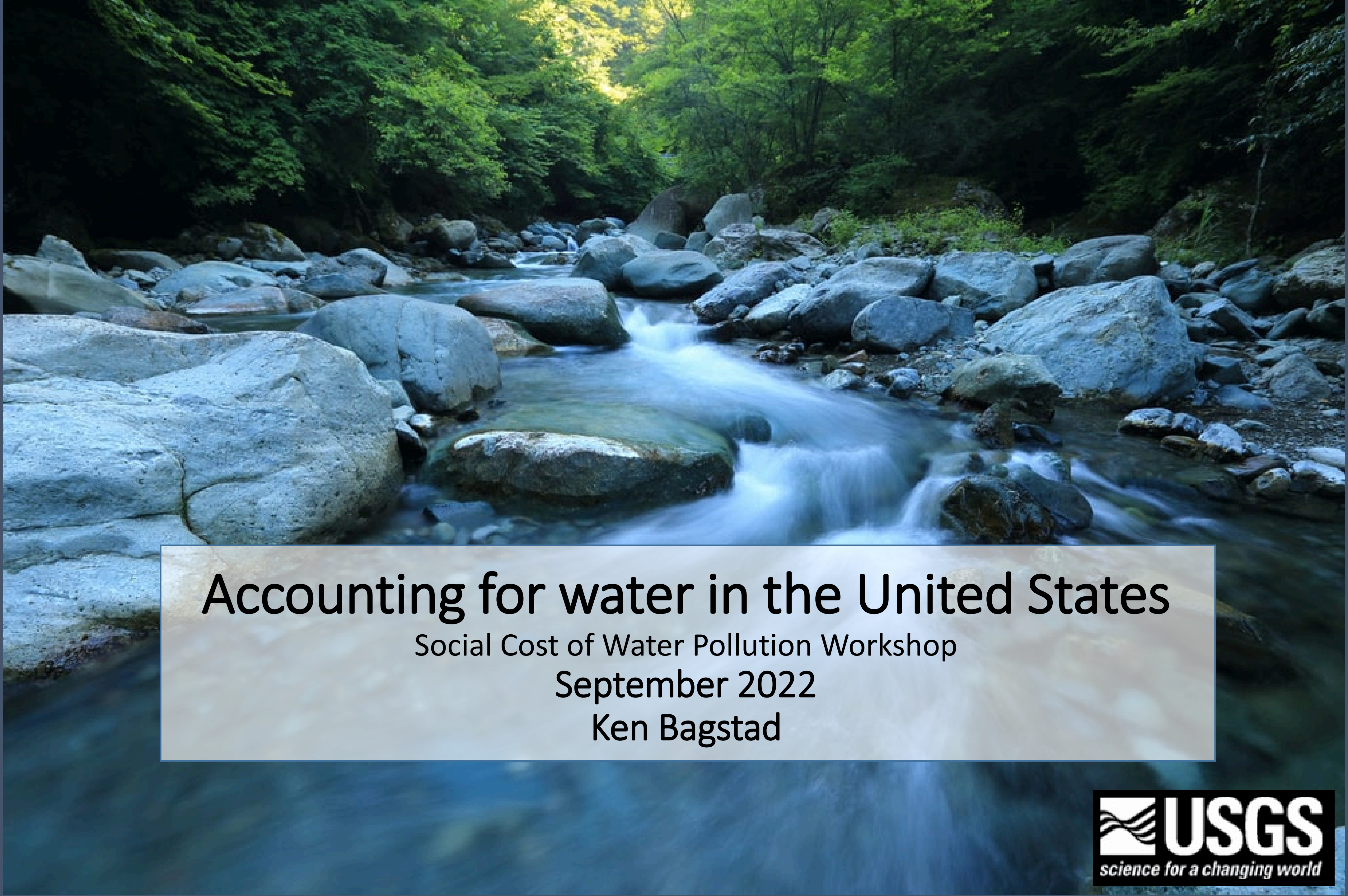


Accounting for water in the United States

Social Cost of Water Pollution Workshop

September 2022

Ken Bagstad

Acknowledgments

- U.S. Natural Capital Accounting Working Group
  - esp. Carter Ingram & Carl Shapiro
- OSTP-led Policy Working Group on Natural Capital Accounting & Environmental-Economic Statistics

THE WHITE HOUSE
WASHINGTON

Powell Center

NATIONAL SOCIO-ENVIRONMENTAL SYNTHESIS CENTER (SESYNC)

SOUTHEAST Climate Adaptation Science Center

NASA

Roadmap

1. Natural capital accounting & the U.S. Strategy
2. From pilot toward production-grade water accounts
3. Insights from ecosystem accounting
4. Lessons & needs for economic valuation

1. Natural capital accounting & the U.S. Strategy

NATIONAL STRATEGY TO DEVELOP STATISTICS FOR ENVIRONMENTAL-ECONOMIC DECISIONS

A U.S. System of Natural Capital Accounting and Associated Environmental-Economic Statistics

Office of Science and Technology Policy

Office of Management and Budget

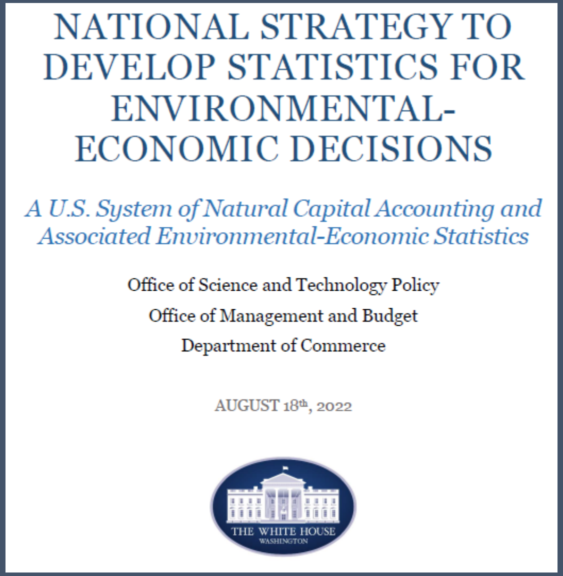
Department of Commerce

AUGUST 18th, 2022

THE WHITE HOUSE
WASHINGTON

National Strategy on Statistics for Environmental-Economic Decisions

- 2022 Interagency Policy Working Group on Natural Capital Accounting & Environmental-Economic Statistics
- Provides interagency coordination, work planning, budgeting supporting a national strategy
  - Earth Day 2022: Plans to develop national strategy announced
  - 8/18/22: Release of national strategy for public comment
  - Early 2023: Final strategy released
  - Late 2023: First national environmental-economic accounts released
  - Early-mid 2030s: Complete, production-grade environmental-economic accounts regularly produced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https://www.whitehouse.gov/ostp/news-updates/2022/08/18/readout-ostp-initial-engagement-on-developing-natural-capital-accounts/

		Co-Lead Departments/ Agencies	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Headline Summaries	Changes in natural capital wealth	BEA, NOAA, DOI, USDA														
	Net domestic product inclusive of natural assets	BEA			*											

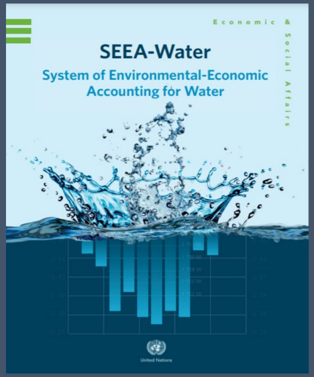
• • •

Phase I Environmental Sectors	Air and emissions	BEA, EPA														
	Water	USGS, EPA, BEA, USDA, NOAA														
	Land	BEA, USDA, DOI, EPA, USFS														
	Environmental activities & jobs	BEA, BLS, EPA, Census														
	Marine natural capital: fish, minerals and perhaps a few other assets	NOAA, BEA														
Phase II Environmental Sectors	Minerals & Energy	DOI, BEA, NOAA														
	Forests	USDA, USFS														
	Urban green space	DOI, USDA, NOAA, USFS														
	Pollinators	USDA														
...ental	Migratory birds, wildlife, and fish	DOI														
	Wetlands and peatlands	DOI, NOAA														

• • •

What water information do we need?

1. How much water do we have?
2. Who uses it? What value does that use add to our communities & economy?
3. How do water & land use impact water quality, and how does that impact other users (including ecosystems)?
4. What tradeoffs emerge, and how can we better navigate them?



Consistent methods

High quality/accuracy

Trusted

High spatiotemporal resolution (easy to aggregate across scales)

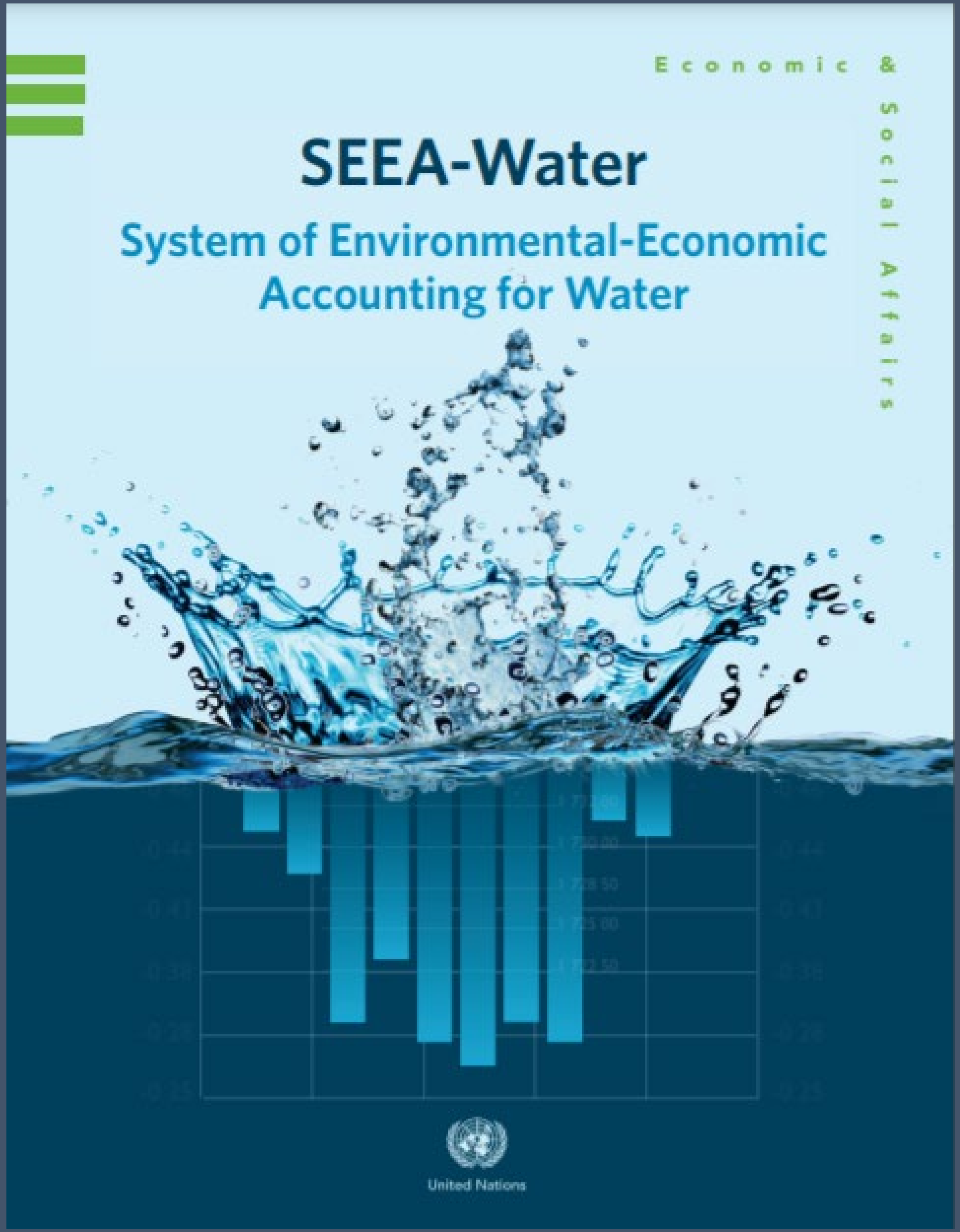
Long time series

Low latency

SEEA Water

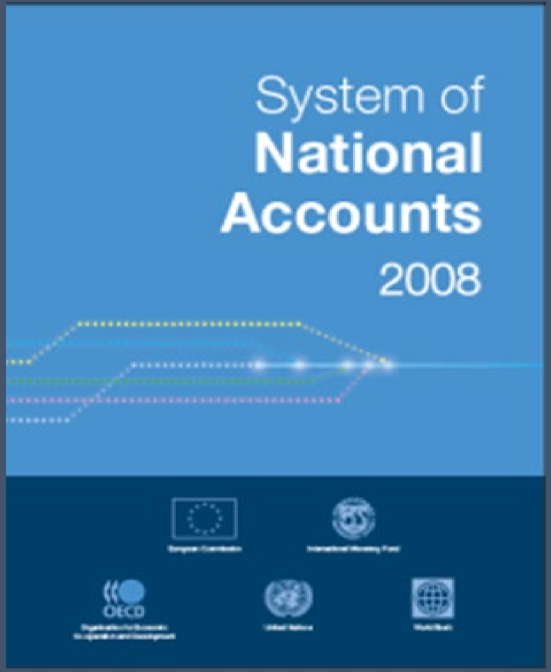
- Well established & used system: predates SEEA Central Framework (2007)
- Measures water asset (volume), flows between environment & economy, quality, emissions, valuation (where possible)

https://seea.un.org/content/seea-water



International standards for natural capital accounting

System of
National Accounts



SEEA –
Central Framework

SEEA - Ecosystem
Accounting

Track natural resources:

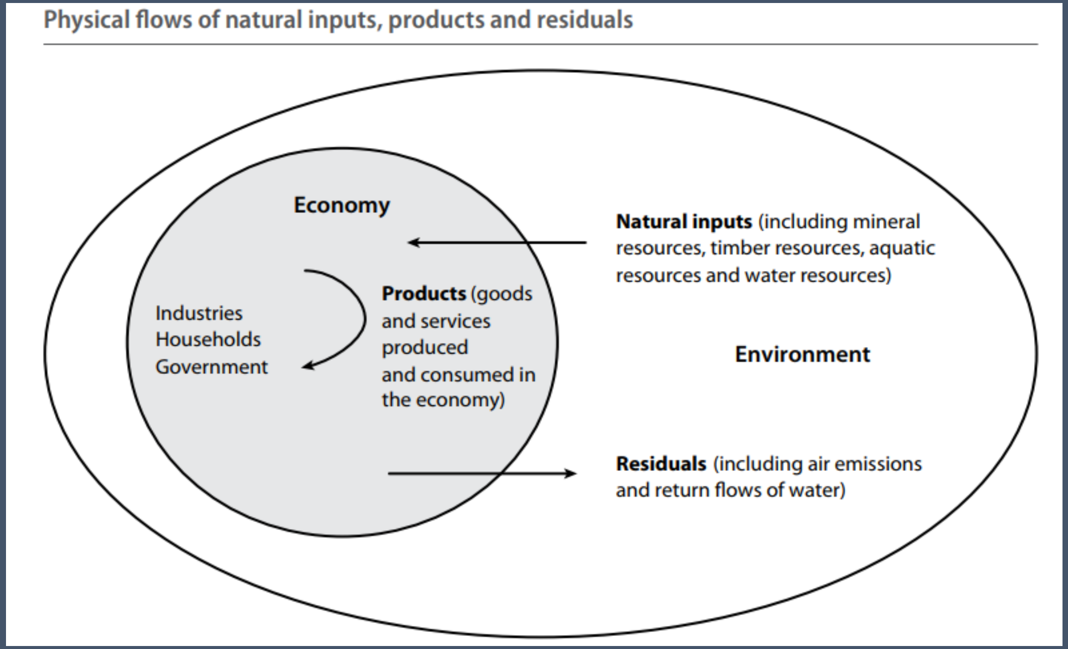
- Over time
- At multiple spatial scales
- Compatible with economic accounts data

https://seea.un.org/

SEEA Central Framework (2012)

- United Nations Statistical Division (UNSD):
  - “an international statistical standard for measuring the environment and its relationship with the economy,” which covers:

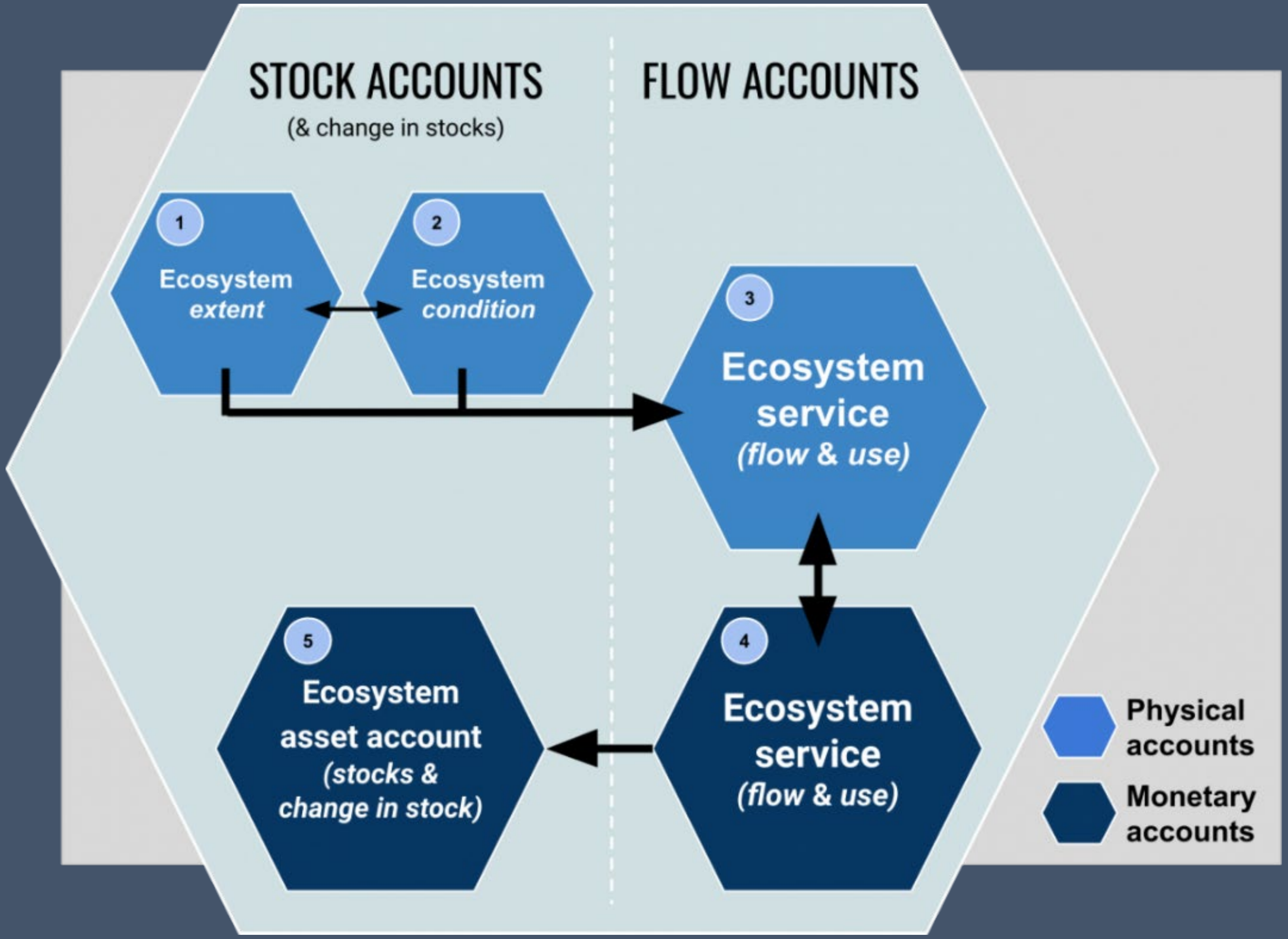
1. Environmental flows
2. Stocks of environmental assets
3. Economic activity related to the environment



https://seea.un.org/content/seea-central-framework

SEEA Ecosystem Accounting (2021)

- Quantify ecosystems as assets
  - Tracking their extent & condition
  - Ecosystem services, in physical & monetary terms



Congruence with economic accounts

- Physical & monetary supply & use tables
- Asset values for balance sheets

Table 2.1: Simplified structure of the supply table

Industries / Products	Industries				Imports	Total
	Agriculture, forestry, etc.	Mining and quarrying	...	Services		
Agriculture, forestry, etc. Ores and minerals, etc. ... Services	Output by product by industry				Imports by product	Total supply by product
Total	Total output by industry				Total imports	Total supply

Table 2.2: Simplified structure of the use table

Industries / Products	Industries				Final uses			Total
	Agriculture, forestry, etc.	Mining and quarrying	...	Services	Final consumption	Gross capital formation	Exports	
Agriculture, forestry, etc. Ores and minerals, etc. ... Services	Intermediate consumption by product and by industry				Final uses by product and by category			Total use by product
Value added	Value added by component and by industry							Value added
Total	Total output by industry				Total final uses by category			

Empty cells by definition

https://unstats.un.org/unsd/nationalaccount/docs/SUT_IOT_HB_Final_Cover.pdf

Congruence with economic accounts

- Physical & monetary supply & use tables
- Asset values for balance sheets

Table III.1
Standard physical supply and use tables for water

A. Physical use table (*physical units*)		Industries (by ISIC category): 1-3	5-33, 41-43	35	36	37	38, 39, 45-99	Total	Households	Rest of the world	Total
From the environment	**1. Total abstraction (= 1.a + 1.b = 1.i + 1.ii)**										
	1.a. Abstraction for own use										
	1.b. Abstraction for distribution										
	1.i. From inland water resources:										

B. Physical supply table (*physical units*)		Industries (by ISIC category): 1-3	5-33, 41-43	35	36	37	38, 39, 45-99	Total	Households	Rest of the world	Total
Within the economy	**4. Supply of water to other economic units**										
	of which:										
	4.a. Reused water										
	4.b. Wastewater to sewerage										
Into the environment	**5. Total returns (= 5.a + 5.b)**										
	5.a. To inland water resources										
	5.a.1. Surface water										
	5.a.2. Groundwater										
	5.a.3. Soil water										
	5.b. To other sources (e.g., sea water)										
	6. Total supply of water (= 4 + 5)										
	7. Consumption (= 3 - 6)										

Note: Dark grey cells indicate zero entries by definition.

https://seea.un.org/sites/seea.un.org/files/seeawaterwebversion_final_en.pdf

Congruence with economic accounts

- Physical & monetary supply & use tables
- Asset values for balance sheets

Table 7.3: Basic Ecosystem services physical supply and use table #2

	Units of measure	Economic units (selected)			Ecosystem assets (selected types)		
		Agri.	Gov.	Households	Forest	Cropland	Grassland
SUPPLY							
ES #1: Biomass provisioning services (rice)	Tonnes					100	
ES #2: Air filtration services (PM2.5)	Tonnes				50		
USE							
ES #1: Biomass provisioning services (rice)	Tonnes	100					
ES #2: Air filtration services (PM2.5)	Tonnes			50			

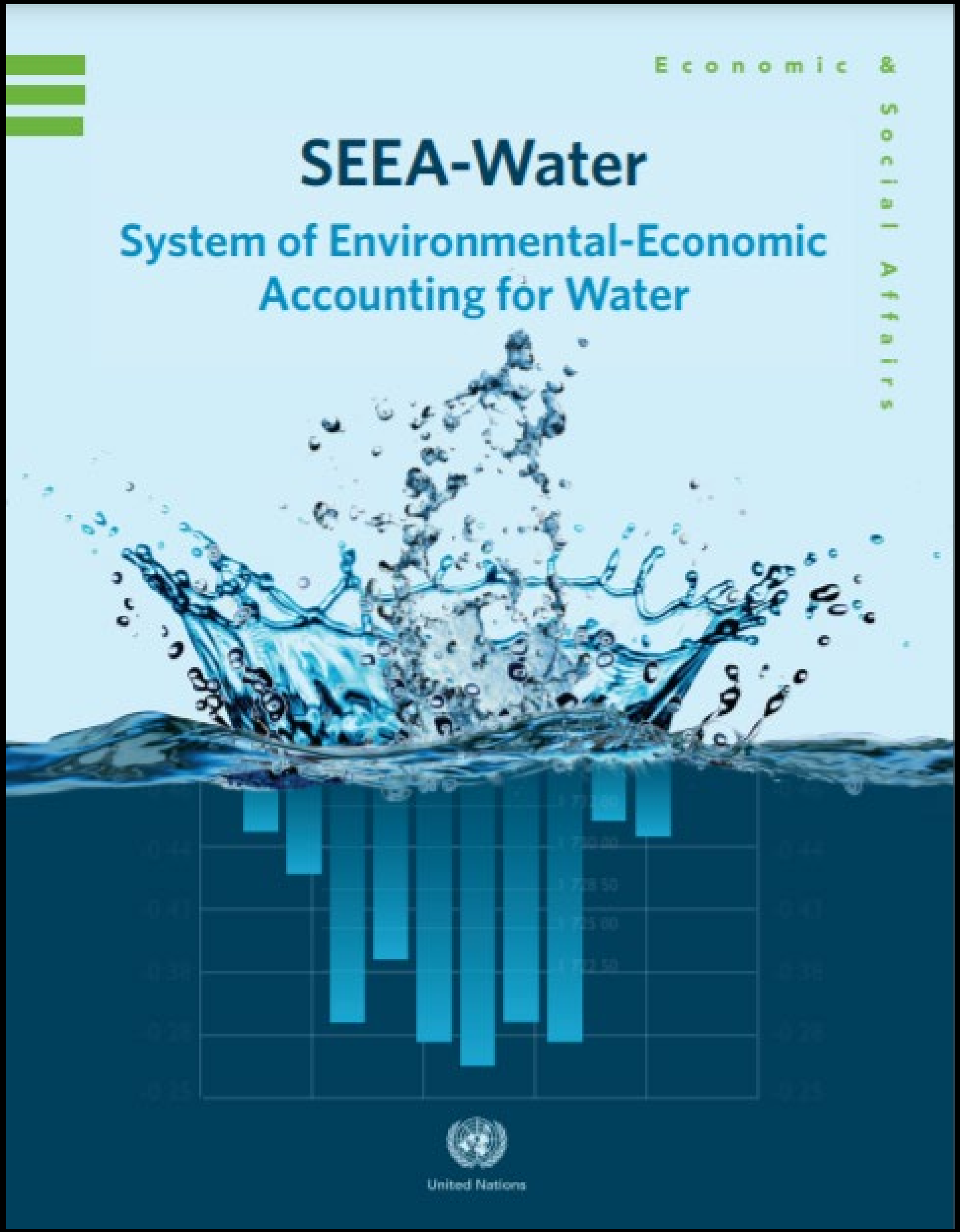
Note: Grey cells indicate not applicable.

https://seea.un.org/sites/seea.un.org/files/documents/EA/seea_ea_white_cover_final.pdf

"The nation behaves well if it treats the natural resources as assets which it must turn over to the next generation increased, and not impaired, in value."
– **Theodore Roosevelt, August 1910**

> "This is a historic step forward towards transforming how we view and value nature. We will no longer be heedlessly allowing environmental destruction and degradation to be considered economic progress."
> – **António Guterres, March 2021**

2. From pilot toward production-grade U.S. water accounts



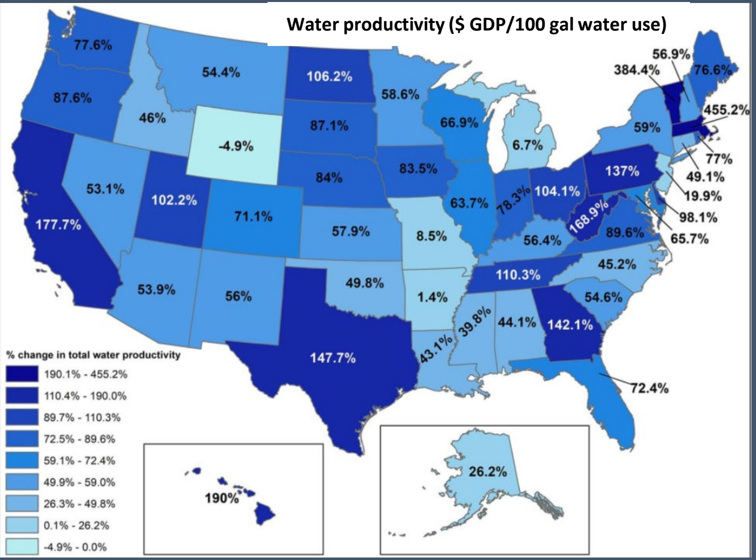
Data sources: 1st-generation water account (Bagstad et al. 2020)

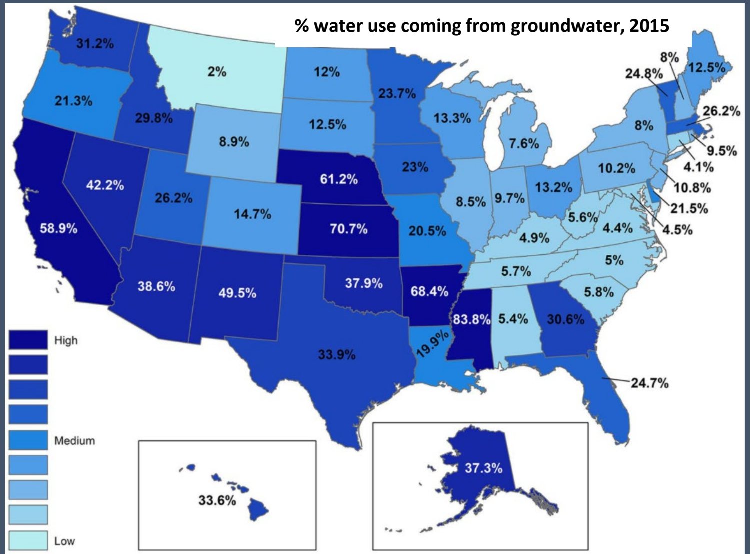
- Physical supply & use accounts: USGS water use data (reported every 5 years, 1950-2015)*
- Water productivity accounts: Water use + BEA GDP data
- Water quality accounts: USGS water quality data for surface & groundwater (NAWQA)
- Water emissions accounts: EPA Permit Compliance System & Integrated Compliance Information System (PCIS-ICIS) database (water emissions by industry)

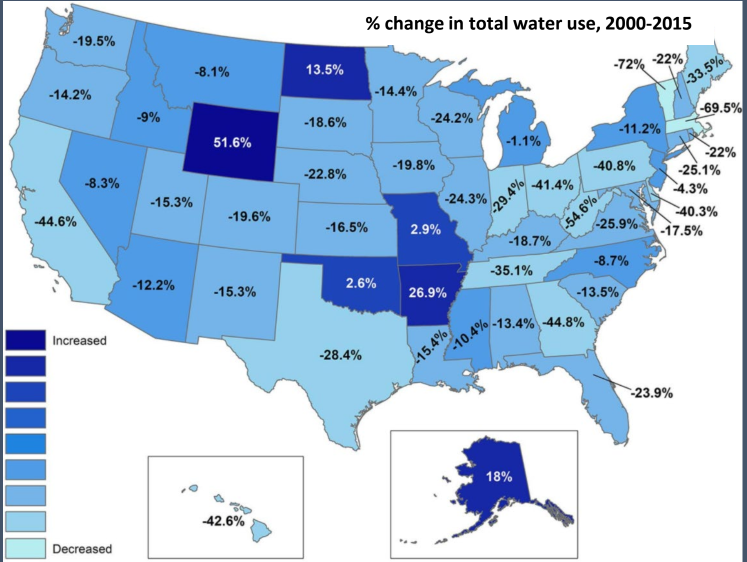
https://www.sciencedirect.com/journal/ecosystem-services/special-issue/10RZK17R0JP

U.S. Water accounts (Bagstad et al. 2020)

- Water use, productivity, quality & emissions
- Identified data gaps in comprehensive water accounts for the U.S.
  - Powell Center funding development of monthly water-use data (2022-2023)
- *Potential uses:* supporting water allocation, pricing, etc.







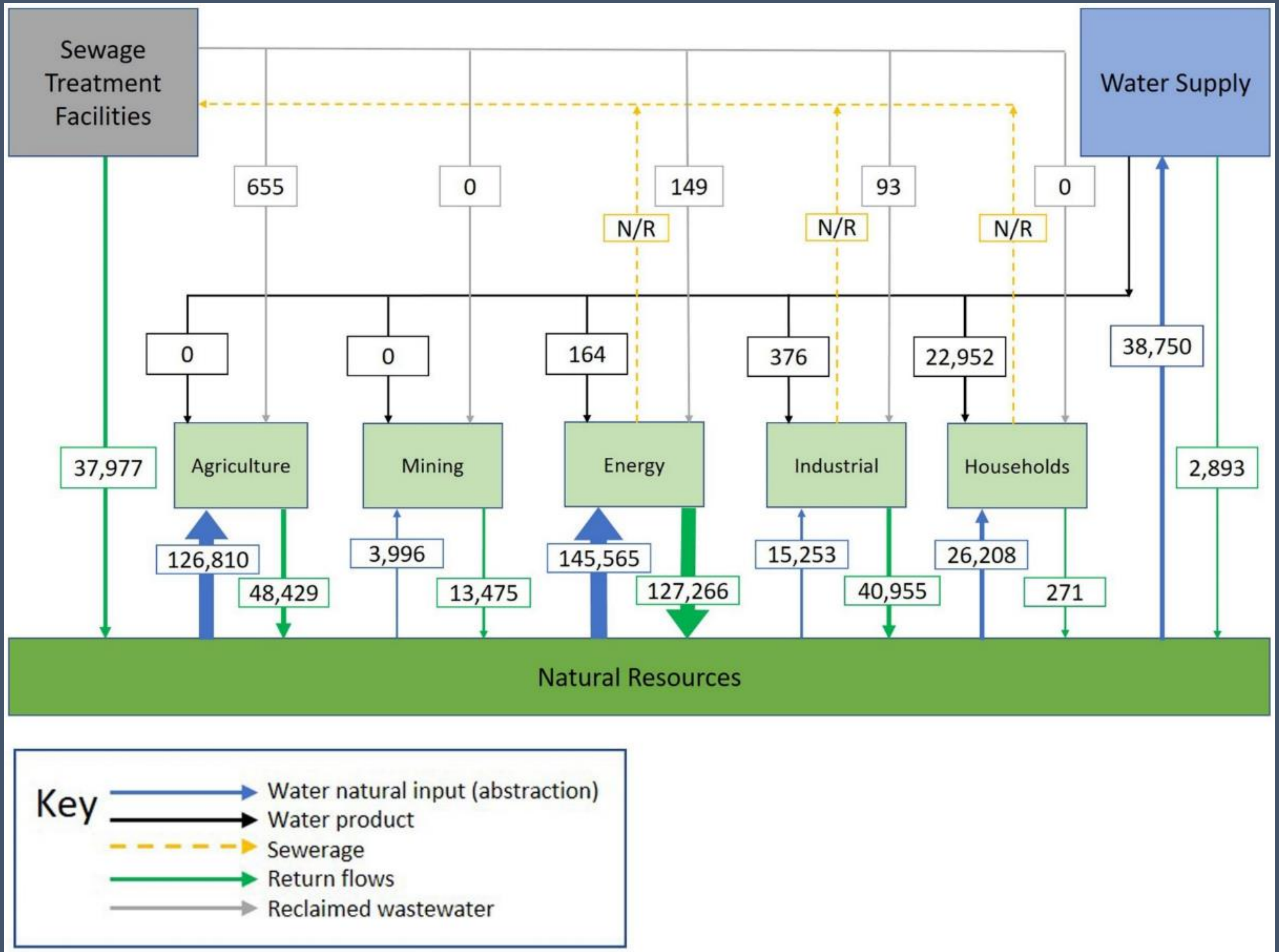
Water accounting tables

Year	11. Agriculture, Forestry, Fishing, and Hunting		2211. Electric Power Generation, Transmission and Distribution	2213. Water, Sewage & Other (Irrigation)				
2000								
2005								

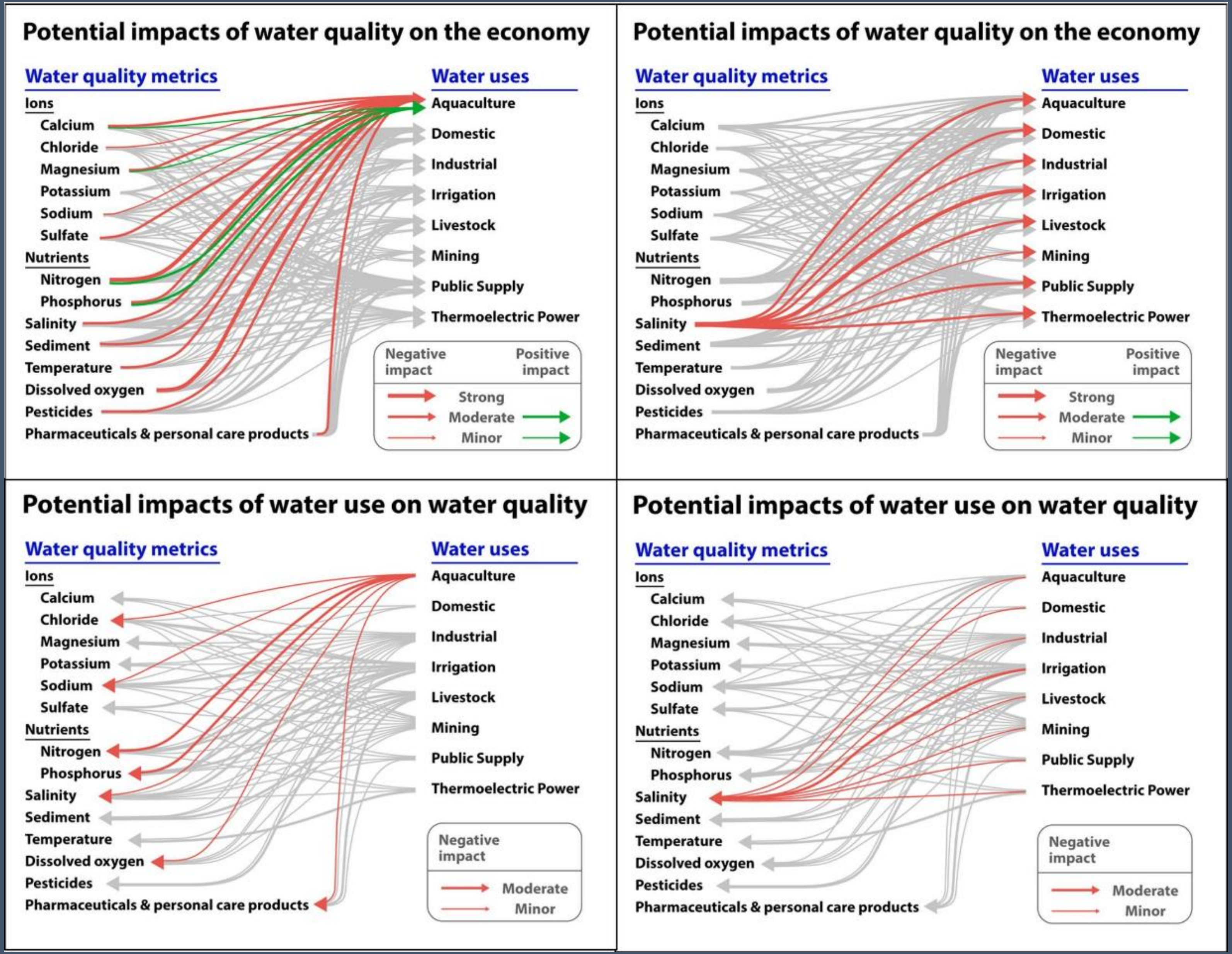
	11. Agriculture, Forestry, Fishing, and Hunting			21. Mining[b]	2211. Electric Power Generation, Transmission and Distribution			2213. Water, Sewage & Other (Irrigation)		31-33. Manufacturing[b]	713910. Golf Courses and Country Clubs	Households (Domestic)	Total
	111. Crop Production (Irrigation)	112. Animal Production (Livestock)	1125. Aquaculture[b]		Thermoelectric Power (Once-through cooling)	Thermoelectric Power (Closed-loop cooling)	Hydroelectric (Evaporative Use)[a]	221310 Water supply (Public supply)[b]	221320 Sewage treatment facilities (Wastewater)[b]				
A. Water Use													
1. Total abstraction	117,018.2	2,093.8	7,450.0	3,996.4	126,110.2	5,027.0	14,113.8	38,419.3	N/R	14,784.0	1,445.1	3,255.8	333,713.3
1.i.1. Surface Water, of which is	60,338.5	868.6	5,839.4	1,132.2	125,986.1	4,555.4	14,113.8	23,268.4	N/R	12,076.9	754.4	46.6	248,980.2
Fresh	60,338.5	868.6	5,833.1	876.5	90,621.6	4,085.0	14,113.8	23,264.6	N/R	11,334.0	754.4	46.6	212,136.5
Saline	0.0	0.0	6.3	255.7	35,364.5	470.5	0.0	3.9	N/R	742.9	0.0	0.0	36,843.7
1.i.2. Ground Water, of which is	56,679.7	1,225.2	1,610.7	2,864.2	124.1	471.5	0.0	15,150.8	N/R	2,707.1	690.7	3,209.2	84,733.1
Fresh	56,679.7	1,225.2	1,610.7	1,004.1	80.8	342.5	0.0	14,887.7	N/R	2,664.2	690.7	3,209.2	82,394.6
Saline	0.0	0.0	0.0	1,860.1	43.4	129.0	0.0	263.1	N/R	42.9	0.0	0.0	2,338.5
2. Use of water from other economic units	0.0	0.0	0.0	0.0	51.8	112.3	0.0	0.0	N/R	376.2	0.0	22,952.4	23,492.7
Reclaimed wastewater	654.7	0.0	0.0	0.0	8.2	141.2	0.0	331.0	N/R	92.9	266.6	0.0	1,494.7

	Industries (by NAICS 2017 category)															Other industries*	Total	% as other industries
	211. Oil & Gas Extraction	212. Mining (Except Oil & Gas)	2211. Electric Power Generation	221310. Water supply & irrigation systems	221320. Sewage Treatment Facilities	311. Food Manufacturing	312. Beverage & Tobacco Product Manufacturing	321. Wood Product Manufacturing	322. Paper Manufacturing	325. Chemical Manufacturing	326. Plastics & Rubber Products Manufacturing	488. Support Activities for Transportation	493. Warehousing & Storage	562. Waste Management & Remediation Services	721. Accommodation			
Nitrogen	1,959	176	30,800	4,625	1,707,044	9,076	224	2,305	4,477	11,390	690	2,745	276	41,457	1,713	61,160	1,880,116	3.3%
Phosphorus	1,813	1,080	3,518	278	229,370	46,984	483	67	3,062	4,483	22,353	57	1	53	7,846	2,468	323,917	0.8%
Organic enrichment	17,864	1,528	7,921	1,878	794,385	126,283	58,362	63,112	221,832	31,190	32,722	32,693	102,963	89,413	7,771	213,202	1,803,117	11.8%
Solids	31,839	47,734	815,669	1,413,230	2,402,702	256,620	4,365	189,360	319,346	291,293	937,321	268,139	5,059	305,549	15,089	3,023,845**	10,327,160	29.3%
Metals	84,022	94,431	53,179	15,175,582	486,175	9,731	82	361	1,338	4,025	8	97,101	73	60,816	21	184,521	16,251,467	1.1%

Quantifying flows of water through the economy



Understanding economic dependencies on water & impacts to water resources



Next steps: From Research toward Production-grade water accounts

Question	Account	Planned update	Agency	Timeline
How much water do we have?	Asset account	Water budget pilot models	USGS	2023+
Who uses it?	Supply & use account	Next-generation water use models	USGS	2023-2026+
What value does it add?	Productivity account	Updated water use + GDP data	USGS & BEA	2023-2026+
How do water & land use affect water quality?	Emissions account	StEWI tool (point source emissions); Modeling nonpoint source emissions	US EPA & USGS	Now; 2023-2024+
How does water quality affect other users?	Quality account	Improved surface & groundwater monitoring & modeling	USGS & US EPA	2023-2026+

Interagency collaboration for water accounting

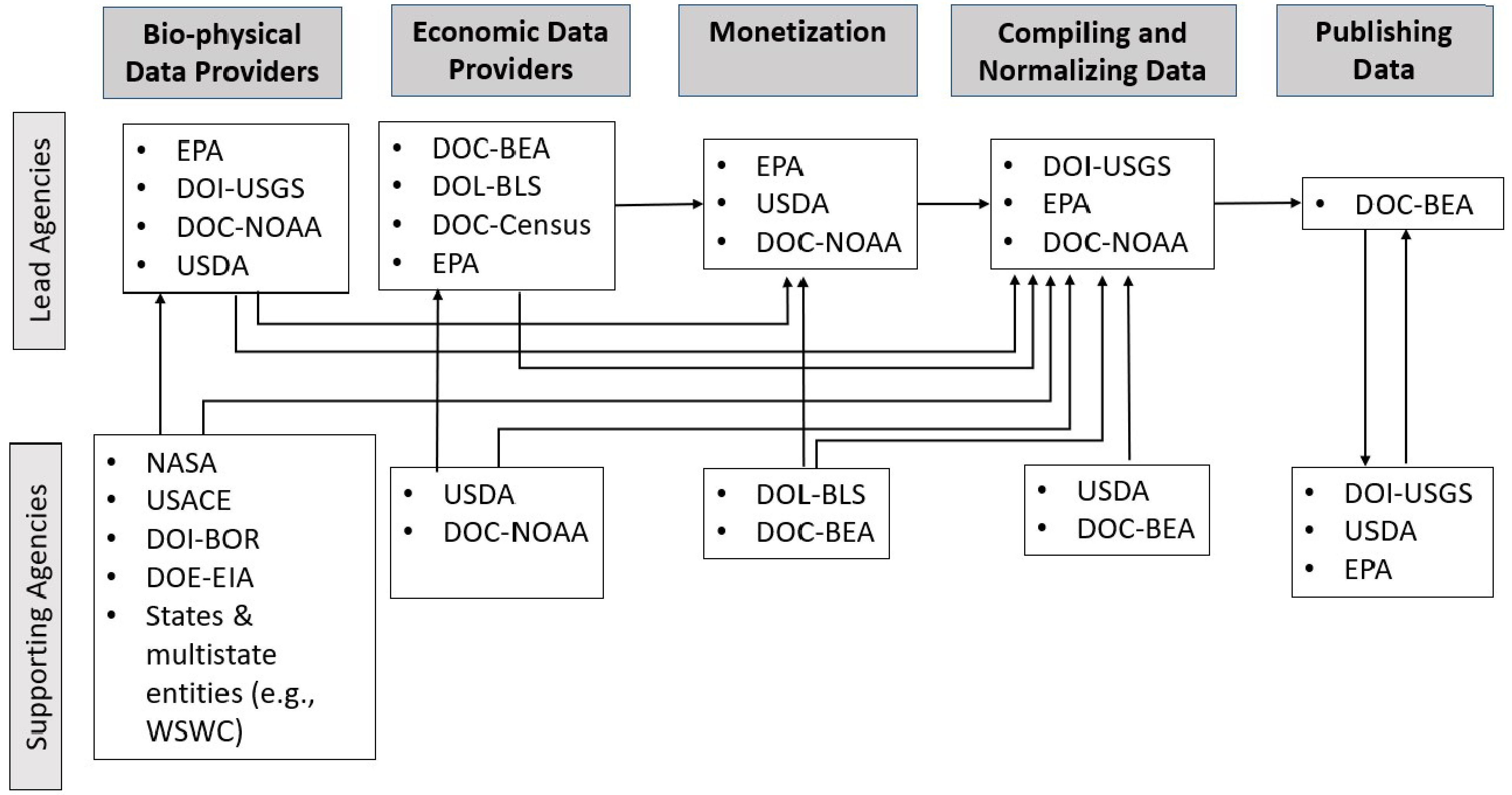


Figure 5. Agencies involved in the Water account.

Using water accounts information

Table S3.2: Types of water policy or management controls as a function of information needed: water use (WU), water emissions (WE), water productivity (WP), other resource use (OU), other economic productivity (OEP), or all of the above (ALL).

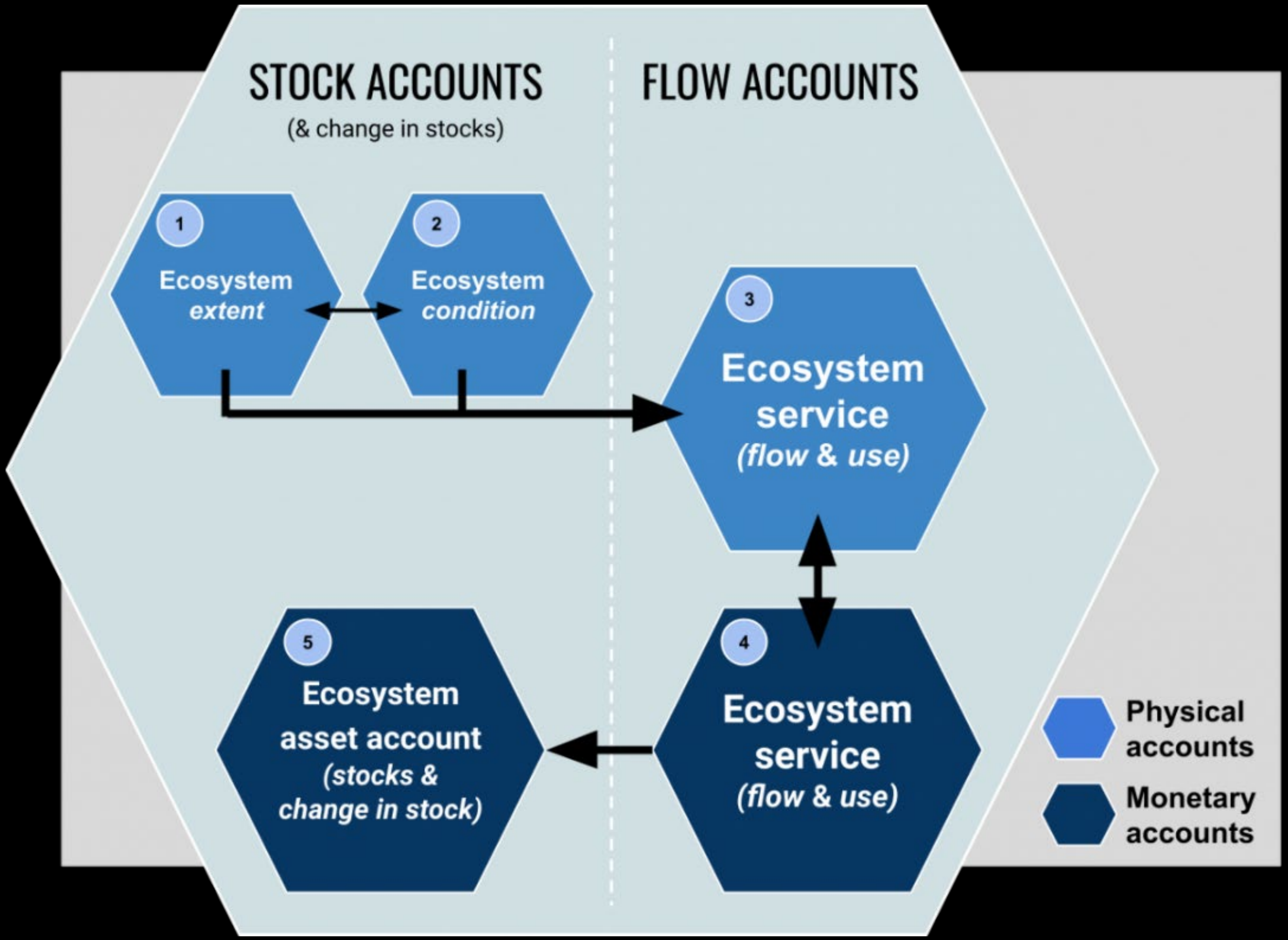
	Individual	Private Company	Community group	Public Utility	Local Govt.	Regional Govt.	National Govt.
Water permits	WU	ALL	ALL	WU	ALL	ALL	ALL
Water pricing or subsidies		ALL	ALL	ALL (but primarily	ALL	ALL	ALL
Economic viability/risk water assessments	W W						
Water distribution &	W						

Table S3.3. Examples of policy or management drivers (and responsible parties or levels) vs. Information needed and control tools

	Water Use	Water Emissions	Water Productivity	Water Use & Water Productivity	Other Resource Use	Other Economic Productivity	All of the Above
National Law: Endangered Species Act (ESA) – Federal Agency (U.S. Fish and Wildlife Service in the U.S.)	Permit controls, built infrastructure controls, or other tools – State, county, or local agency.	Emission controls (sometimes) – State, county of local agency.	Not usually considered. Could inform ESA anticipatory management.	Not usually considered. Could inform ESA anticipatory management.	State, county or local controls on biological resources use, and/or impacts of other resource uses (e.g., mineral or energy extraction).	Considered by default, but often without attached "externalities" (such as species loss). Could inform ESA anticipatory management.	Not usually considered in an integrated way. Could inform ESA anticipatory management.
Legal Compact: interstate or trans-national boundary water allocation – Transboundary or Federal or Interstate Organization	Permit controls, built infrastructure controls, or other tools – State, county, or local agency.	Considered occasionally.	Not usually considered. Could inform anticipatory management or trade-off decisions.	Not usually considered. Could inform anticipatory management or trade-off decisions.	State, county or local controls on natural resource use, and/or impacts use.	Considered by default, but often without attached "externalities". Could inform anticipatory management or trade-off decisions.	Not usually considered in an integrated way. Could inform anticipatory management or trade-off decisions.
National Law: Clean Water Act	Permit controls, built infrastructure	Emission controls–	Not usually considered.	Not usually considered.	State, county or local controls on natural	Considered by default, but often without	Not usually considered in an integrated way. Could

Bagstad et al. 2020, Supplemental Information

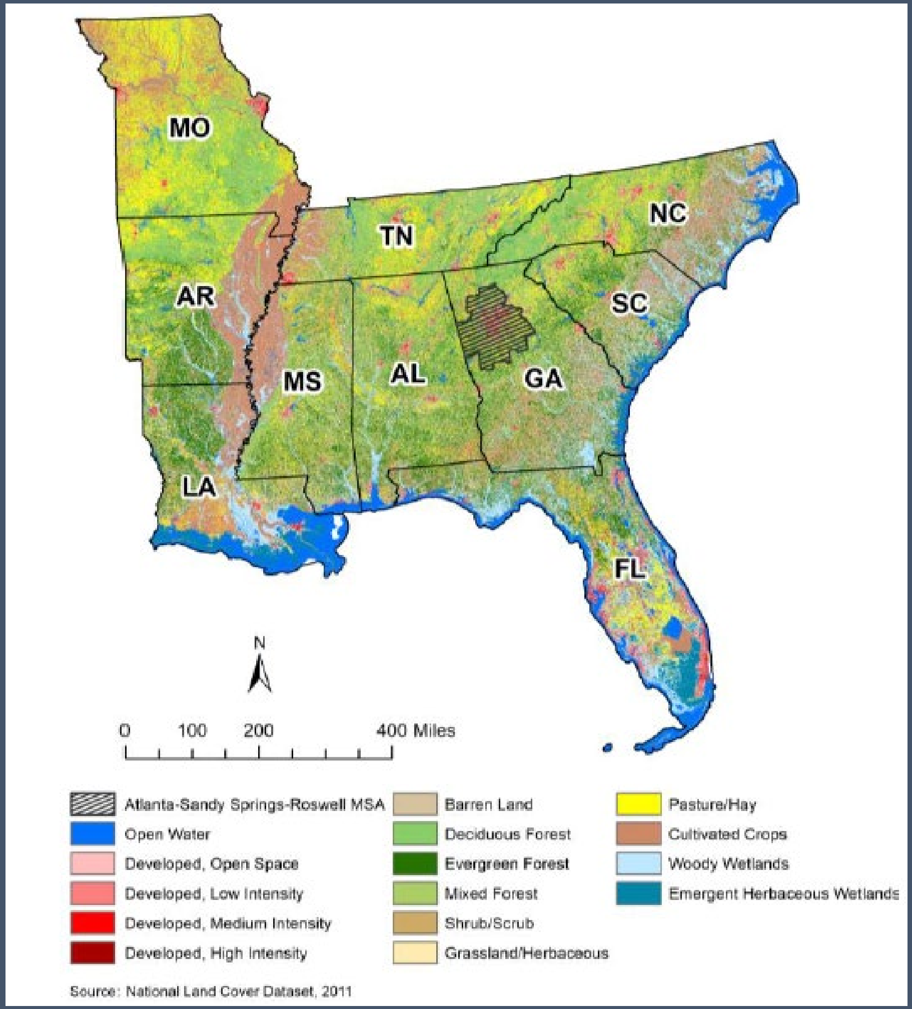
3. Insights from ecosystem accounting



Water in the ecosystem accounts

- Final services:
  - Water supply
  - Sediment regulation
  - Water purification – retention & breakdown of nutrients & other pollutants
  - Water flow regulation – baseflow & peak flows
  - Flood control services – coastal & riverine
- Intermediate services – water for:
  - Crop provisioning
  - Livestock provisioning
  - Aquaculture
  - Wild fish
  - Recreation-related services

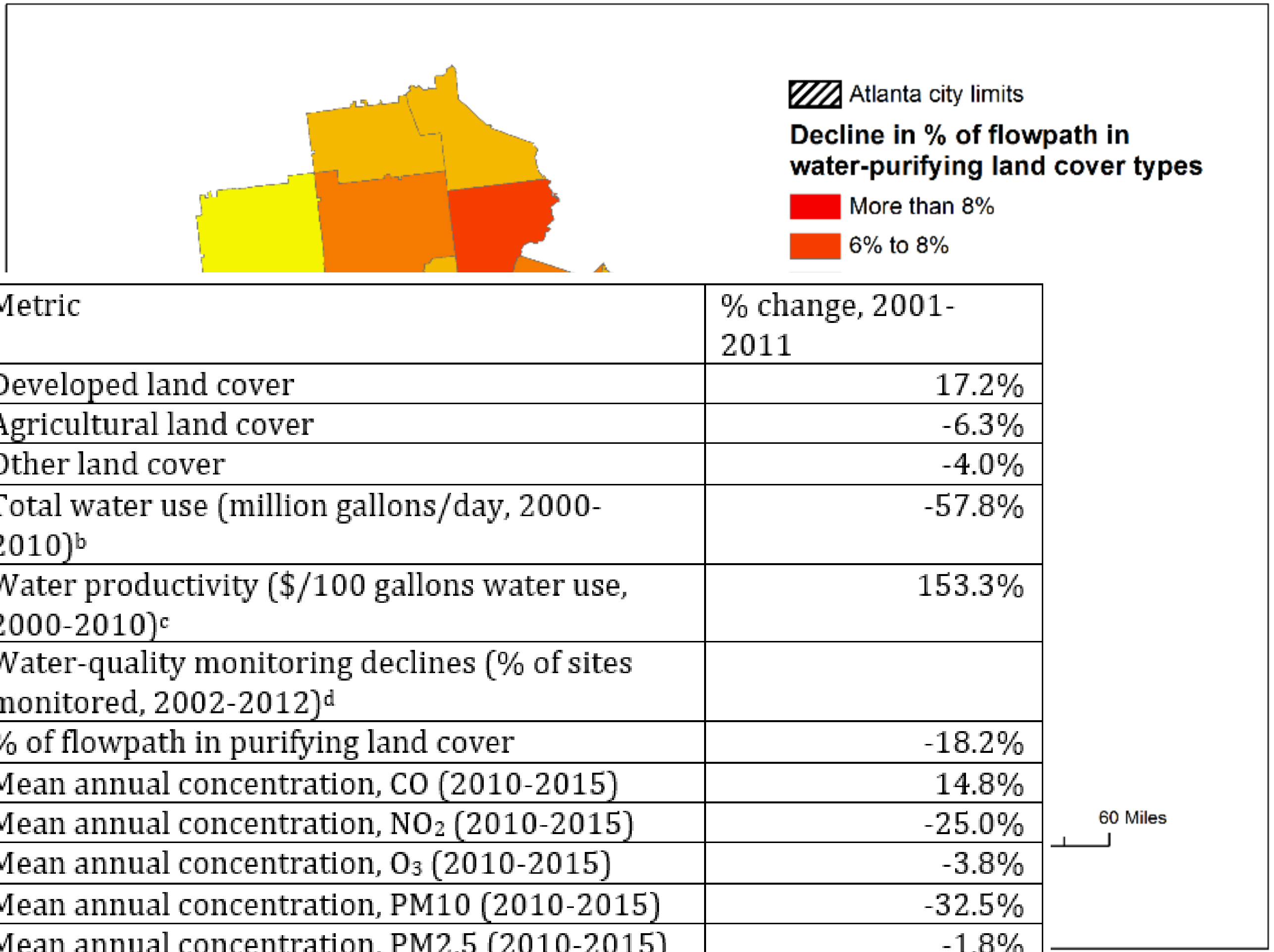
Ecosystem accounts, SE U.S. (Warnell et al. 2020)



				Ecosystem Types (Land Cover)																
				Offshore	Open Water - non-freshwater	Open Water - freshwater	Developed - Open	Developed - Low	Developed - Medium	Developed - High	Barren	Deciduous Forest	Evergreen Forest	Mixed Forest	Shrub/Scrub	Grassland/Herbaceous	Pasture/Hay	Cultivated Crops	Woody Wetlands	Emergent Herbaceous Wetlands
Wild pollination*	Area of pollinator habitat in flight range of pollinator-dependent crops (sq km)		2001									5,471	2,516	1,336	1,290	165			7,061	172
			2006									4,152	2,125	1,459	2,191	423			11,539	371
			2011									53,679	30,441	6,670	18,388	9,314			43,104	3,354
	Area of pollinator-dependent crops in flight range of pollinator habitat (sq km)		2001															11,182		
			2006															21,581		
			2011															65,818		
	Ratio of pollinator habitat to pollinator dependent crops		2001															1.66		
			2006															1.05		
			2011															2.55		
Water purification	Area of purifying land cover types between NPS sources and waterways (sq km)		2001									31,542	20,238	6,959		5,385			25,463	3,379
			2006									31,453	19,780	6,678		5,997			25,427	3,504
			2011									31,005	19,330	6,353		6,192			25,151	3,789
	% of flowpath between NPS sources and waterways in purifying land cover types		2001			30.6%														
			2006			30.4%														
			2011			29.9%														
Bird biodiversity	Bird species richness (out of 160 species modeled)		2001	158	157		156	149				160	160				160	160	158	148
			2006	158	157		156	150				160	160		145		160	160	159	150
			2011	158	157		156	150				160	160		144		160	160	159	147
Air purification	Wind Speed (m/s)		2010	2.42																
			2015	2.54																
	Temperature (°C)		2010	17.06																
			2015	17.38																
	Precipitation (mm/yr)		2010	962																
			2015	1344																
	Pollution removal (tonnes/year)	CO	2010	98,690																
			2015	92,583																
		NO_2	2010	438,139																
			2015	494,268																
		O_3	2010	4,531,927																
			2015	4,258,878																
		PM_{10}	2010	1,327,037																

Ecosystem accounts support fine-grained analysis

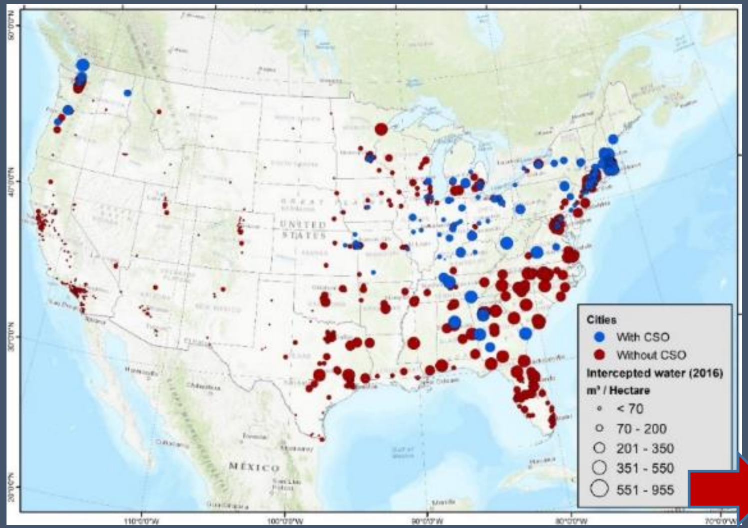
- Atlanta MSA (right)
- New county-level GDP estimates from BEA enable finer scale analysis
- Ability to extract results for any geography e.g., watersheds, public lands



Account	Metric	% change, 2001-2011
Land accounts[a]	Developed land cover	17.2%
	Agricultural land cover	-6.3%
	Other land cover	-4.0%
Water accounts	Total water use (million gallons/day, 2000-2010)[b]	-57.8%
	Water productivity ($/100 gallons water use, 2000-2010)[c]	153.3%
	Water-quality monitoring declines (% of sites monitored, 2002-2012)[d]	
Ecosystem accounts[e]	% of flowpath in purifying land cover	-18.2%
	Mean annual concentration, CO (2010-2015)	14.8%
	Mean annual concentration, NO_2 (2010-2015)	-25.0%
	Mean annual concentration, O_3 (2010-2015)	-3.8%
	Mean annual concentration, PM10 (2010-2015)	-32.5%
	Mean annual concentration, PM2.5 (2010-2015)	-1.8%
	Mean annual concentration, SO_2 (2010-2015)	-42.7%
	Mean annual removal rates, CO (2010-2015)	22.5%
	Mean annual removal rates, NO_2 (2010-2015)	18.9%
	Mean annual removal rates, O_3 (2010-2015)	3.4%
	Mean annual removal rates, PM10 (2010-2015)	-20.3%
	Mean annual removal rates, PM2.5 (2010-2015)	0.3%
	Mean annual removal rates, SO_2 (2010-2015)	-46.6%
	Total precipitation (mm/yr)	39%
	Recreational birding-days	209.6%
Economic accounts[f]	GDP, all industries	8.8%
Population (2000-2010)[g]		24.0%

Urban ecosystem accounts (Heris et al. 2021)

Rainfall interception, urban heat island mitigation for 768 cities >50,000 population

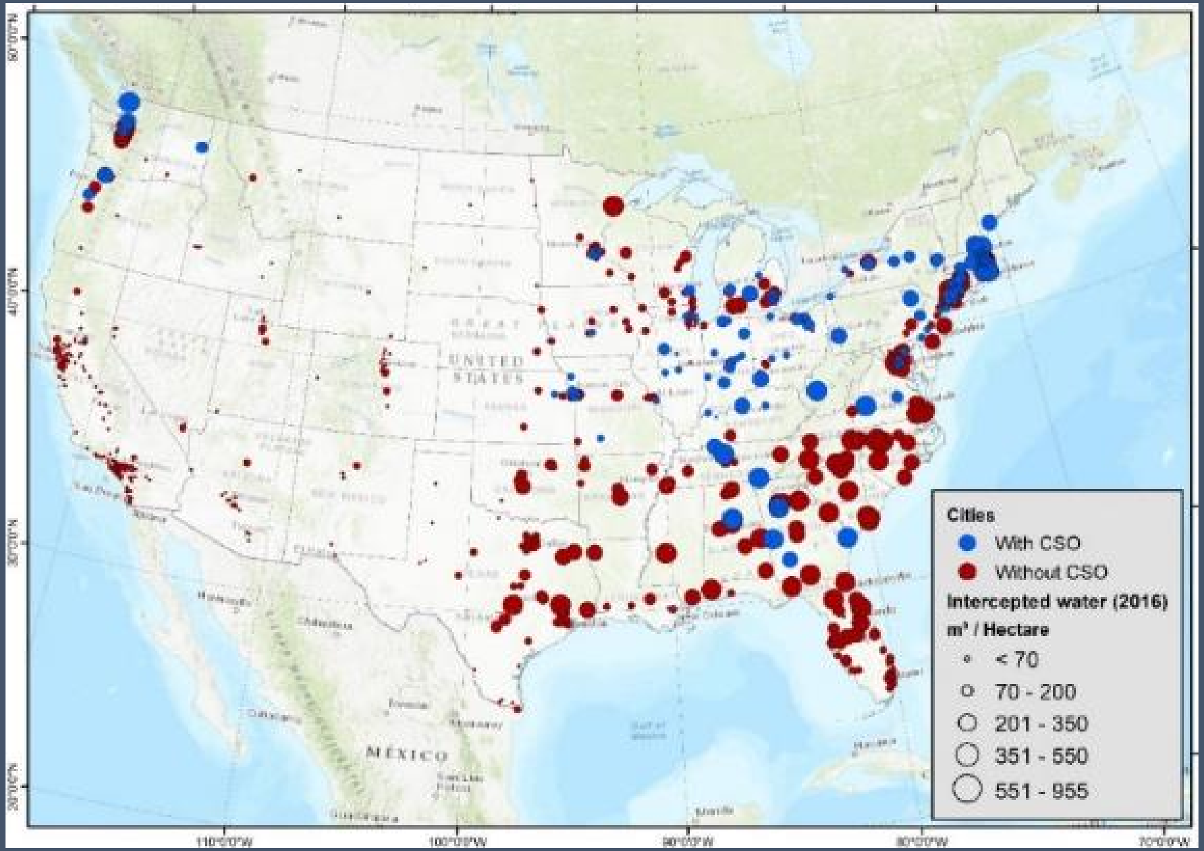


Ecosystem Accounting Area	Service Type	Year	Ecosystem Types (Land cover): Open Water	Developed - Open	Developed - Low	Developed - Medium	Developed - High	Barren	Deciduous Forest	Evergreen Forest	Mixed Forest	Scrub/Shrub	Grassland/Herbaceous	Pasture/Hay	Cultivated Crops	Woody Wetlands	Emergent Herbaceous Wetlands	Total
736 cities with population >=50k and valid regression results	Energy Savings (Million $)	2011	0.0	150.2	238.4	87.0	6.3	0.1	14.8	12.4	3.0	3.2	2.4	1.2	0.4	3.1	0.3	522.7
		2016	0.0	150.5	247.7	91.8	6.5	0.2	12.4	12.2	7.5	2.8	1.7	1.7	0.5	2.9	0.4	538.6
Cities of Colorado (17 with population >=50k)		2011	0.0	2.9	12.5	3.9	0.1	0.0	0.1	0.1	0.0	0.2	0.0	0.0	0.0	0.1	0.0	20.0
		2016	0.0	2.9	12.7	3.9	0.1	0.0	0.1	0.2	0.0	0.3	0.0	0.0	0.0	0.1	0.0	20.3
Denver, CO		2011	0.0	1.0	3.3	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1
		2016	0.0	0.9	3.2	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0
130 cities with CSOs with population >=50k	Avoided Runoff Value (Million $)	2011	0.7	85.6	59.7	16.9	1.2	0.4	155.7	29.1	47.4	2.8	2.2	8.7	0.9	20.7	1.6	433.6
		2016	0.6	83.7	59.0	17.4	1.2	0.4	149.4	30.2	46.6	1.9	2.1	8.2	0.9	21.6	1.6	424.7

Ecosystem Accounting Area	Service Type	Year	Economic units: NAICS 11 Livestock	Wastewater treatment 221320	NAICS 31-33 Manufacturing	NAICS 44-45 Retail	NAICS 48-49 Transport warehousing	NAICS 51-56 Offices	NAICS 61 Educational services	NAICS 62 Health care & social assistance	NAICS 71 Entertainment	NAICS 92 Government	Households (No NAICS Code)	No NAICS equivalent	Total
736 cities with population >=50k and valid regression results	Energy Savings (Million $)	2011	0.0	0.0	1.3	2.1	11.3	2.9	3.5	0.9	0.2	0.9	497.7	1.8	522.7
		2016	0.0	0.0	1.3	2.1	11.2	2.9	3.5	1.0	0.2	0.9	513.7	1.8	538.6
Cities of Colorado (17 with population >=50k)		2011	0.0	0.0	0.0	0.1	0.0	1.7	0.1	0.0	0.0	0.1	17.6	0.3	20.0
		2016	0.0	0.0	0.0	0.1	0.0	1.7	0.1	0.0	0.0	0.1	17.9	0.3	20.3
Denver, CO		2011	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.1	4.3	0.1	5.1
		2016	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.1	4.3	0.1	5.0
130 cities with CSOs with population >=50k	Avoided Runoff Value (Million $)	2011	0.0	433.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	433.6
		2016	0.0	421.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	424.7

Urban rainfall interception account: assumptions

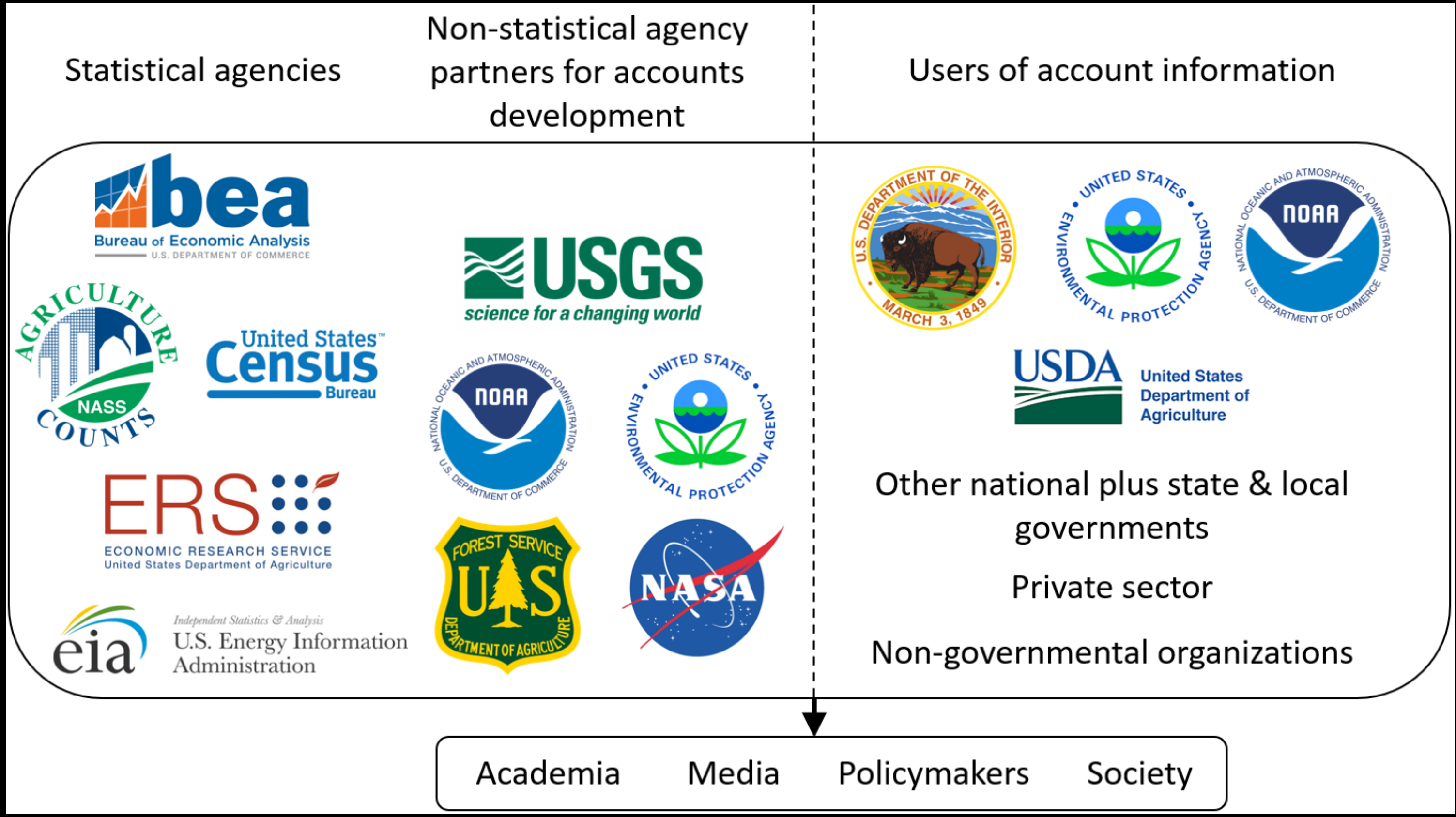
- Tree cover, LAI, rain events data
- 25.5% of urban intercepted rainfall would otherwise fall on impervious surface (Nowak & Greenfield 2012)
- Replacement of intercepted rainfall in cities with CSOs at $\$2.58/m^3$ (Hirabayashi 2013)
- 2.63 billion m^3 intercepted in 2016, ca. 27% in cities with CSOs, valued at $425 million



Water in the ecosystem accounts: Next steps

1. Best-available water models + best-available valuation data
   - Multiple water-based ecosystem services (water supply, regulation, water quality, flood regulation…)
2. Distinguish beneficiaries (not always easy)
3. Public code repositories
   - Open code that can be reviewed & improved upon by the community
   - Open data BUT simultaneous ability to keep private, as needed, to meet privacy needs of statistical community
   - Capable of being re-run to update time series

4. Lessons & needs for economic valuation



Valuation: Challenges

- National scale
- Without oversimplifying (ecological, hydrologic, socioeconomic heterogeneity)
- Consistent with SNA (i.e., exchange values vs. welfare)

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CORRESPONDENCE | 18 May 2021

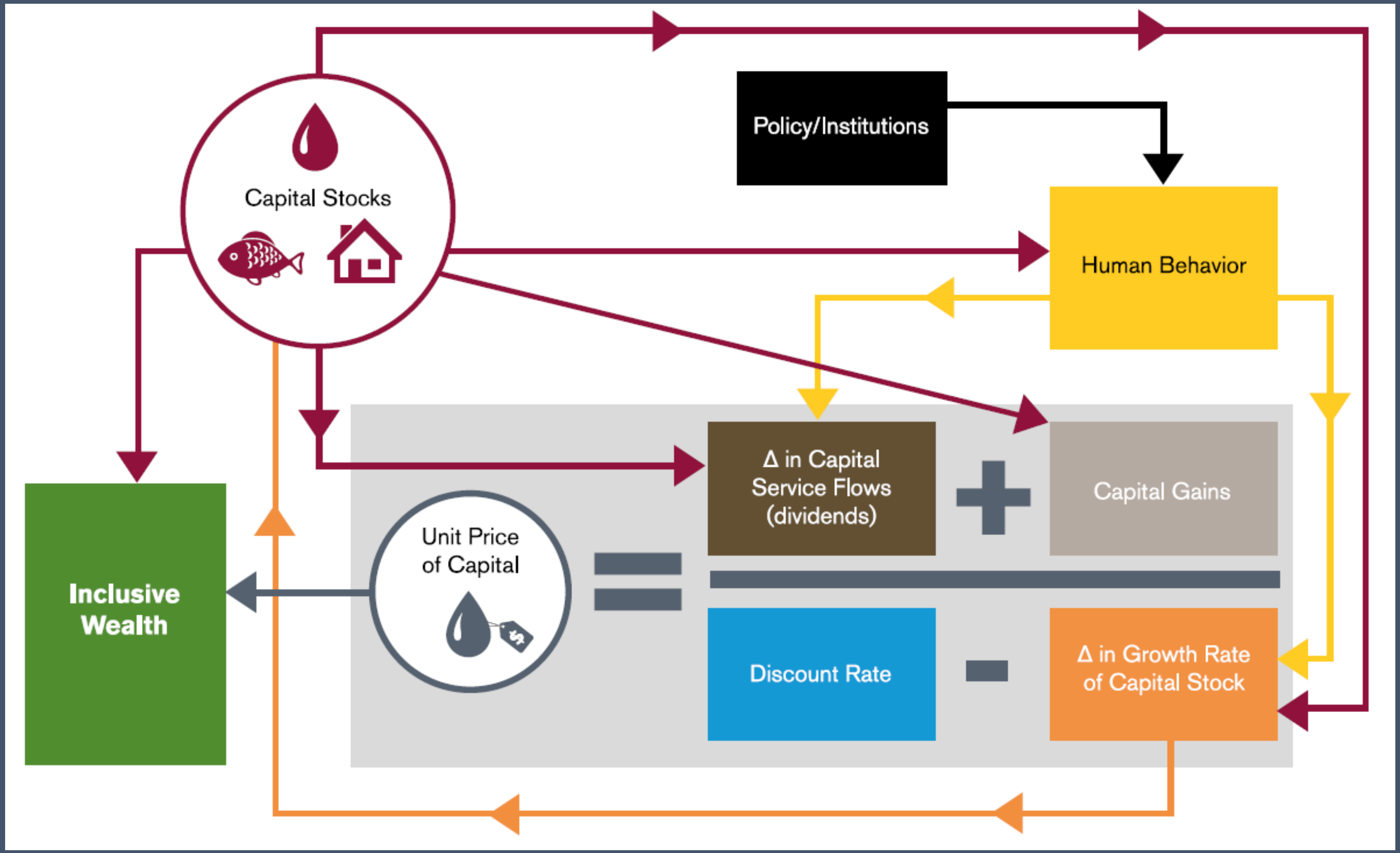
Statistics: unify ecosystems valuation

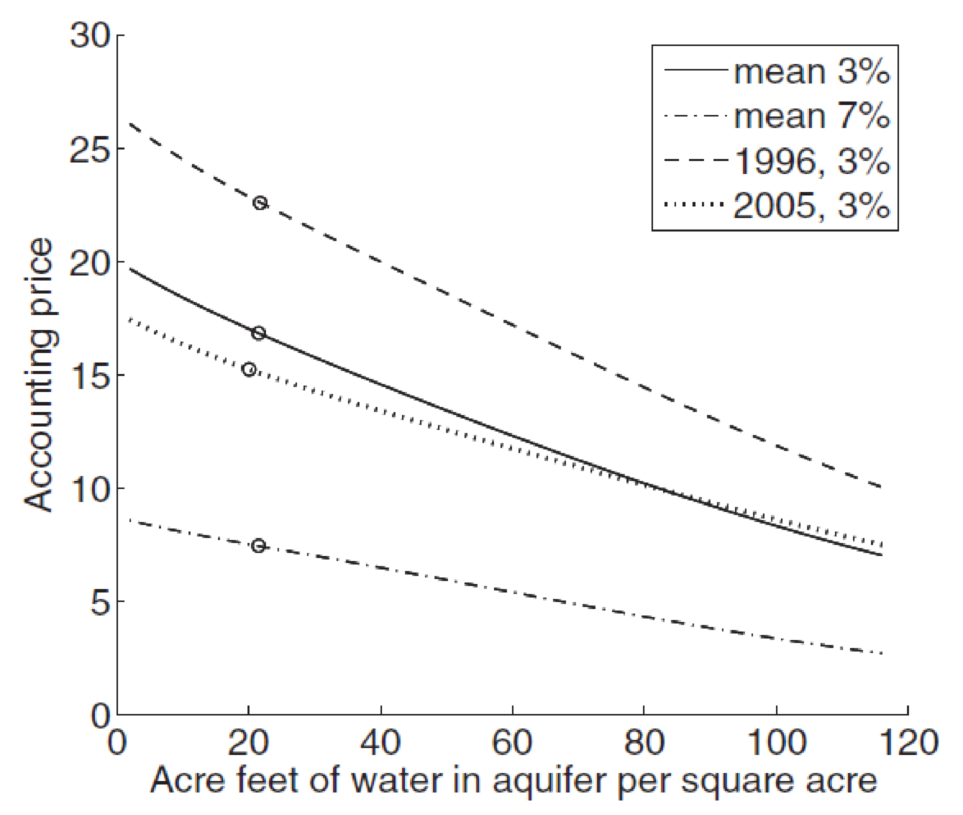
Nils Brown , Aldo Femia , Dennis Fixler , Ole Gravgård Pedersen , Sven C. Kaumanns , Gian Paolo Oneto , Simon Schürz , Francesco N. Tubiello & Scott Wentland

Valuation: Challenges

1. (A)typical challenges? – problems with WTP, resource rent, avoided/replacement costs OK with usual caveats
2. Benefit function transfer – potentially, but be careful, design & test transfer functions with eye toward SNA compliance
3. SCC admissible as a valuation method "when derived from models that are consistent with the exchange value concept, i.e., limited to assessment the effects on measures of output" (§ 9.32);
    1. Follow same approach to apply social cost of water pollution to value ecosystem filtration of water pollutants as an ecosystem service

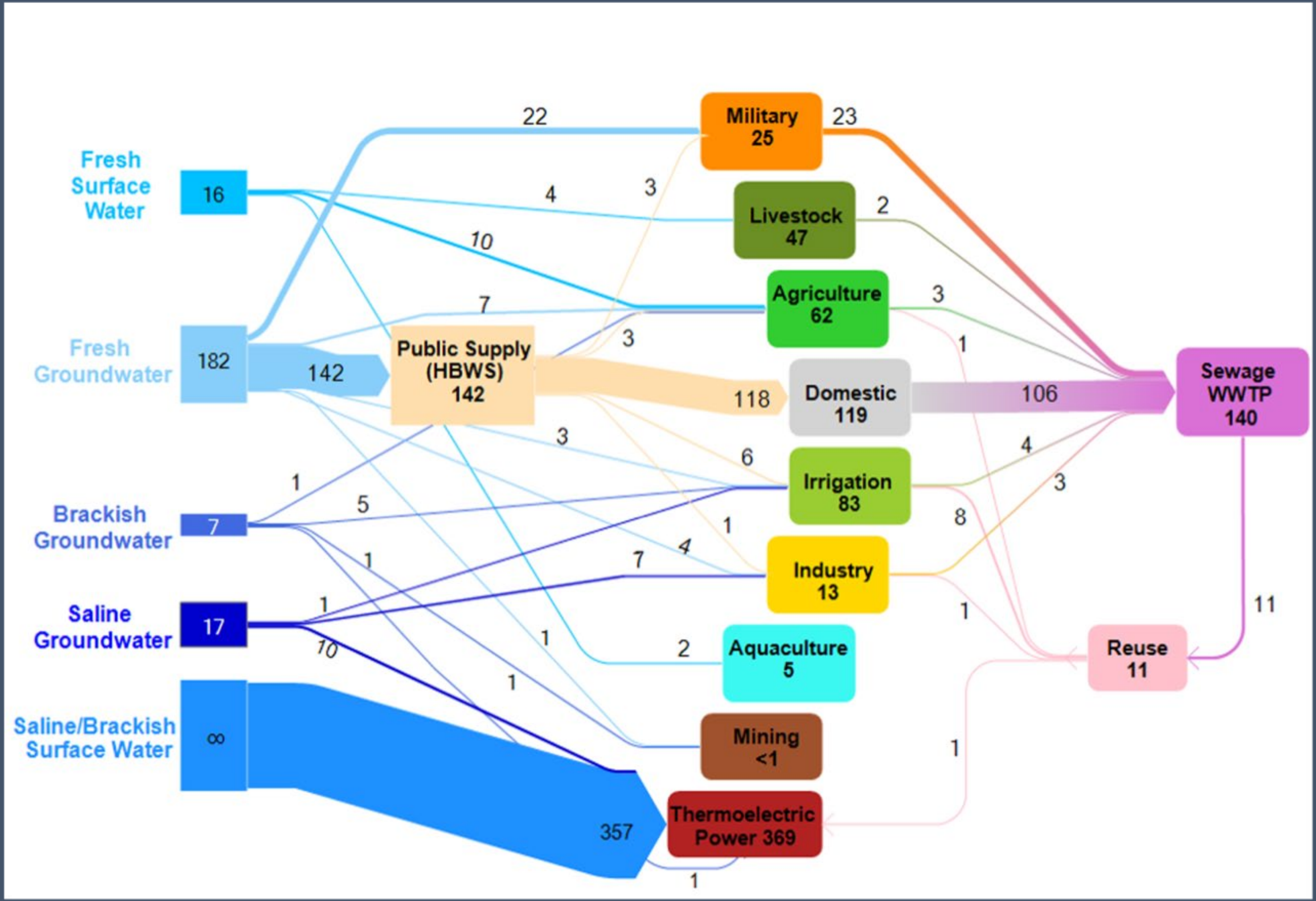
Valuation: Capital theory-consistent approach





Fenichel et al. 2016, KS groundwater example

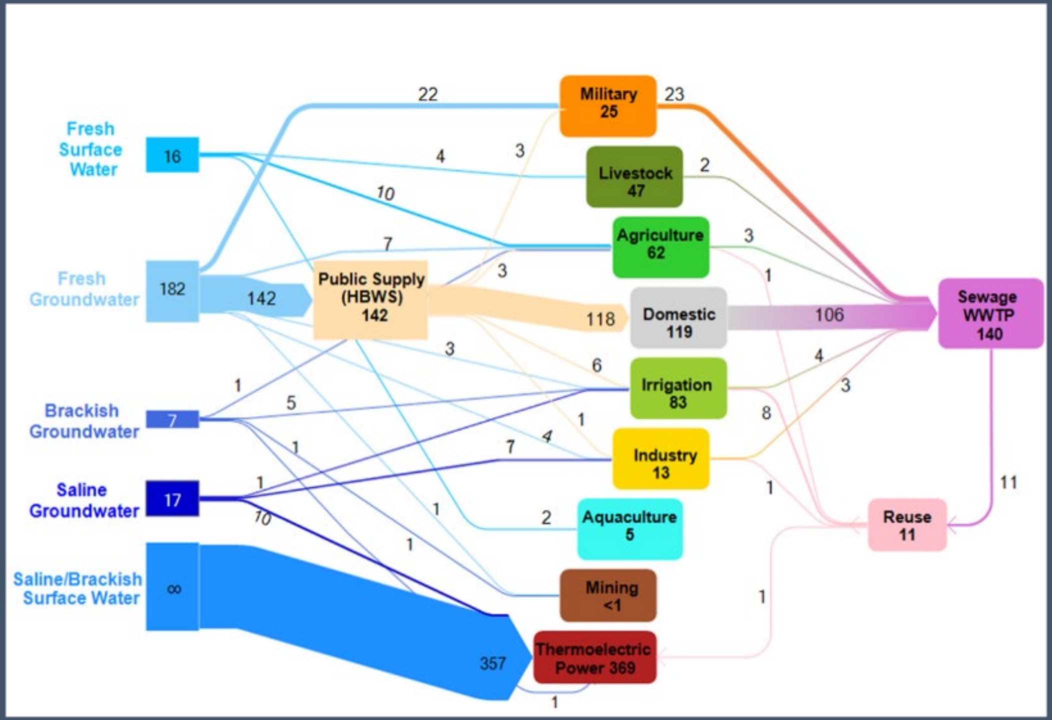
State & local water accounting: O'ahu example



Oleson et al. in prep

State & local water accounting: O'ahu example

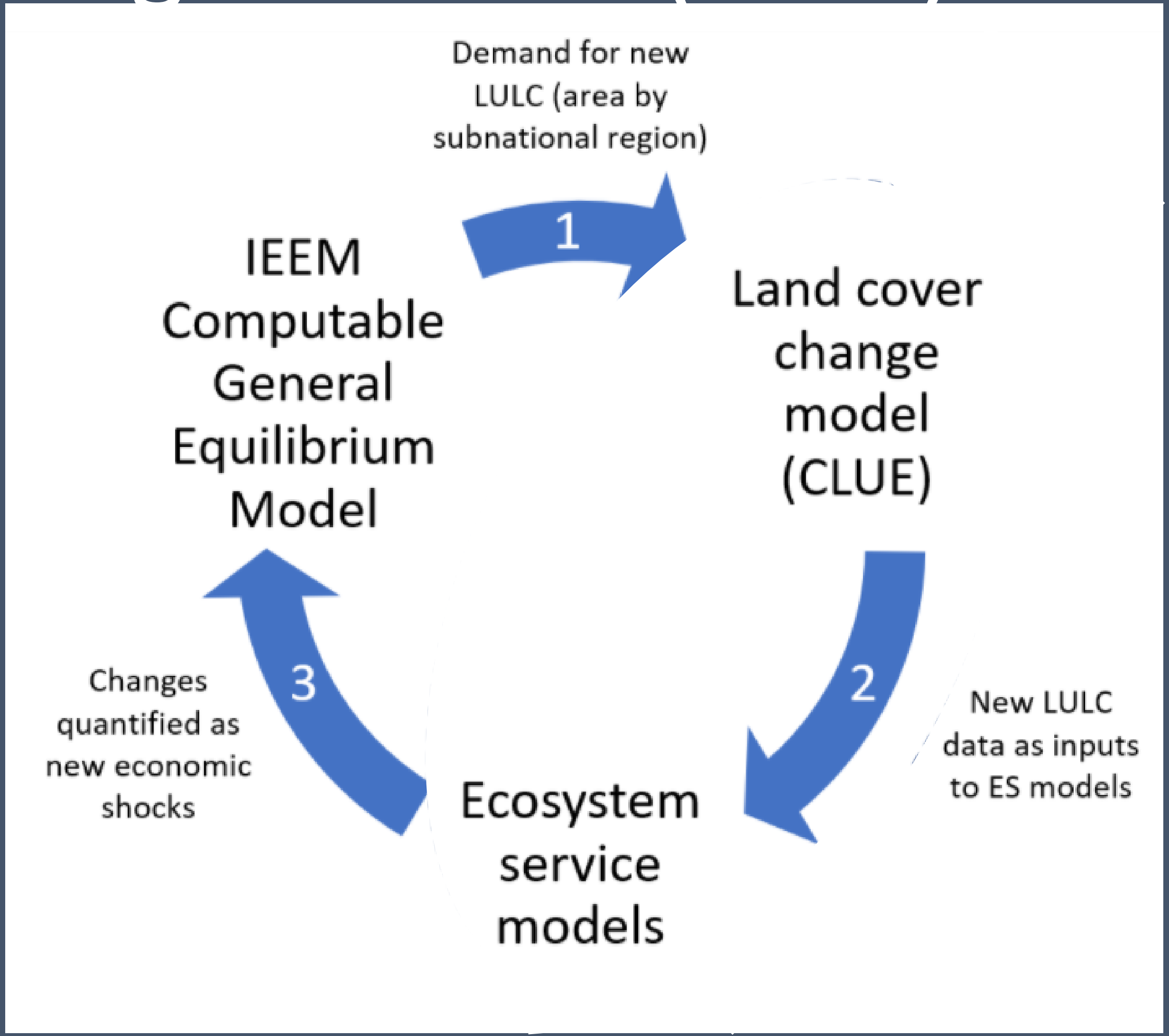
- Relevant for many state agencies (e.g., agriculture, environment, economic development, tourism) & policy initiatives
- What's needed?
  - Ability to do forward-looking policy analysis
  - Champions within state government who understand & can use NCA



Oleson et al. in prep

Forward-looking analysis: Integrated Economic-Ecological Model (IEEM)

- Computable general equilibrium (CGE) models evaluate fiscal/trade/agricultural policy effects on income, jobs, trade balances, etc.
- Integrate with NCA to evaluate ecosystem service changes & feedbacks to the economy
  - Soil erosion, fisheries, pollinators, timber, natural hazards



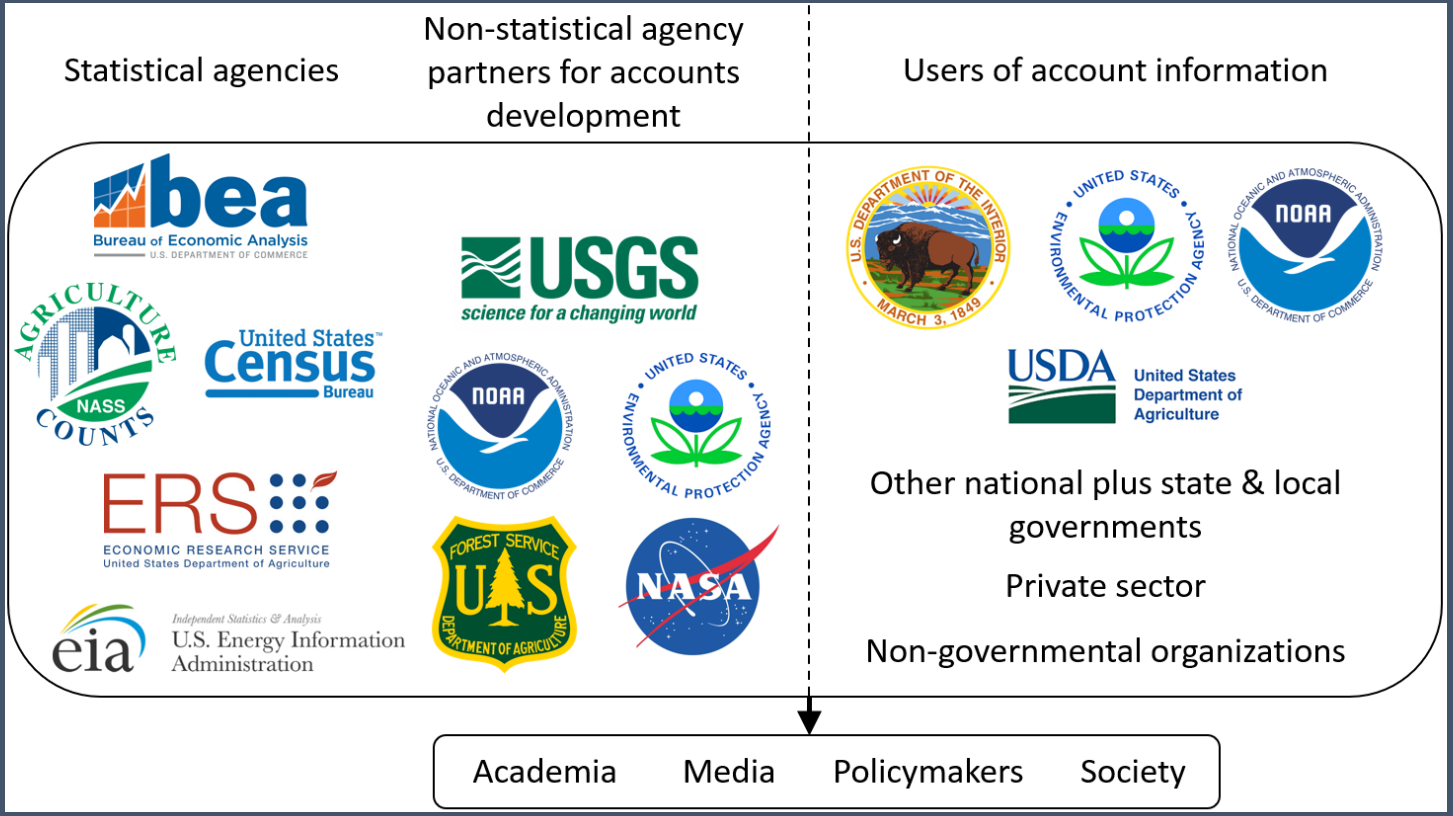
Forward-looking analysis: Rwanda

- Example: development scenario effects on Rwanda's economy & ecosystem services (Banerjee et al. 2020)
- IDB has extended to 21 Latin American nations
- Comparable global approaches using GTAP (World Bank 2021)

		Difference between BASE in 2015 and 2035	Percent difference between scenario and BASE in 2035						
		BASE	FOR1	FOR2	FUEL	IRRIG	FERT	COMBI1	COMBI2
Macroeconomic indicators (IEEM)	Absorption	329.3	-0.1	0.2	1.2	0.5	6.7	8.4	8.4
	Private consumption	311.9	0.0	0.3	1.9	0.5	8.2	10.7	10.7
	Fixed investment	350.5	-0.2	0.1	0.1	0.5	6.4	6.8	6.8
	Exports	427.3	1.3	0.9	3.1	0.8	11.0	16.4	16.4
	Imports	361.2	0.2	0.2	0.9	0.1	4.4	5.7	5.7
	GDP	332.7	0.1	0.3	1.6	0.6	8.1	10.5	10.5
	Genuine savings	364.9	-0.5	0.2	0.4	1.1	10.8	11.6	11.6
	Indirect tax income	317.0	0.0	0.3	1.2	0.5	7.9	9.8	9.8
	Real exchange rate	-1.2	-0.1	0.4	0.8	1.2	7.0	8.7	8.7
	Wages	113.8	-1.5	-0.1	-0.6	0.6	11.0	9.3	9.3
	Unemployment*	-48.6	2.2	0.3	1.3	-0.5	-8.9	-6.2	-6.2
	Poverty*	-79.4	1.2	-0.2	0.0	-1.1	-17.5	-17.4	-17.4
	Agricultural activity	178.6	-1.6	0.1	0.2	1.6	23.6	23.5	23.5
	Livestock activity	166.2	-1.6	0.1	0.1	0.7	8.7	7.7	7.7
	Forestry activity	394.8	2.6	2.2	-3.3	0.2	2.9	2.2	2.2
	Manufacturing activity	353.8	0.4	0.5	1.6	0.5	9.4	11.9	11.9
	Services activity	401.0	0.3	0.3	0.7	0.5	4.8	6.4	6.4
SEEA Central Framework: Land & water-use change	Agricultural land use	0.9	-2.0	0.0	0.0	-0.1	-0.8	-2.8	-2.8
	Livestock land use	2.1	-1.9	0.0	0.0	0.7	8.6	7.1	7.1
	Forestry land use	7.7	53.0	53.0	0.0	0.0	0.0	53.0	53.0
	Water use	223.6	-0.4	0.5	-0.5	1.1	15.7	15.6	15.6
Ecosystem services	Carbon storage	-0.3	3.3	2.8	0.0	0.0	0.0	3.0	3.7
	Annual water yield	0.7	-1.8	-1.7	0.0	0.0	-0.1	-1.3	-1.7
	Quick flow	1.1	-2.9	-2.1	0.0	0.0	0.0	-2.5	-3.8
	Local recharge	-0.8	0.9	0.6	0.0	0.0	0.0	0.9	1.8
	Sediment export*	-20.9	0.2	0.1	0.0	0.0	0.0	0.2	0.2
	Nitrogen export*	0.0	-3.4	-2.5	0.0	0.0	47.1	42.4	44.9
	Phosphorus export*	-2.1	-3.1	-2.2	0.0	0.0	49.7	45.2	50.1

Lessons learned from NCA in the U.S. & Europe (Bagstad et al. 2021)

1. Coordination (U.S. statistical & science agencies are fragmented)
2. Develop demand among all user groups (Federal agencies, states, private sector – Ingram et al. 2022)
3. Technical paths forward to move from pilot to production accounts
4. Non-Federal partners can help substantially with #2 & 3



https://www.sciencedirect.com/journal/ecosystem-services/special-issue/10RZK17R0JP

Getting involved

1. Read & provide comment on the U.S. NCA strategy (through Oct. 21)
    1. https://www.federalregister.gov/documents/2022/08/22/2022-17993/request-for-information-to-support-the-development-of-a-strategic-plan-on-statistics-for
2. Agency scientists & staff: build relationships with agencies & offices planning next-generation accounts for water
3. Academic scientists
    1. Develop & test regional, state, local-level accounts (incl. translation of national NCA into locally relevant accounts)
    2. Research needed methods/applications for next-generation accounts, incl. valuation
4. All: Work with decision makers at all levels to make NCA an indispensable tool for environmental-economic decision making
    1. Partner with decision makers; cut through the jargon to understand NCA & why it matters
    2. Role for professional societies?


Thanks!
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