incorporated into products										
Evaporation of abstracted wat	76.2	43.2	2.5	1.8	10	0.7	3.6			138
Transpiration										
Water incorporated into products										
Total supply	267.5	314.8	812.3	479.1	261.1	627.3	55.7	0	1169	3986.8
Physical use table for water										

Physical Use Table for Water

Physical use table for water

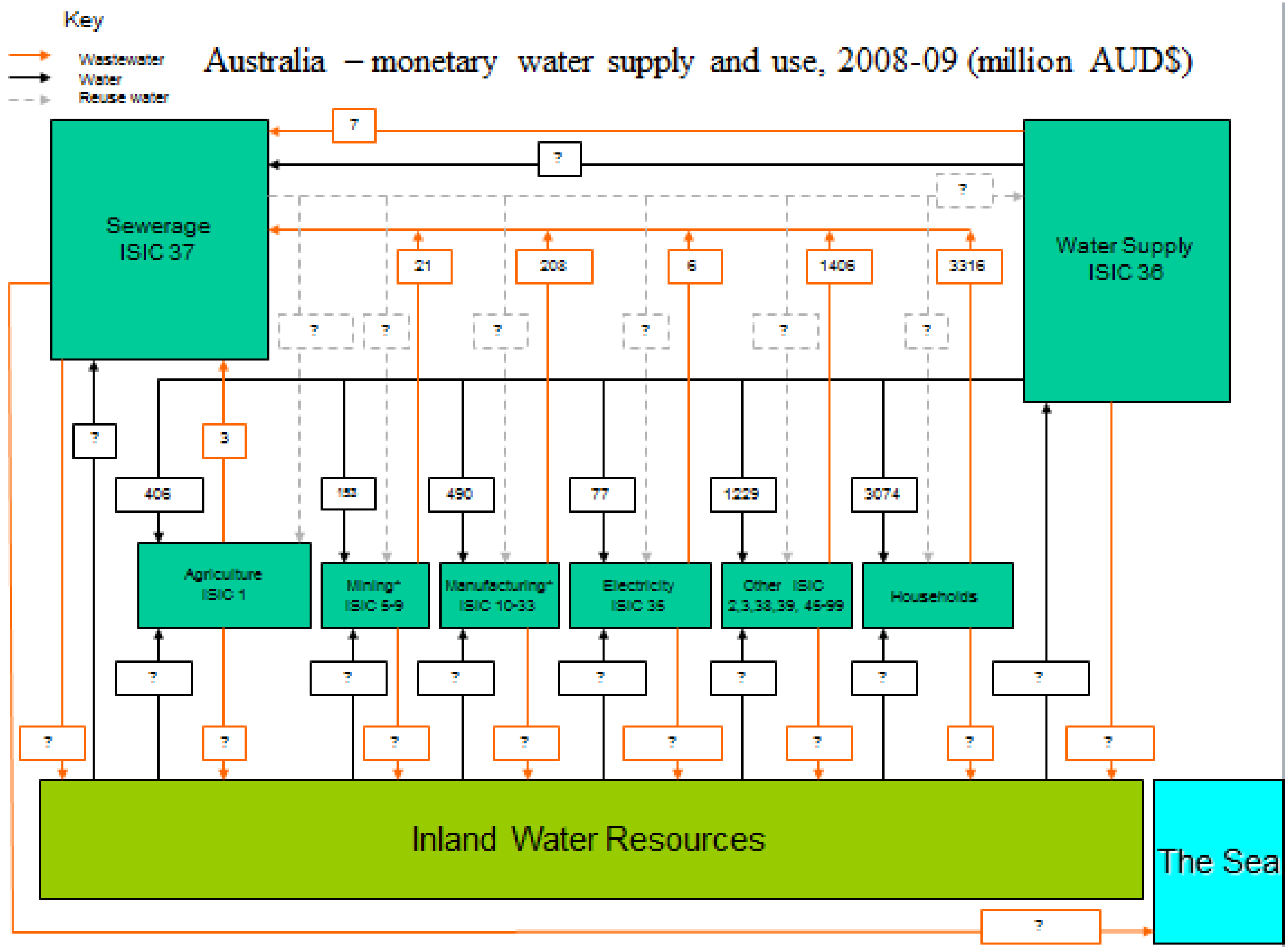
	Abstraction of water; Intermediate consumption; Return flows							Final consumption	Accumulation	Flows to the rest of the world	Flows to the environment	Total use
	Agriculture, forestry and fishing	Mining & quarrying, Manufacturing and Construction	Electricity, gas, steam and air conditioning	Water collection, treatment and supply		Sewerage	Other industries	Households		Exports		
				Total (excluding household	Household activity							
Sources of abstracted water												
Inland water resources												
Surface water	55.3	79.7	301	4.5	0	0.1						440.6
Groundwater	3.1	34.8	3.2	423.1	9.8		2.3					466.5
Soil water	50											50
Total	108.4	114.5	304.2	427.6	9.8	0.1	2.3					957.1
Other water sources												
Precipitation				0	1	100						100
Sea water			100	1.1								101.1
Total	0	0	100	1.1	1	100	0					201.1
Total use abstracted water	108.4	114.5	404.2	428.7	10.8	100.1	2.3					1158.2
Abstracted water												
Distributed water	38.7	45	3.9	27.4	0	0	51.1	239.5		0		405.6
Own use	108.4	114.6	404.2	23	0	100.1	2.3	10.8				763.4
Wastewater and reused water												
Wastewater												
Wastewater received from other units				0		427.1				0		427.1
Own treatment	12	40.7										52.7
Reused water												
Distributed reuse												
Own use												
Total	12	40.7	0	0	0	427.1	0	0		0		479.8
Return flows of water												
Returns of water to the environment												
To inland water resources											668.6	668.6
To other sources											362.4	362.4
Total return flows											1031	1031
Evaporation of abstracted water, transpiration and water incorporated into products												
Evaporation of abstracted water											138	138
Transpiration												
Water incorporated into products												
Total use	267.5	314.8	812.3	479.1	10.8	627.3	55.7	250.3	0	0	1169	3986.8



Key
Wastewater
Water
Reuse water
Australia – physical water supply and use, 2008-09 (GL)
Sewerage
Water Supply
Agriculture
Mining
Manufacturing*
Electricity
Other Industries
Households
Inland Water Resources
The Sea
?
79
103
7
27
9
87
2
3267
143
339
228
944
1594
3626
715
336
44841
320
172
9336
33
515
334
12
44484
93
722
1163

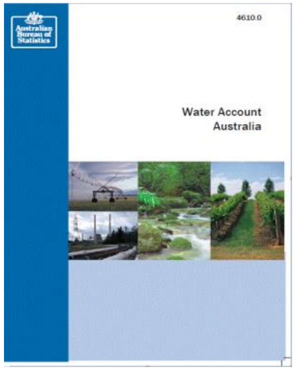
Monetary Supply and Use Account

	Industries (by ISIC Division)							Rest of the world	Taxes less subsidies on products, trade and transport margins	Actual final		
	ISIC 01-03	ISIC 05-33, 41-43	ISIC 35	ISIC 36	ISIC 37	ISIC 38,39, 45-99	Total industry			Households	Government	Total
Supply of water products (Currency units)												
Natural water	L.1.1	L.1.1	L.1.1	L.1.1	L.1.1	L.1.1	L.1.1		M.1.1.1-[N.1.1.1+N.1.2.1]			1.1-[N.1.1.1+N.1.2.1]
Sewerage services	L.1.2	L.1.2	L.1.2	L.1.2	L.1.2	L.1.2	L.1.2		M.1.1.2-[N.1.1.2+N.1.2.2]			1.2-[N.1.1.2+N.1.2.2]
Total supply of products												
Intermediate consumption and final use (Currency units)												
Natural water	L.4.1	L.4.1	L.4.1	L.4.1	L.4.1	L.4.1	L.4.1			N.1.1.1+N.1.2.1	N.1.1.1+N.1.2.1	L.4.1+N.1.1
Sewerage services	L.5.1	L.5.1	L.5.1	L.5.1	L.5.1	L.5.1	L.5.1			N.1.1.2+N.1.2.2	N.1.1.2+N.1.2.2	L.5.1+N.1.1.2+N.1.2.2



Key
Wastewater
Water
Reuse water
Australia – monetary water supply and use, 2008-09 (million AUD$)
Sewerage ISIC 37
Water Supply ISIC 36
7
?
21
208
6
1406
3316
3
406
153
490
77
1229
3074
Agriculture ISIC 1
Mining* ISIC 5-9
Manufacturing* ISIC 10-33
Electricity ISIC 35
Other ISIC 2,3,38,39, 45-99
Households
Inland Water Resources
The Sea

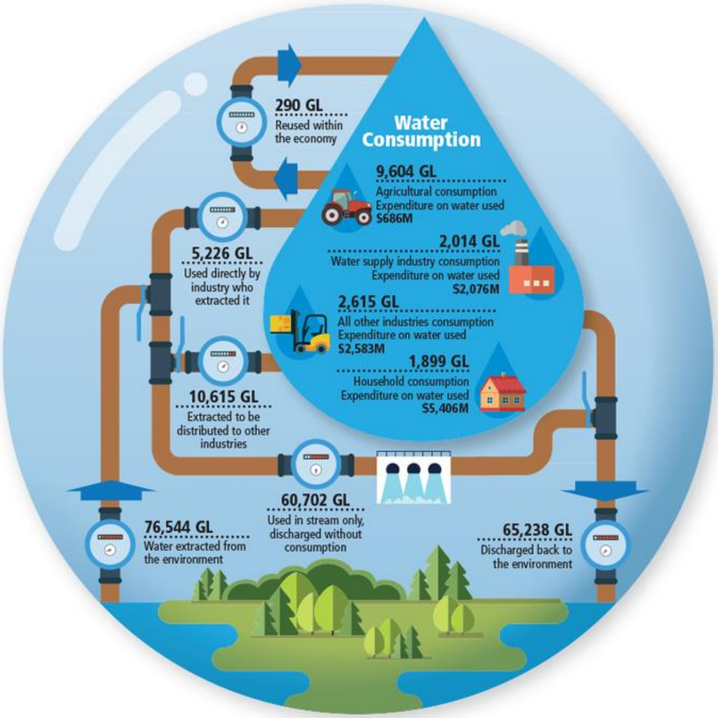
Water Account, Australia



What is in the publication?

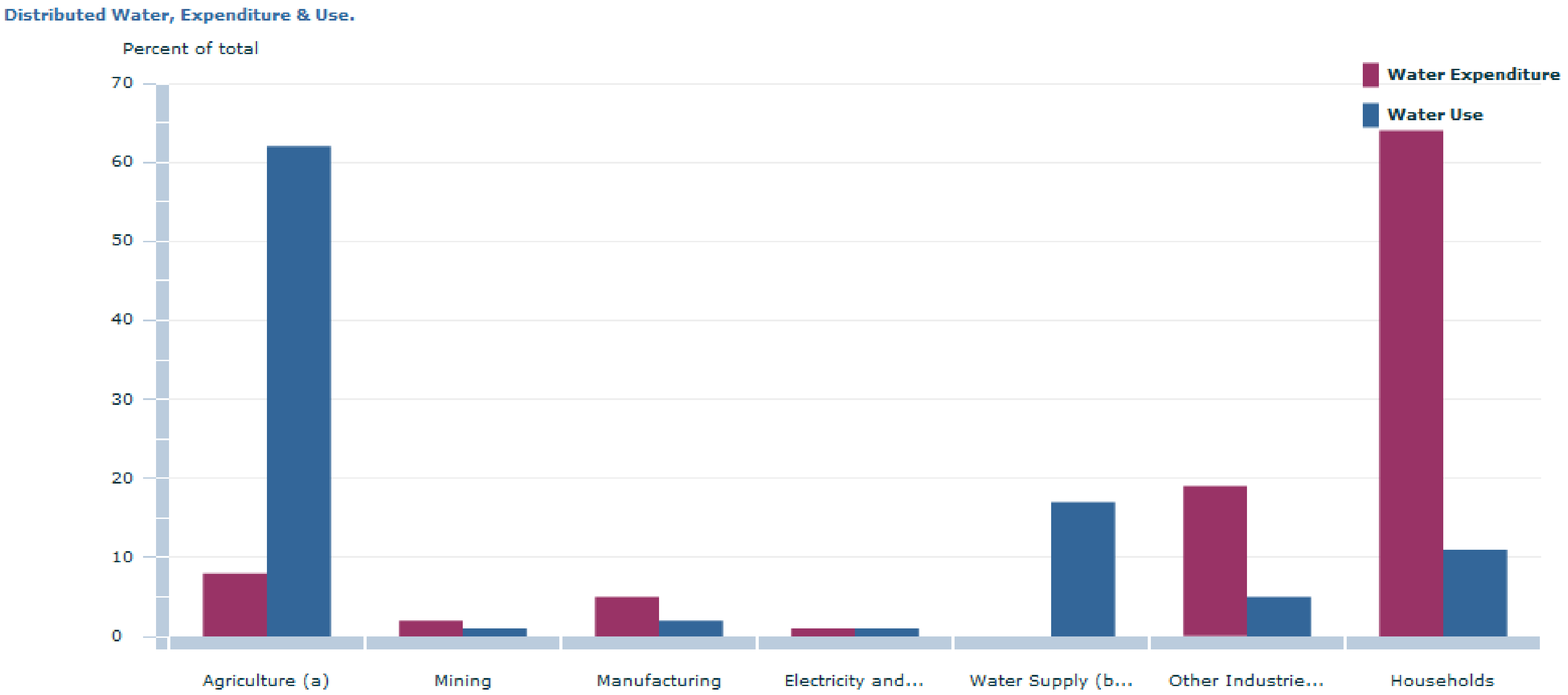
- Web-based publication (previously a .pdf file and hard copy)
- Downloadable spreadsheets
  - Summary tables
  - Physical Water Supply and Use
  - Monetary Supply and Use
  - Water Supply, Sewerage and Drainage
  - Agriculture
  - Soil water use and household rainwater tank
  - Time series, all states/territories

1.1 WATER CONSUMPTION AND RELATED FLOWS, AUSTRALIA, 2015-16

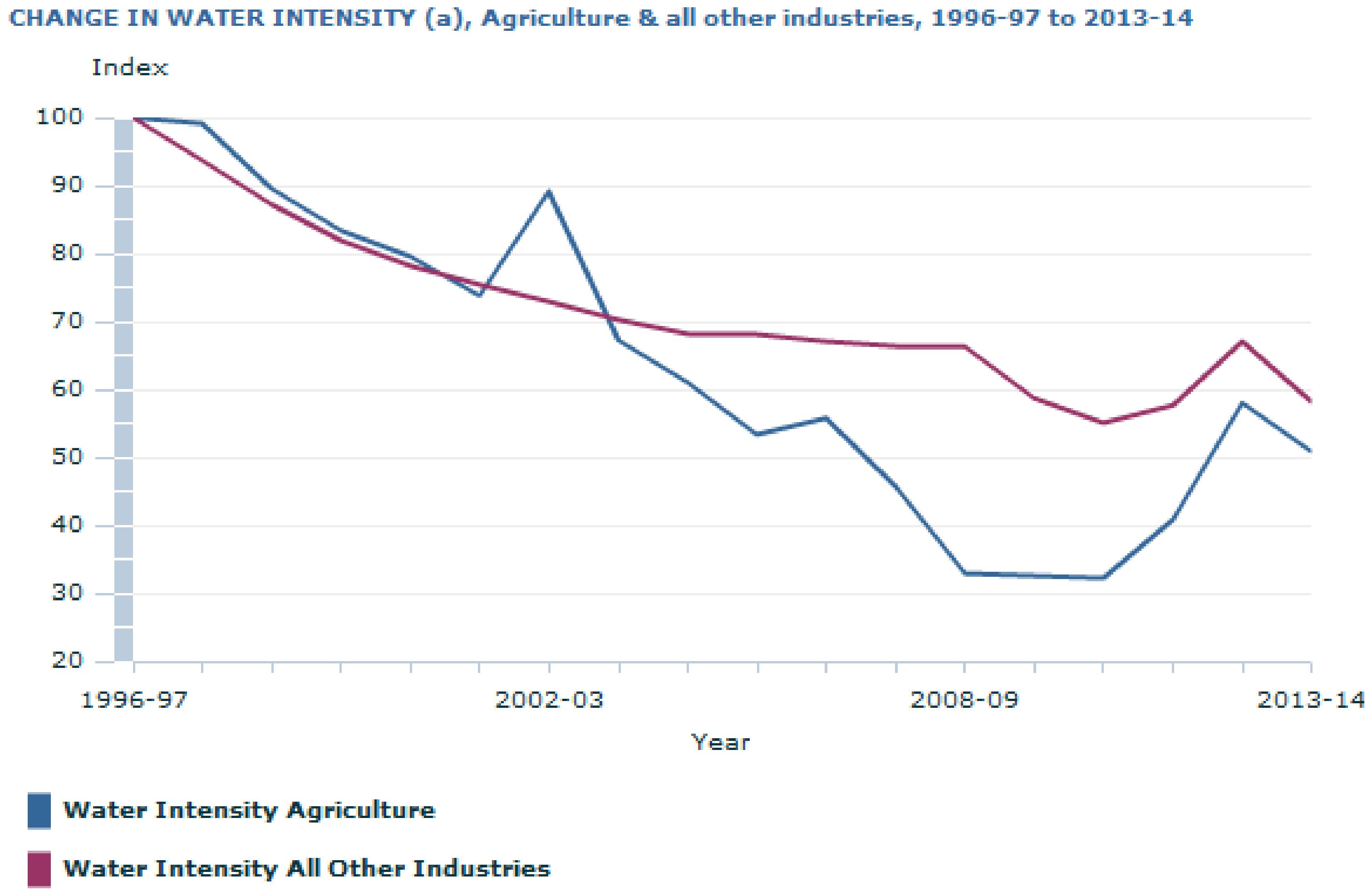


Water Account, Australia

Monetary vs. physical use of distributed water (% of total use), 2013-14



Australia, Industry intensity of water use: 1996-97 to 2013-14



Water emissions account

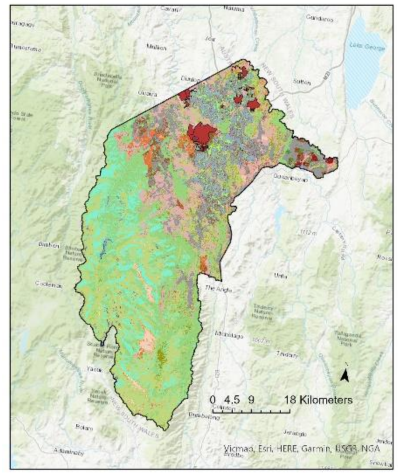
Physical supply table for gross releases of substances to water	Generation of gross releases to water			Accumulation	Flows with the rest of the world	Flows from the environment	Total supply
	Sewerage industry	Other industries	Households	Emissions from fixed assets			
Emissions by type of substance							
BOD / COD *	5 594	11 998	2 712				20 304
Suspended solids							
Heavy metals							
Phosphorous	836	1 587	533				2 956
Nitrogen	10 033	47 258	1 908				59 199
Releases to other economic units							
BOD / COD *		7 927	8 950				16 877
Suspended solids							
Heavy metals							
Phosphorous		814	6 786				7 600
Nitrogen		15 139	30 463				45 602

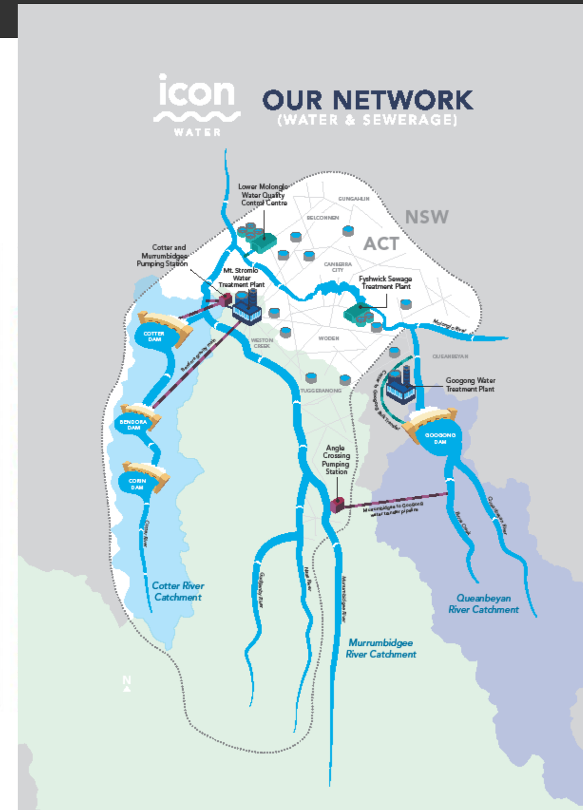
Physical use table for gross releases of substances to water	Collection of gross releases to water				Flows with the rest of the world	Flows to the environment	Total use
	Sewerage industry	Other industries	Households				
Emissions received by the environment							
BOD / COD *						20 304	20 304
Suspended solids							
Heavy metals							
Phosphorous						2 956	2 956
Nitrogen						59 199	59 199
Collection by other economic units							
BOD / COD *	16 877						16 877
Suspended solids							
Heavy metals							
Phosphorous	7 600						7 600
Nitrogen	45 602						45 602

Australian National University

Ecosystem accounting and water

Ecosystem assets
- Lakes
- Rivers
- Dams
- Vegetation
- Soil





Ecosystem assets supply ecosystem services

Water-related ecosystem services

Provisioning services

- Water supply
- Soil and sediment retention

Regulating and maintenance services

- Water purification services
  - Retention and breakdown of nutrients
  - Retention and breakdown of other pollutants
- Water flow regulation services
  - Baseline flow maintenance services
  - Peak flow mitigation services
- Flood control services
  - Coastal protection services
  - River flood mitigation services
- Storm mitigation services

Cultural services

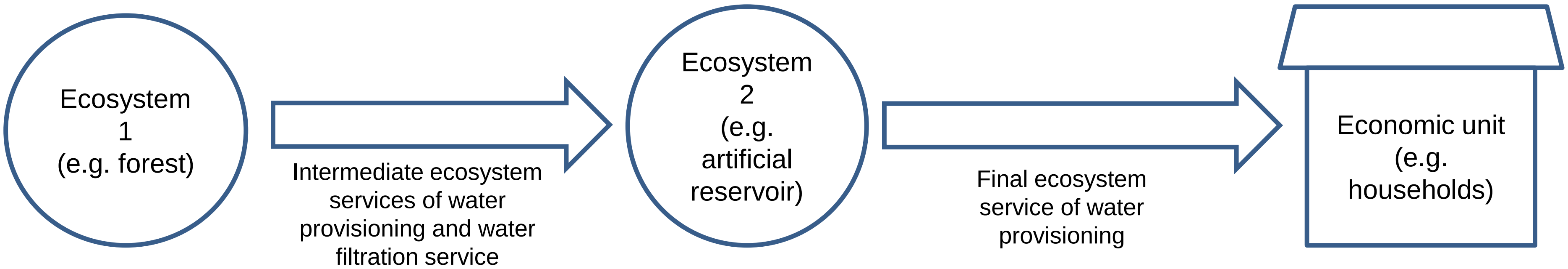
- Recreation-related services
- Visual amenity services
- Education, scientific and research services
- Spiritual, artistic and symbolic services
- Other cultural services

Relatively new and lots of work happening – very hard to keep up to date

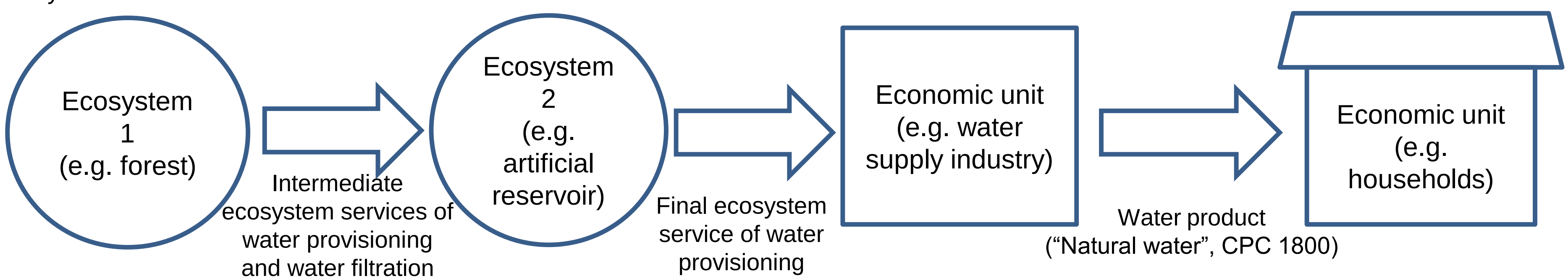
Australian National University

Accounting for multiple water-related ecosystem service

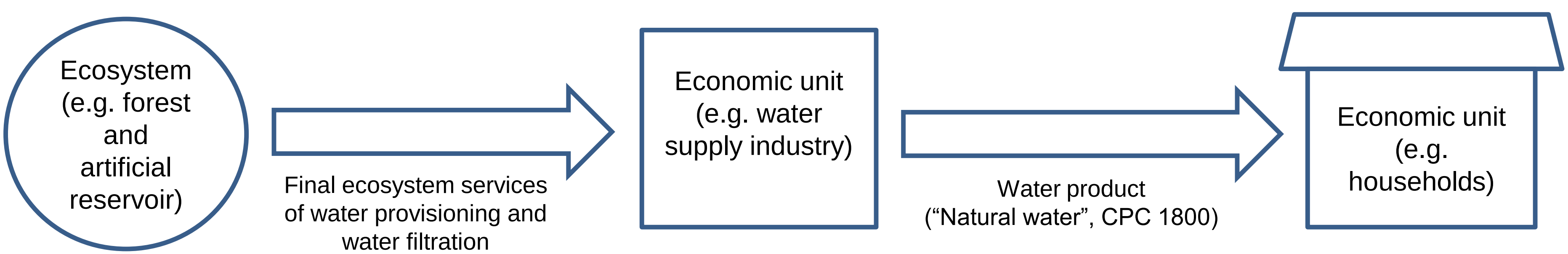
a. Water abstracted from an artificial reservoir directly by households



b. Water abstracted from artificial reservoirs by water supply industry, supplied to households with forests and artificial reservoir shown as two ecosystems



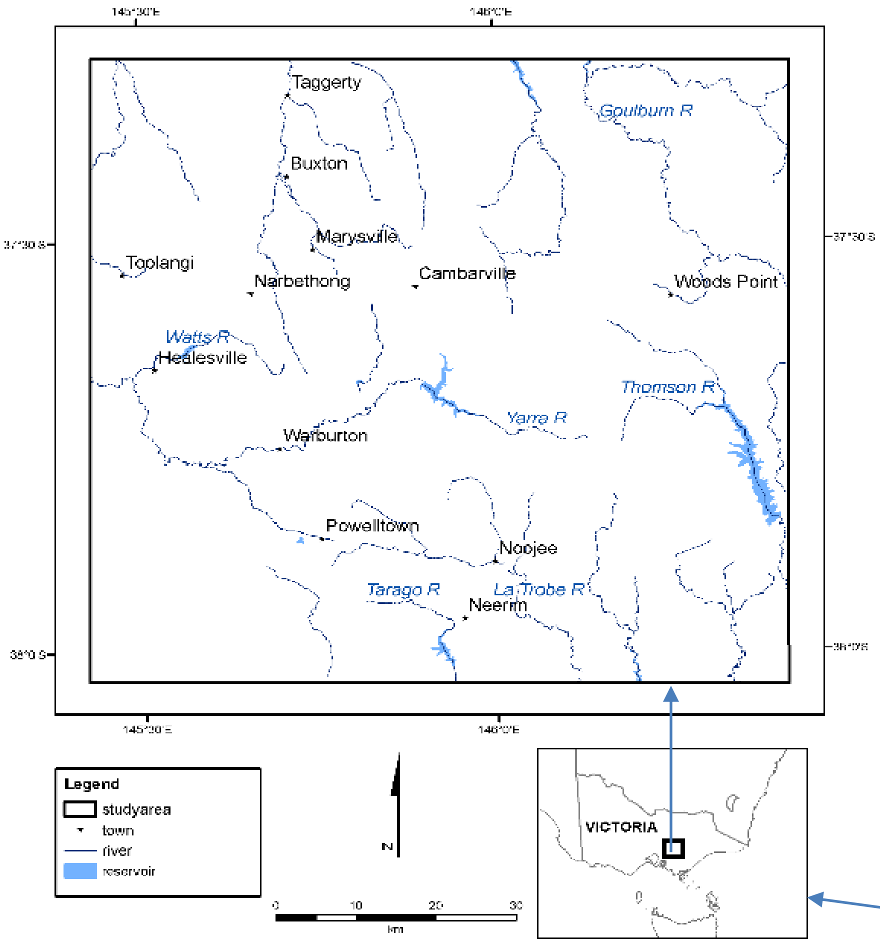
c. Water abstracted from artificial reservoir by water supply industry, supplied to households with forests and artificial reservoir shown as one ecosystem



Vardon, M., Keith, H., Lindenmayer, D. 2019. Accounting and valuing the ecosystem services related to water supply in the Central Highlands of Victoria, Australia. Ecosystem Services: Volume 39, October 2019, 101004. https://doi.org/10.1016/j.ecoser.2019.101004

Australian National University

Case study – Central Highland of Victoria Australia

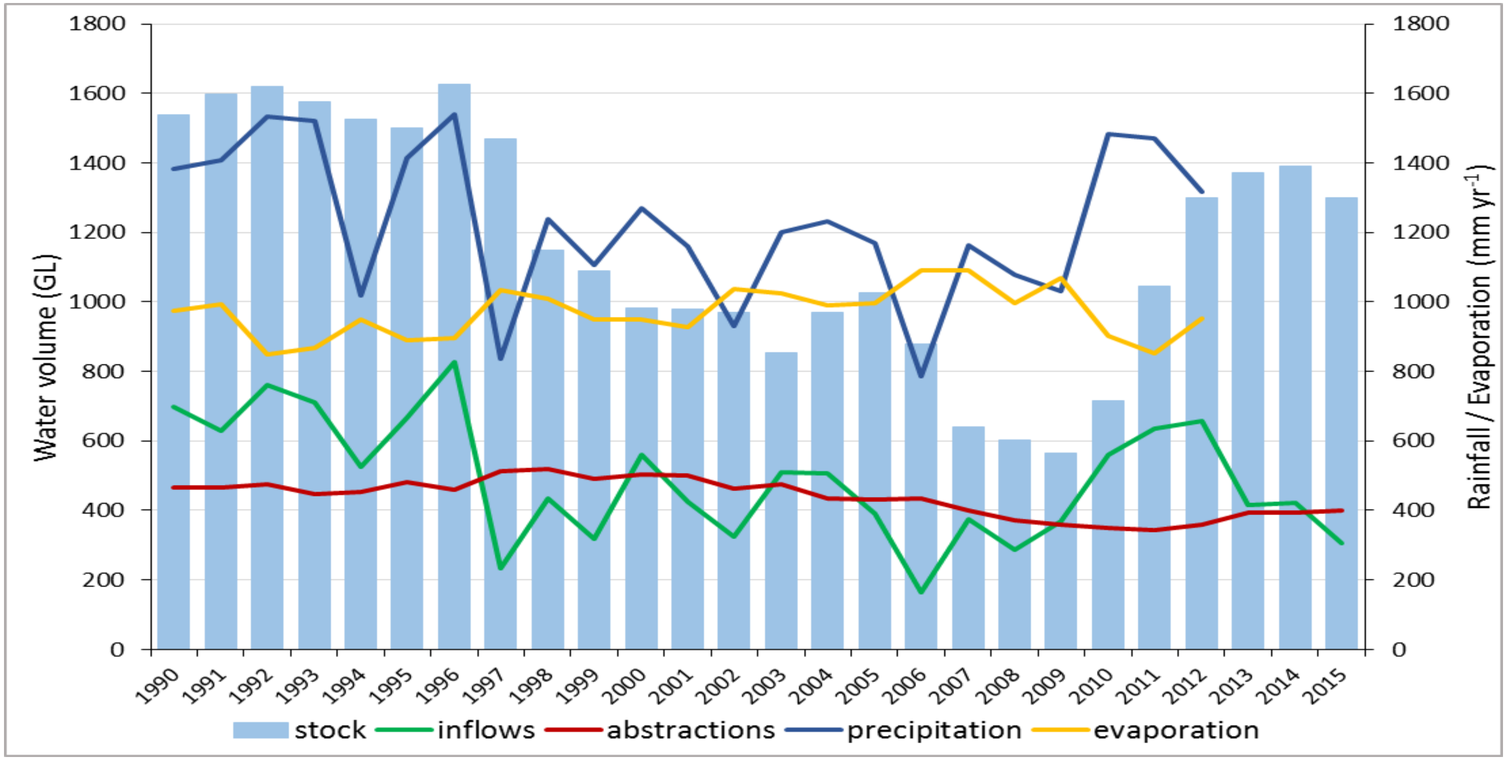


Context

- Near Melbourne a city of 5+ million people
- Mix of land covers and much native forest
- Land use conflict
- Proposal to expand national park network
- Systematic information lacking
- Suite of ecosystem accounts prepared for the area
- Applying the SEEA to specific issues

Keith, H., Vardon, M., Stein, J.A., L. Stein, J.L. and & Lindenmayer, D. (2017). Ecosystem accounts define explicit and spatial trade-offs for managing natural resources. Nature Ecology & Evolution (18 September 2017): doi:10.1038/s41559-017-0309-1 https://www.nature.com/articles/s41559-017-0309-1

Times series of physical water stocks and flows



Keith, H., Vardon, M., Stein, J.A., L. Stein, J.L. and & Lindenmayer, D. (2017). Ecosystem accounts define explicit and spatial trade-offs for managing natural resources. Nature Ecology & Evolution (18 September 2017): doi:10.1038/s41559-017-0309-1 https://www.nature.com/articles/s41559-017-0309-1

Value of water supplied by Melbourne Water

STRAIGHT FROM ANNUAL REPORTS – ADJUSTEMENTS MADE AS MELBOURNE WATER ALSO PROVIDES SEWERAGE SERVICES

	2010-11 ($m)	2011-12 ($m)	2012-13 ($m)	2013-14 ($m)	2014-15 ($m)	2015-16 ($m)
Revenue						
Revenue from water supply	*379.7*	*512.3*	*547.6*	*911.2*	*876.2*	*964.2*
Other revenue	*617.6*	*727.9*	*710.6*	*805.5*	*873.5*	*889.1*
Total revenue	**997.3**	**1,240.2**	**1,258.2**	**1,716.7**	**1,749.7**	**1,853.3**
Expenses						
Operating and other expenses	*(253.0)*	*(272.2)*	*(367.7)*	*(404.9)*	*(408.2)*	*(366.3)*
Wages, employee benefits	*(75.0)*	*(103.5)*	*(86.9)*	*(100.7)*	*(106.4)*	*(115.6)*
Depreciation and amortisation	*(231.9)*	*(242.6)*	*(315.9)*	*(351.6)*	*(367.5)*	*(373.8)*
Financial expenses	*(223.3)*	*(249.2)*	*(549.3)*	*(727.6)*	*(707.2)*	*(676.7)*
Total expenses	**(783.2)**	**(867.5)**	**(1,319.8)**	**(1,584.8)**	**(1,589.3)**	**(1,532.4)**
					(1,115.4)	
Net result before tax	**214.1**	**372.7**	**(61.6)**	**131.9**	**160.4**	**339.2**
Tax (expense)/benefit	(56.2)	(102.8)	21.8	(42.0)	(44.2)	(185.9)
Net result after tax	**157.9**	**269.9**	**(39.8)**	**89.9**	**116.2**	**153.4**
					160.40	
Estimated IVA for Melbourne Water = Wages, employee benefits + depreciation and amortisation + net result before tax	***521.0***	***718.8***	***341.2***	***584.2***	***634.3***	***828.6***
Estimated IVA for water supply = Estimated IVA for Melbourne Water x percentage of revenue from water supply	**198.4**	**296.9**	**148.5**	**310.1**	**317.6**	**431.1**

Note all values in AUD, current prices. USD:AUD ~ 1.0:1.3

Keith, H., Vardon, M., Stein, J.A., L. Stein, J.L. and & Lindenmayer, D. (2017). Ecosystem accounts define explicit and spatial trade-offs for managing natural resources. Nature Ecology & Evolution (18 September 2017): doi:10.1038/s41559-017-0309-1 https://www.nature.com/articles/s41559-017-0309-1

Valuation of ecosystem services – exchange value

Three method were considered

1. Resource rent

- Problem of negative rents

2. Production function

- Data intensive and data not readily available

3. Replacement cost

- Replacement cost chosen - data available and use recommend by Edens, B. and Graveland, C. (2014). *Water Resources and Economics*: **7**, 66–81.

Note: SEEA Ecosystem Accounting – valuation is guidance only (not standard)

Replacement Cost method

Assumptions

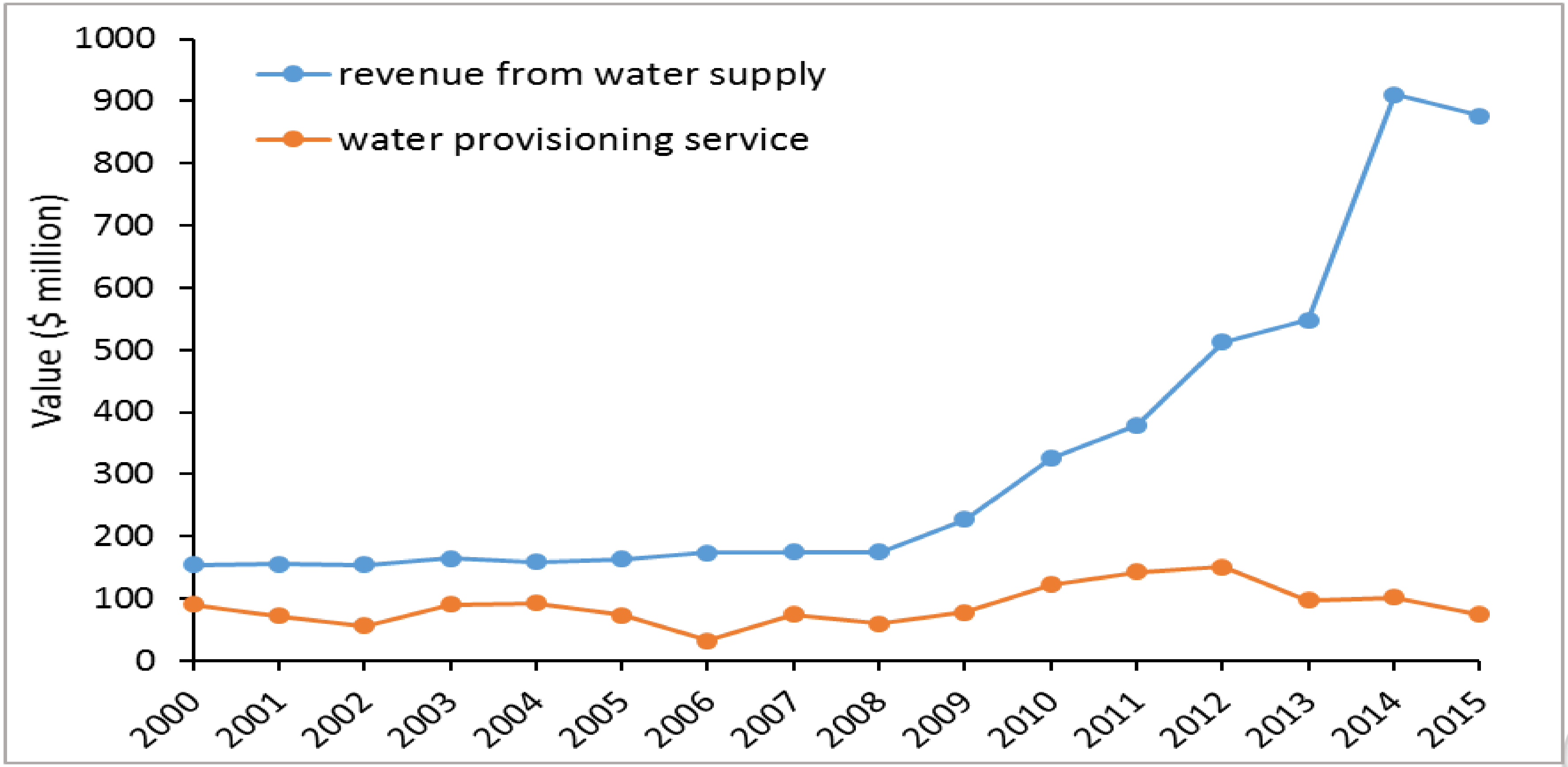
1. that the service if lost would be replaced
2. that water consumption patterns would be unaffected by any increase in cost.

Options for replacement of water in Central Highlands

1. transfer of water from other regions
2. use of desalination
3. use of recycled water

LEAST COST BUT NOT CHOSEN BY GOVERNMNT

Value of water sales and ecosystem services used



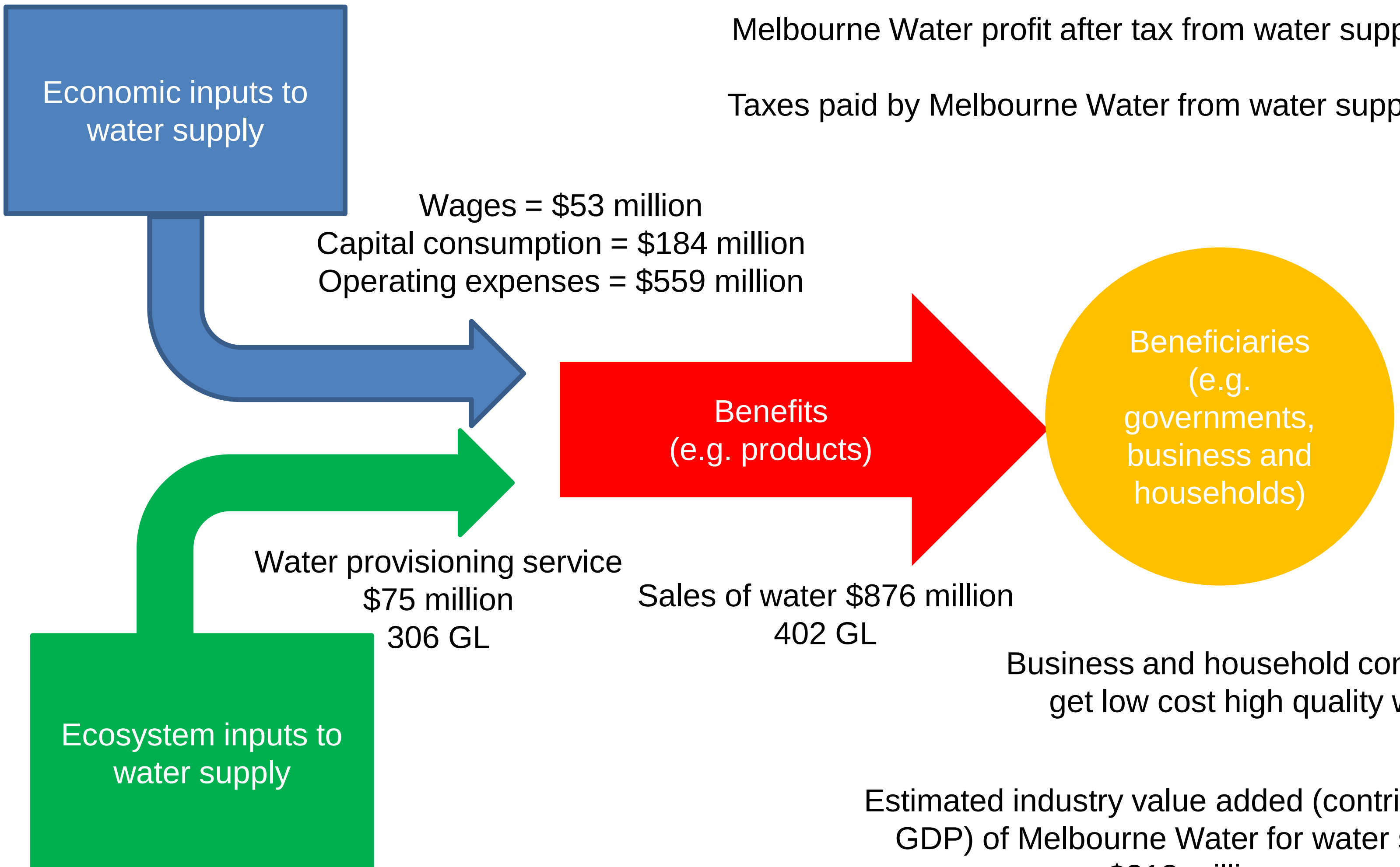
Note all values in AUD, current prices. USD:AUD ~ 1.0:1.3

Keith, H., Vardon, M., Stein, J.A., L. Stein, J.L. and & Lindenmayer, D. (2017). Ecosystem accounts define explicit and spatial trade-offs for managing natural resources. Nature Ecology & Evolution (18 September 2017): doi:10.1038/s41559-017-0309-1 https://www.nature.com/articles/s41559-017-0309-1

Melbourne Water 2014-15: use of ecosystem services, cost of water production and industry value added

Melbourne Water profit after tax from water supply$58 million

Taxes paid by Melbourne Water from water supply $22 million

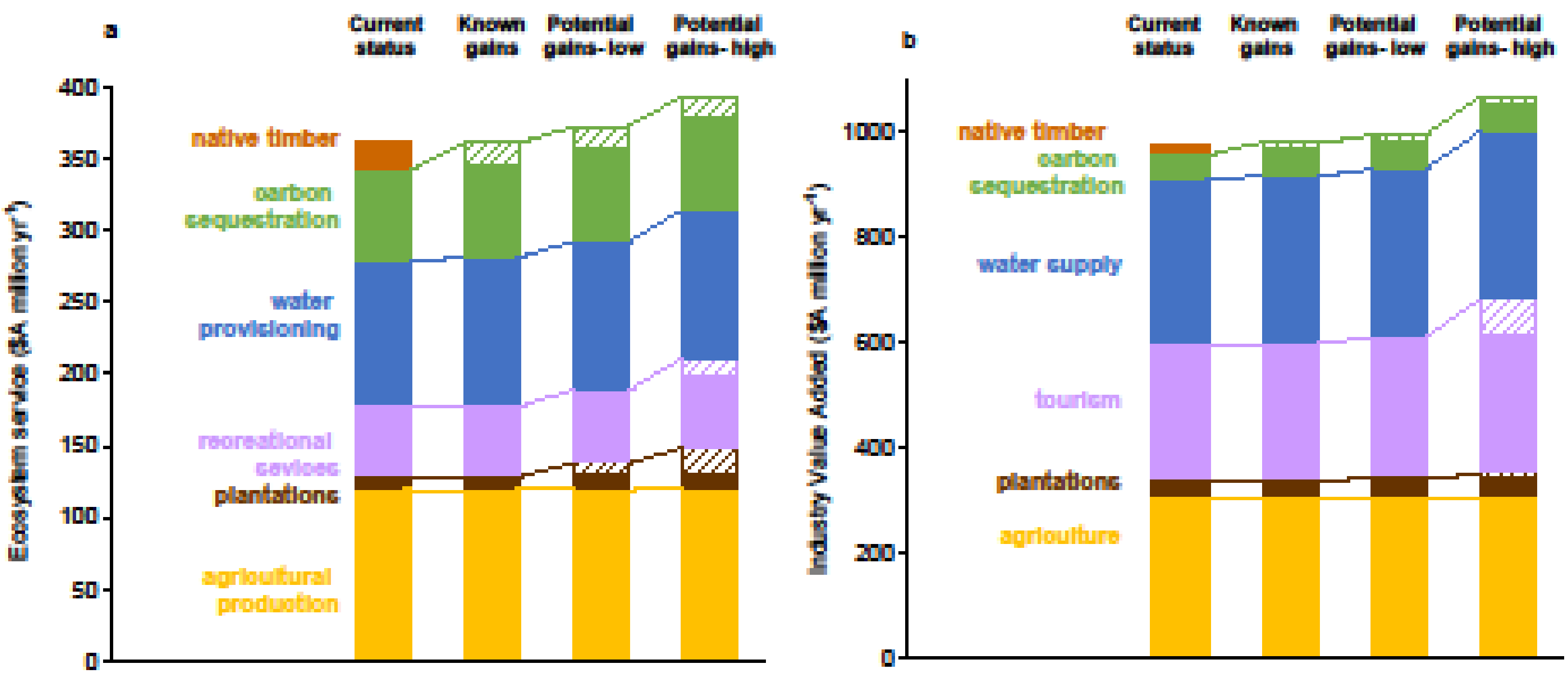


Business and household consumers get low cost high quality water

Estimated industry value added (contribution to GDP) of Melbourne Water for water supply
$318 million
(IVA = profit before tax + wages + capital consumption)

Note all values in AUD, current prices. USD:AUD ~ 1.0:1.3

Value of ecosystems and value added of industries using ecosystem service in the Central Highlands of Victoria – three scenarios



Note all values in AUD, current prices. USD:AUD ~ 1.0:1.3

Keith, H., Vardon, M., Stein, J.A., L. Stein, J.L. and & Lindenmayer, D. (2017). Ecosystem accounts define explicit and spatial trade-offs for managing natural resources. Nature Ecology & Evolution (18 September 2017): doi:10.1038/s41559-017-0309-1 https://www.nature.com/articles/s41559-017-0309-1

Key message

SEEA is:

- A way of organizing economic and environment information that decision makers at the heart of government understand – Ministries of Finance and Central Planning Agencies
- Water accounts have been produced and used for water management and policy in many countries
- Ecosystem accounting is a rapidly evolving area and accounting for the ecosystem services related to water will make water accounts more useful

Contact details:

Dr Michael Vardon

Associate Professor

Environmental Accounting

michael.vardon@anu.edu.au

Threatened Species Recovery Hub

National Environmental Science Programme

SUSTAINABLE FARMS

The work presented is the result of the efforts of many people and organisations.

Special thanks to: Jerry Webb, Michael Nagy, Ricardo Martinez-Lagunes, Stuart Peevor, Jane Godfrey, Richard Mount, Warwick McDonald, Sjoerd Schenau, Cor Graveland, JP Castaneda, Sofia Ahlroth, Ogoposte Pule, Dimpho Galegane, Nkandu Kabibwa, Mkhuzo Chongo, Ken Bagstad, Gan Hong, and Sanjesh Naidu.

My work in the development and application of water accounting has been supported over many years by the Australian National University, Australian Bureau of Statistics, (Australian) Bureau of Meteorology, World Bank (WAVES) and United Nations

WAVES

Australian National University

Questions

?