ARIES and natural capital accounting: Paths forward to systematize accounts

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BASQUE CENTRE
FOR CLIMATE CHANGE
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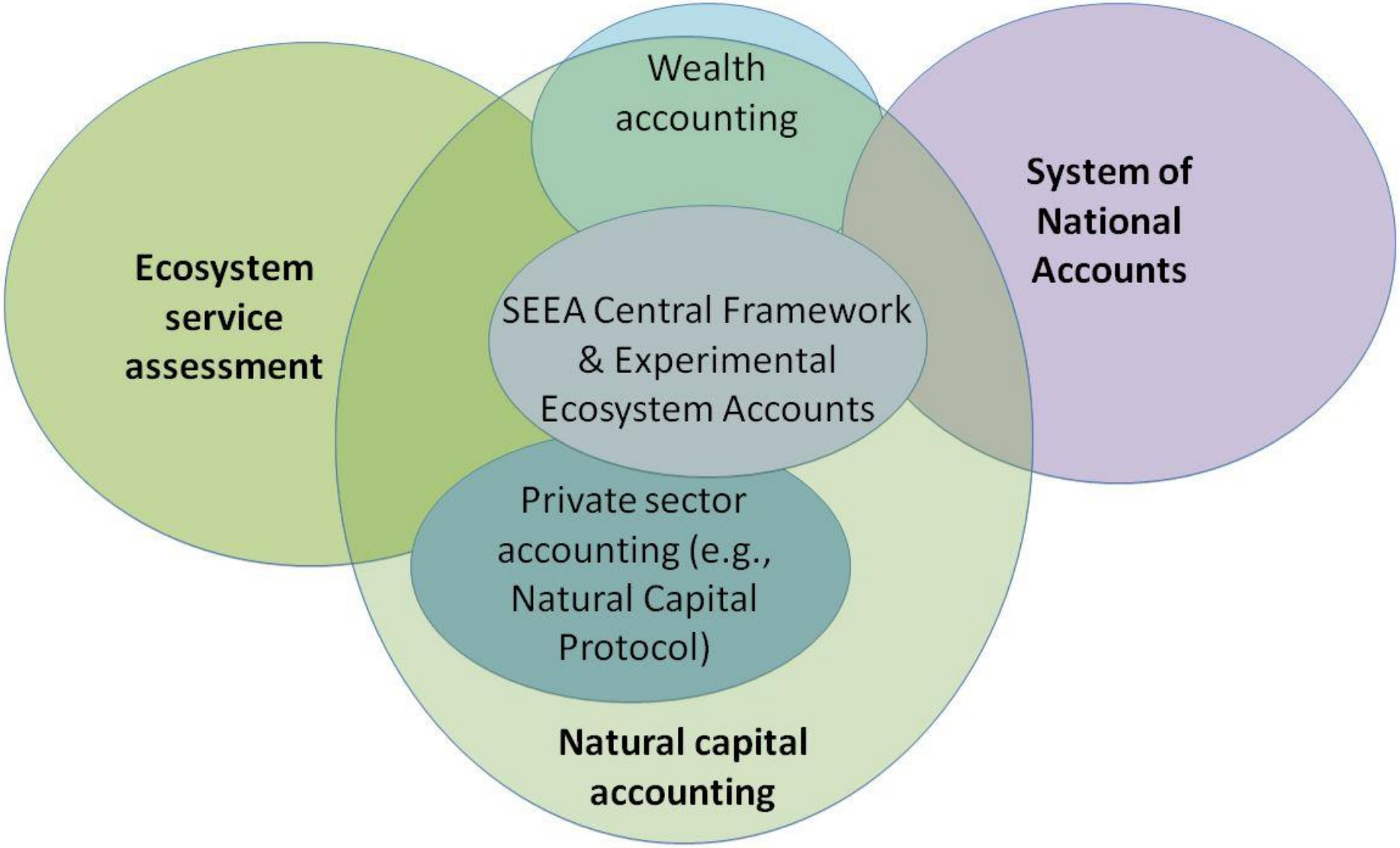
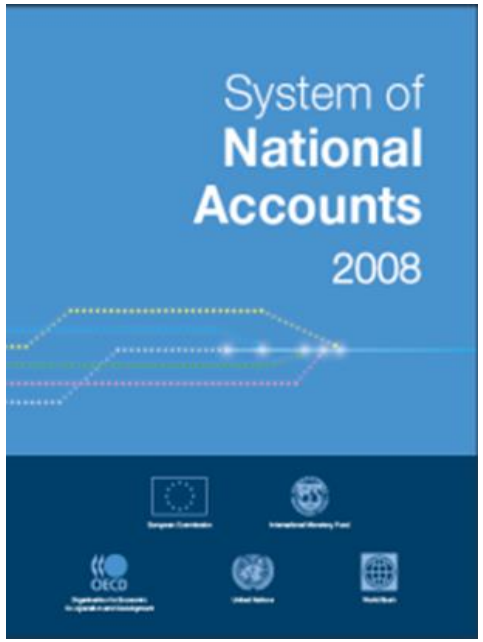
on Ecosystem
Services Modeling

What is natural capital accounting?



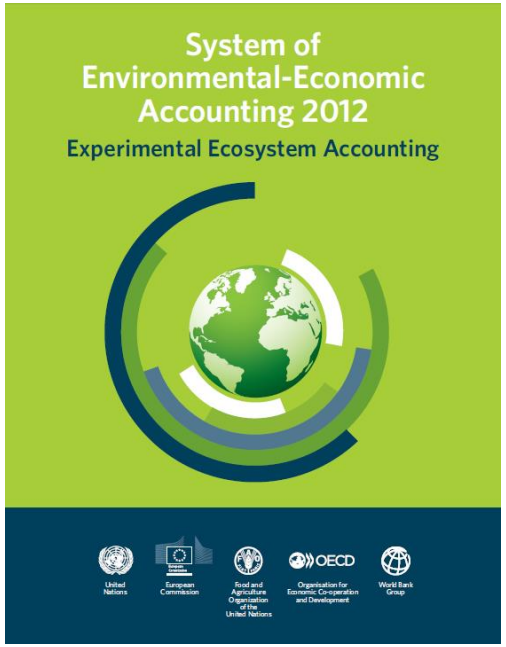
International standards

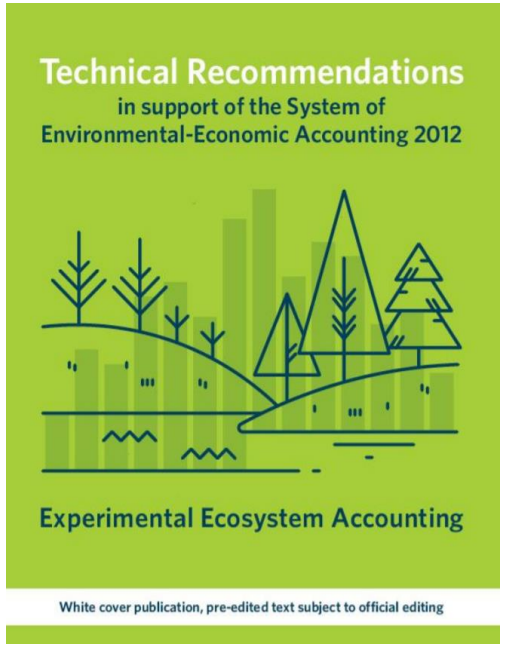
System of National Accounts



SEEA – Central Framework

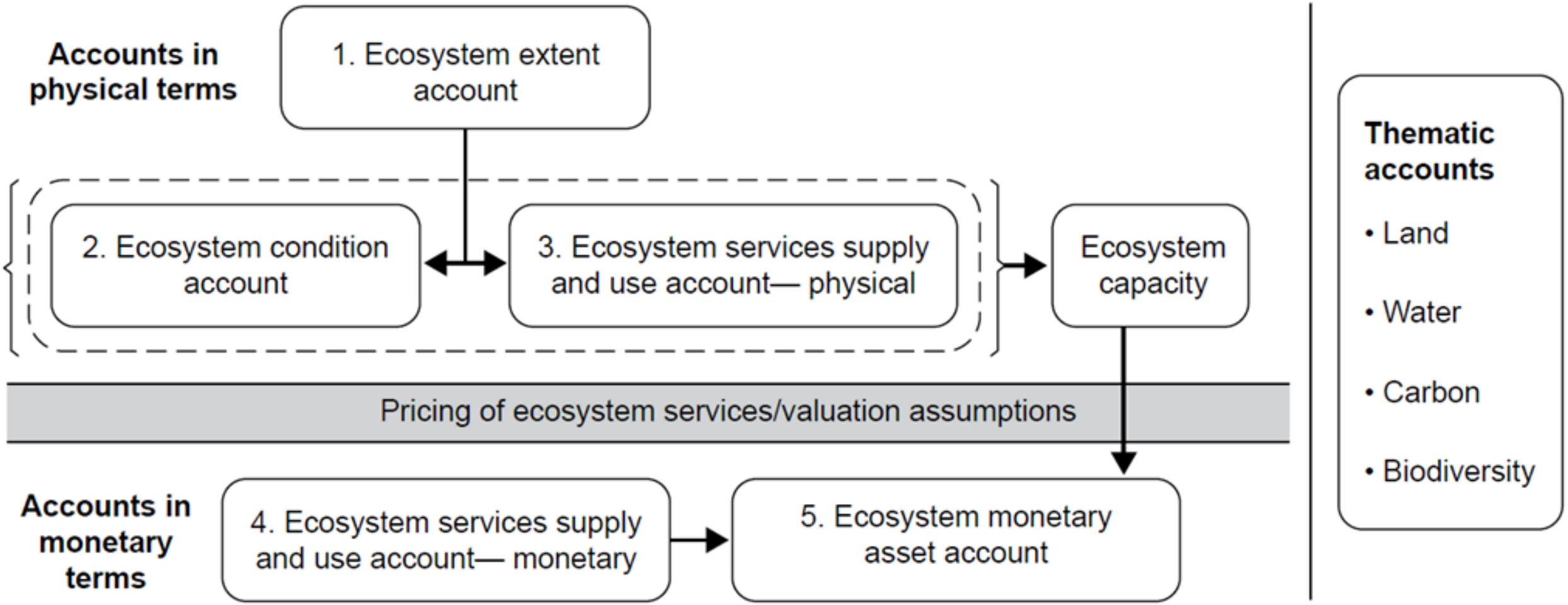
SEEA – Experimental Ecosystem Accounting



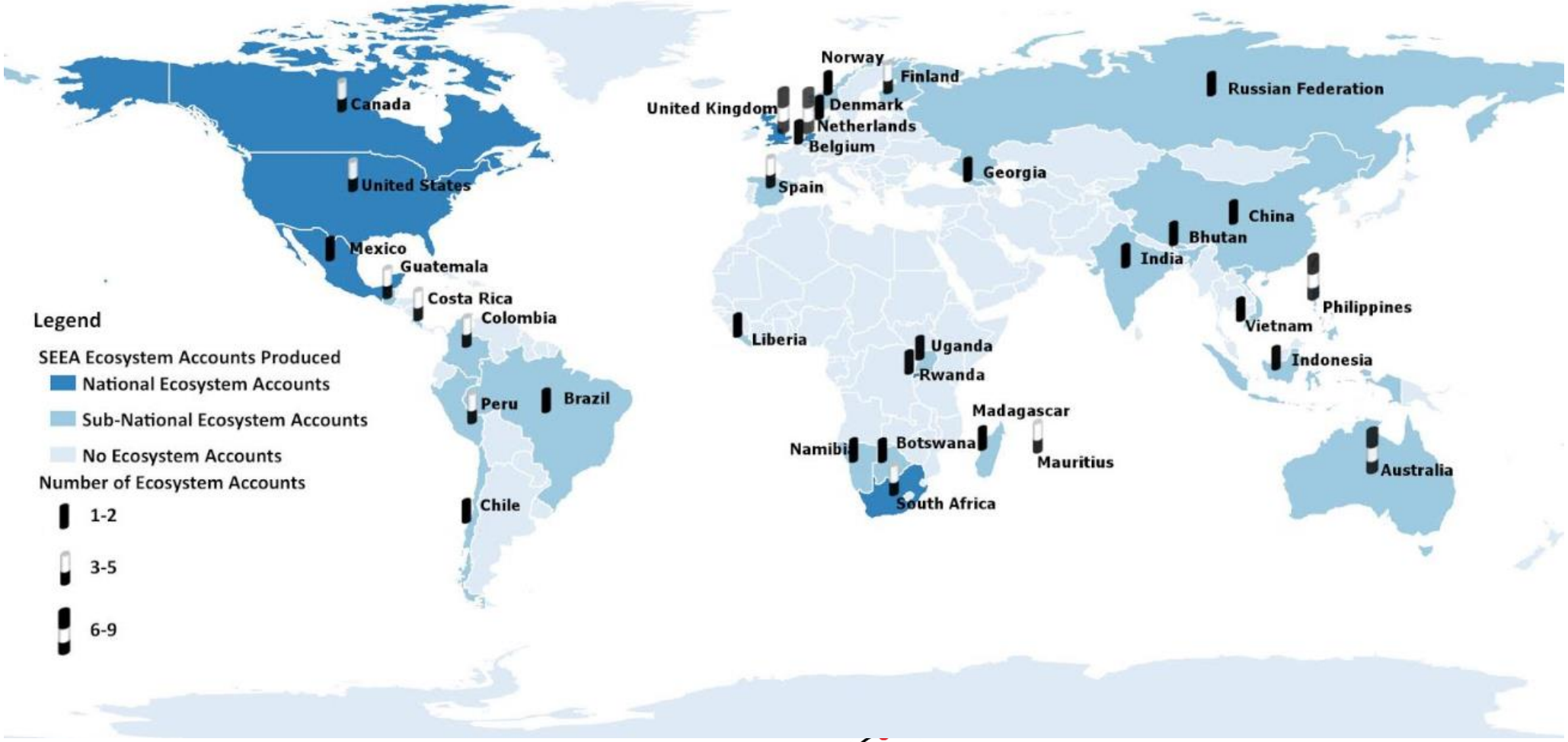


http://unstats.un.org/unsd/envaccounting/pubs.asp

Components of ecosystem accounting



Where are ecosystem accounts being compiled?



(Plus EU-wide accounts)

Hein et al. in review

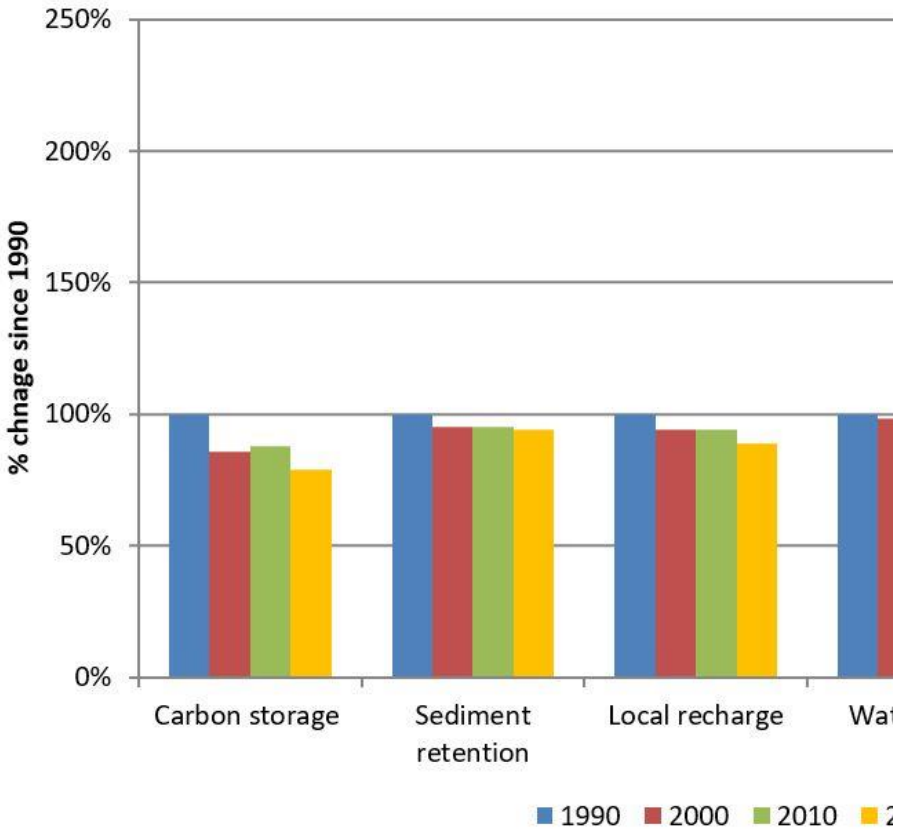
Lessons learned to date

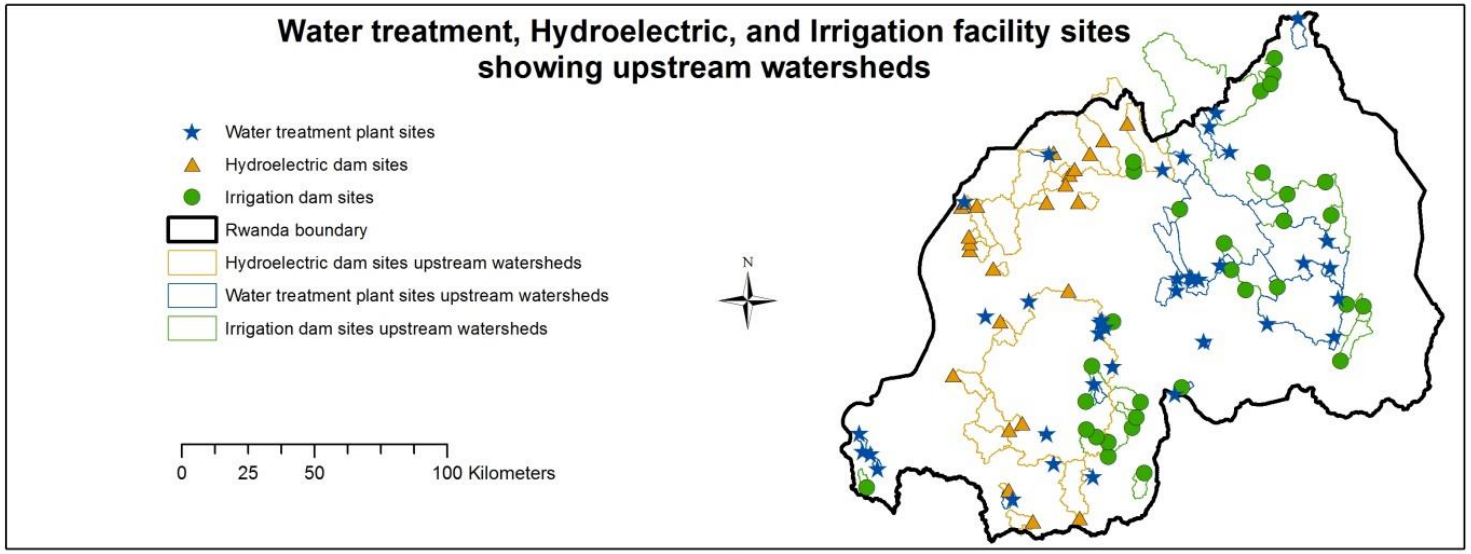
1. Accounts require a lot of time & expertise to compile (problem everywhere, esp. in developing world)
2. No country has compiled a full set of accounts – view of nature-economic connections is incomplete everywhere
3. Accounts based on global data lack needed credibility
4. Different countries use different metrics & methods – makes international comparison difficult to impossible
5. Time series data are critical
6. Valuation is hard, requires more work

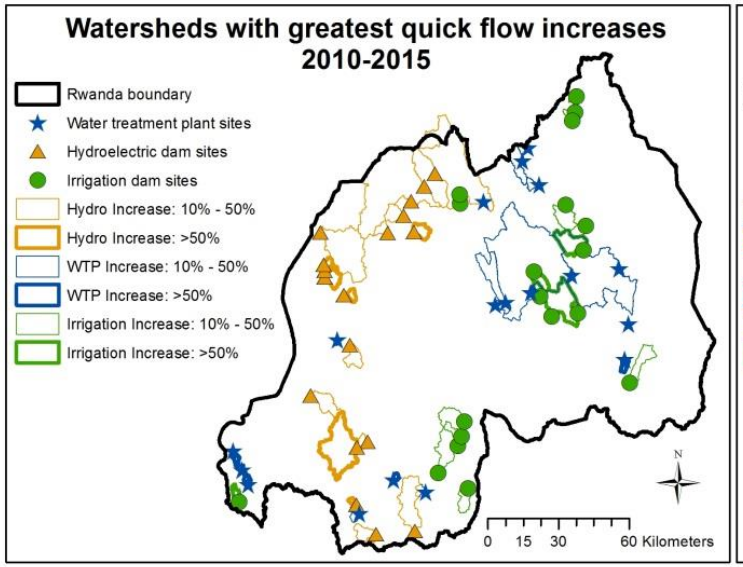
Example: Rwanda

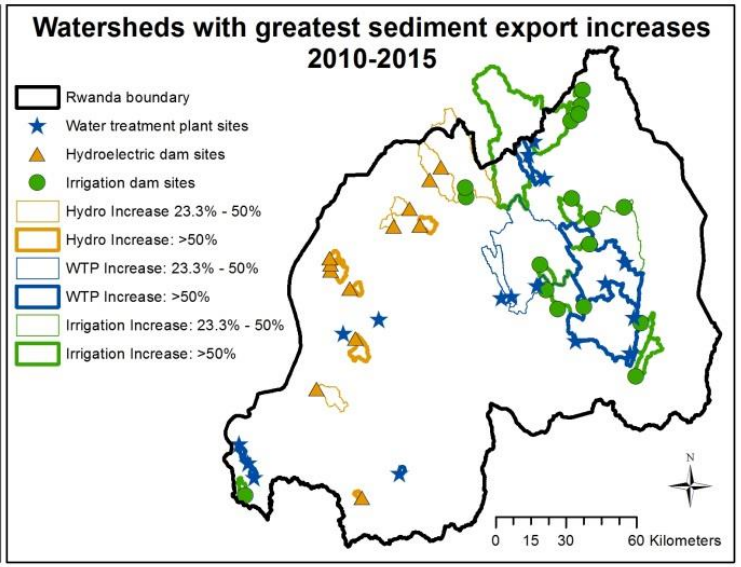
I. Potential supply table

		Ecosyster					
		Dense forest	Moderate forest	Sparse forest	Woodland	Closed grassland	Open grasslar
Carbon storage (MT)	1990	35	25	277	3	1	1
	2000	25	50	157	2	2	3
	2010	19	42	170	0	2	1
	2015	46	16	76	0	5	1
Sedin (1000	1990	7	38	1,158	18	41	8

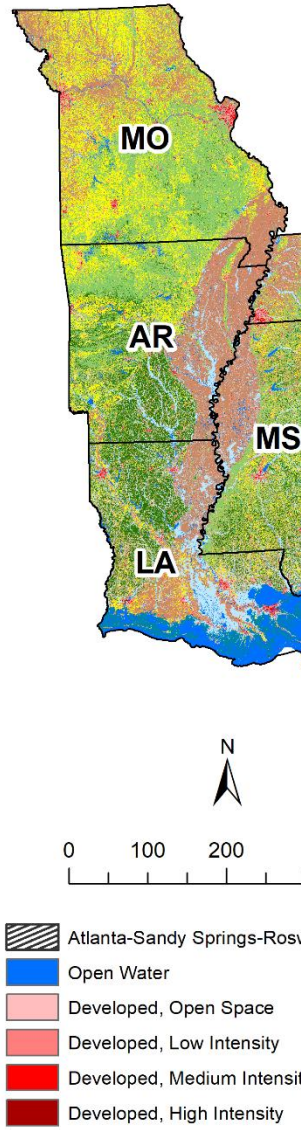








Example: Southeast U.S.



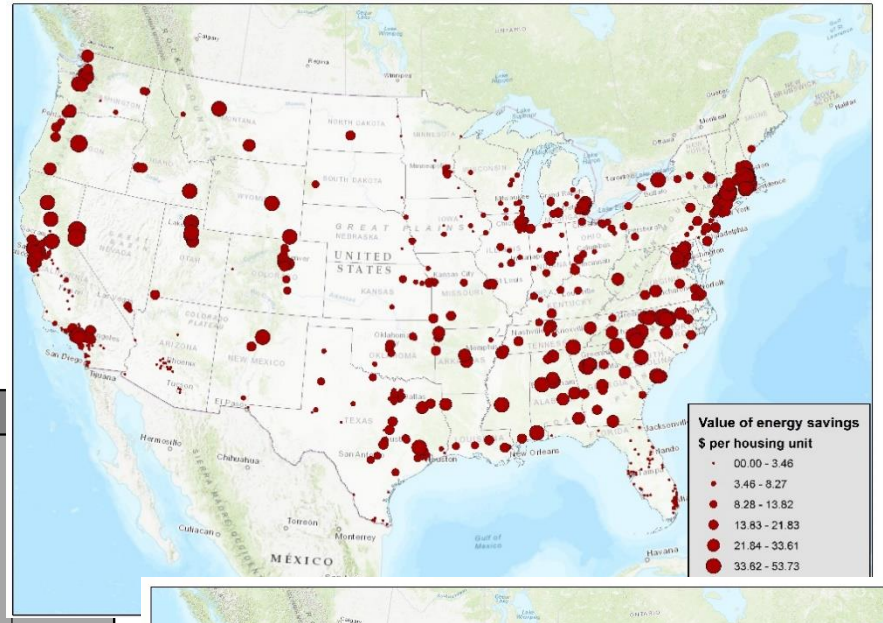
Source: National Land Cover Dataset, 2011

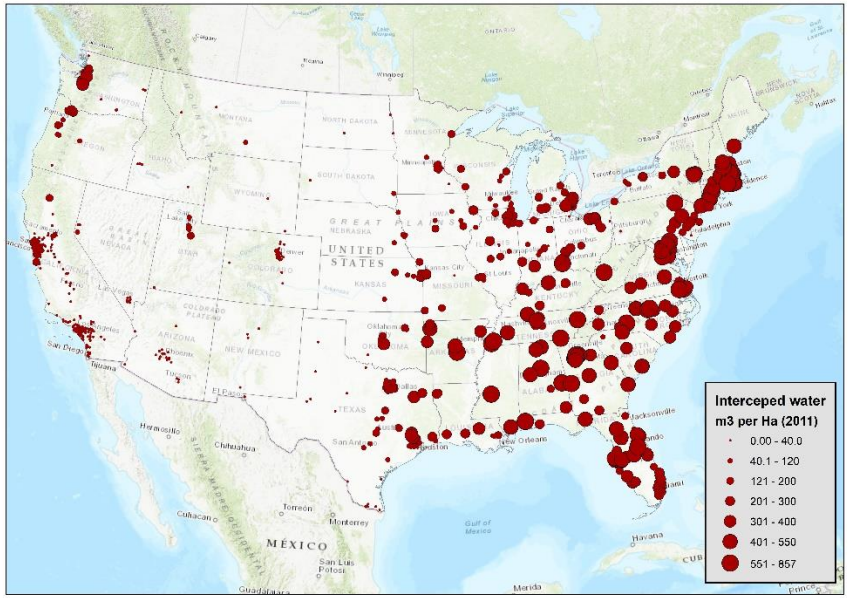
			Ecosystem Types (Land Cover)																Total
			Offshore	Open Water	Developed - Open	Developed - Low	Developed - Medium	Developed - High	Barren	Deciduous Forest	Evergreen Forest	Mixed Forest	Shrub/Scrub	Grassland/Herbaceous	Pasture/Hay	Cultivated Crops	Woody Wetlands	Emergent Herbaceous Wetlands	
Recreational birding (thousands of birding days)		2001	2,015	8,471	6,935	5,897	1,850	978	416	6,586	3,441	365	1,075	1,498	2,285	4,614	7,106	3,343	56,874
		2006	518	4,418	8,552	9,451	4,368	1,129	780	6,273	3,433	531	2,208	2,808	2,833	3,658	6,196	2,204	59,360
		2011	1,236	5,207	10,022	7,420	3,553	1,046	1,408	7,173	3,816	692	1,966	1,833	4,050	2,634	4,964	3,695	60,715
Air pollutant concentrations (annual mean, ppb except for PM (µg/m3))	CO	2010	314.6																314.6
		2015	290.1																290.1
	NO_2	2010	7.3																7.3
		2015	7.0																7.0
	O_3	2010	30.6																30.6
		2015	27.9																27.9
	PM_{10}	2010	9.5																9.5
		2015	9.5																9.5
	$PM_{2.5}$	2010	10.9																10.9
		2015	10.4																10.4
	SO_2	2010	2.0																2.0
		2015	1.0																1.0
Carbon storage* (kilotons of C)		2001	0	0	307,170				0	11,039,035			1,211,205	601,250	4,941,118		3,276,189	741,315	22,117,283
		2006	0	0	361,629				0	11,074,236			1,282,818	713,026	4,897,046		3,260,913	748,974	22,338,642
		2010	0	0	384,934				0	10,935,461			1,464,086	740,303	4,887,533		3,225,475	782,570	22,420,361

Example: U.S. urban accounts

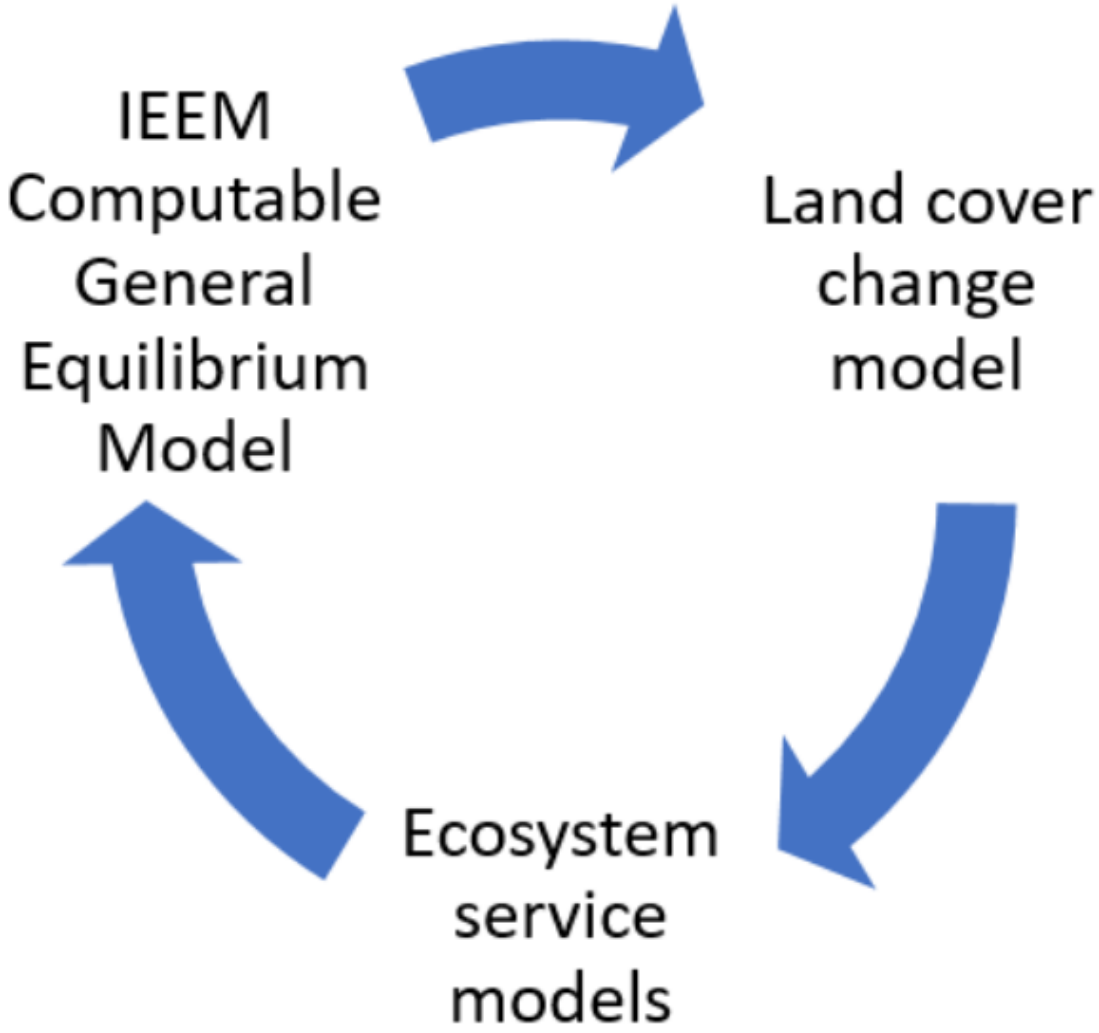
Ecosystem Accounting Area	Service Type	year	Ecosystem types (Land cover)															
			Open Water	Developed - Open	Developed - Low	Developed - Medium	Developed - High	Barren	Deciduous Forest	Evergreen Forest	Mixed Forest	Scrub/shrub	Grassland/Herbaceous	Pasture/Hay	Cultivated Crops	Woody Wetlands	Emergent Herbaceous Wetlands	Total
All U.S. cities (population>=50,000)	Intercepted water by urban trees (1000m3)	2001	7,647.7	320,911.4	209,883.4	54,797.1	3,327.4	1,199.0	422,914.2	260,253.1	69,532.0	37,858.4	22,132.8	18,067.9	10,728.6	300,915.5	15,339.8	1,755,508.2
		2011	5.5	404,770.9	266,974.4	70,641.5	7,073.8	1,872.6	433,311.9	184,358.4	59,537.3	49,801.8	35,074.9	25,727.2	14,510.1	303,279.8	16,909.7	1,873,849.7
	Energy Savings by urban trees mWh	2001	0.0	686,907.8	1,195,035.5	436,080.9	39,102.9	716.8	193,749.1	134,299.6	36,265.7	25,264.6	14,026.5	12,641.4	16,846.8	32,990.7	1,291.7	2,825,220.1
		2011		967,225.9	1,799,185.3	733,586.3	87,435.7	622.4	117,722.0	70,589.8	19,465.6	20,085.0	14,030.8	8,470.0	2,902.2	13,480.5	1,210.8	3,856,012.2
Colorado	Intercepted water by urban trees (1000m3)	2001	12.3	626.6	1,684.2	258.3	6.7	0.1	134.8	579.8	0.4	184.0	36.1	6.3	12.2	216.9	16.7	3,775.3
		2011	0.0	770.6	2,317.4	665.4	59.2	1.1	131.7	522.5	0.6	350.7	80.2	11.7	22.0	235.6	23.1	5,191.8
	Energy Savings by urban trees mWh	2001		11,578.5	51,036.4	8,749.4	315.5	0.3	442.0	571.3	0.9	532.6	140.0	24.4	83.5	814.1	65.2	74,354.1
		2011		16,970.1	93,034.7	30,284.4	3,441.3	6.4	486.9	628.3	5.0	876.0	216.9	30.0	32.5	720.0	62.6	146,795.0

Ecosystem Accounting Area	Service Type	Year	Economic units												
			NAICS 11 Livestock	221320 Wastewater treatment	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	
All U.S. cities (population>=50,000)	Intercepted water by urban trees (1000m3)	2001	0.0	1,755,508.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,755,508.2
		2011	0.0	1,873,849.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,873,849.7
	Energy Savings by urban trees MegaWh	2001	325.6	0.0	16,047.8	28,927.2	10,951.7	28,933.7	26,132.7	9,097.3	840.5	8,615.9	2,624,267.5	71,080.1	2,825,220.1
		2011	302.3	0.0	17,722.2	25,660.4	13,799.7	31,539.6	33,475.0	9,472.4	1,421.8	6,816.4	3,639,349.7	76,452.6	3,856,012.2
Colorado	Intercepted water by urban trees (1000m3)	2001	0.0	3,775.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3,775.3
		2011	0.0	5,191.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5,191.8
	Energy Savings by urban trees MegaWh	2001	0.5	0.0	76.5	248.1	98.4	311.0	561.1	166.3	11.8	177.5	71,386.3	1,316.6	74,354.1
		2011	2.7	0.0	411.0	1,218.9	330.1	1,428.8	1,621.2	513.6	77.4	611.2	137,884.7	2,695.4	146,795.0
Denver	Intercepted water by urban trees (1000m3)	2001	0.0	649.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	649.4
		2011	0.0	886.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	886.8
	Energy Savings by urban trees MegaWh	2001	0.0	0.0	15.9	38.6	34.3	76.8	297.2	64.7	9.9	114.2	22,199.4	312.5	23,163.4
		2011	0.8	0.0	167.1	340.1	169.4	465.5	772.3	198.1	70.5	408.2	44,609.0	735.9	47,936.7
Sensitivity analysis on Denver	Intercepted water by urban trees (1000m3)	2011	0.0	17,178.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17,178.4
	Energy Savings by urban trees MegaWh	2011	2.1	0.0	257.0	305.3	280.3	742.2	951.5	20.7	37.6	520.7	56,004.4	17.2	59,139.7





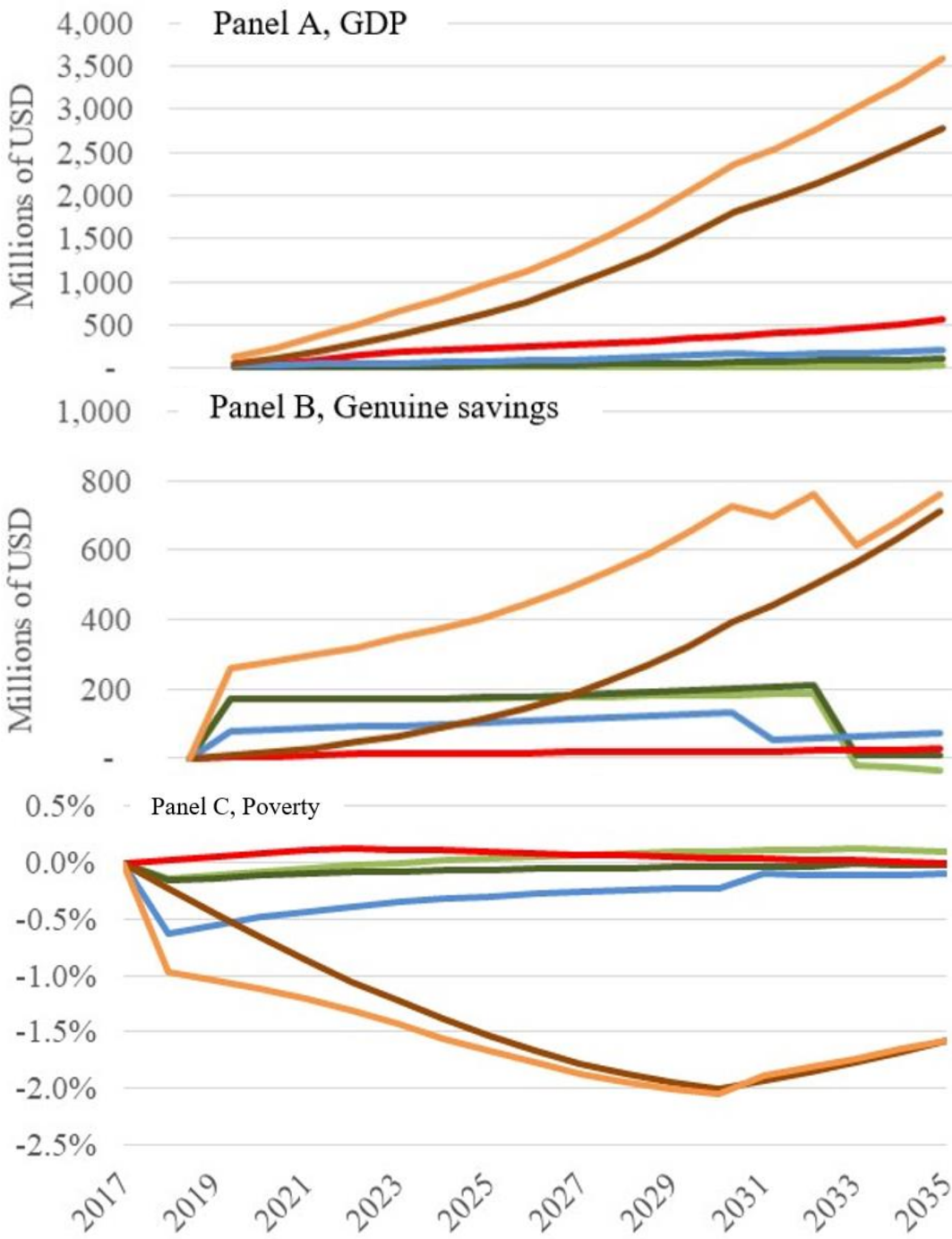
Example: Linking economic (CGE) & ecosystem service models



Example: Rwanda economics

Table 1. Macro-indicators for Rwanda in 2014; billions of USD.

Demand	
Private consumption	6.2
Government consumption	1.1
Private fixed investment	1.9
Exports	1.0
Total demand	10.2
Supply	
GDP	7.9
Imports	2.3
Total supply	10.2



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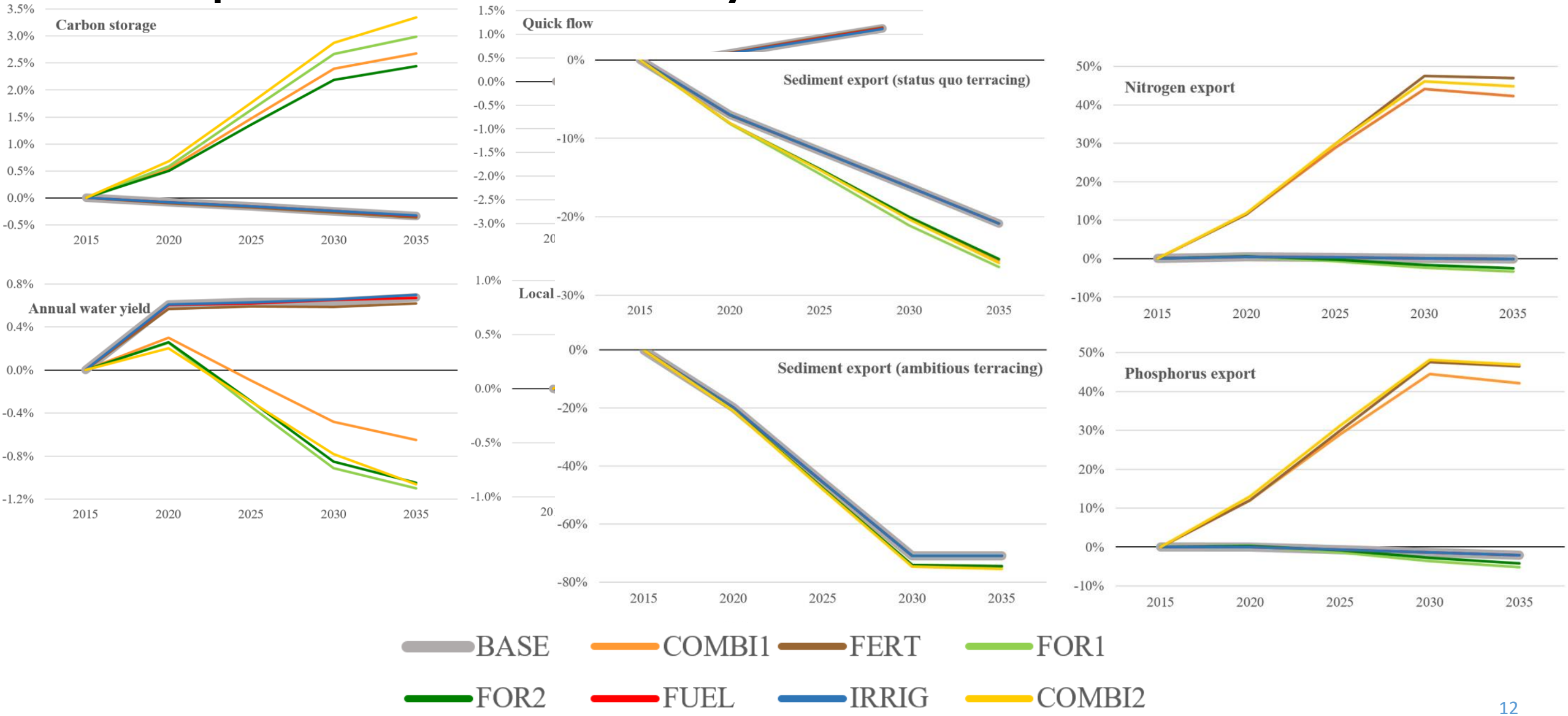
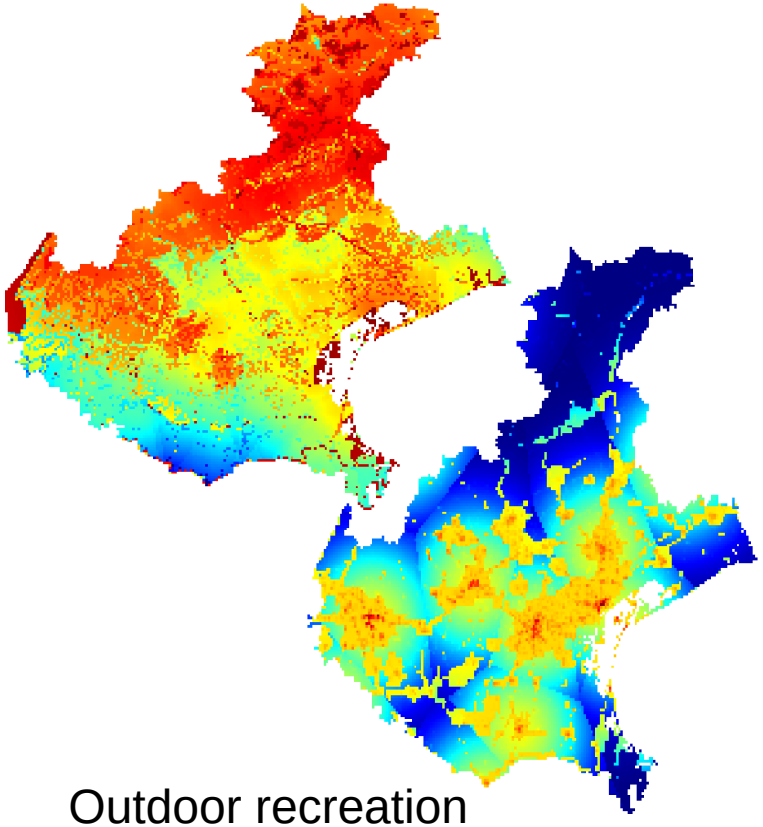
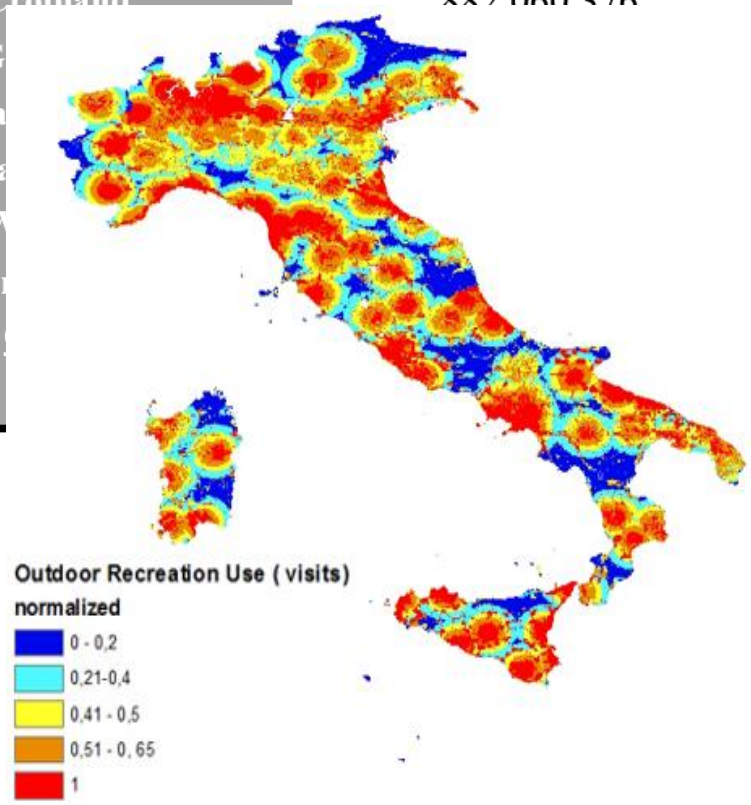
Example: Rwanda ecosystem services

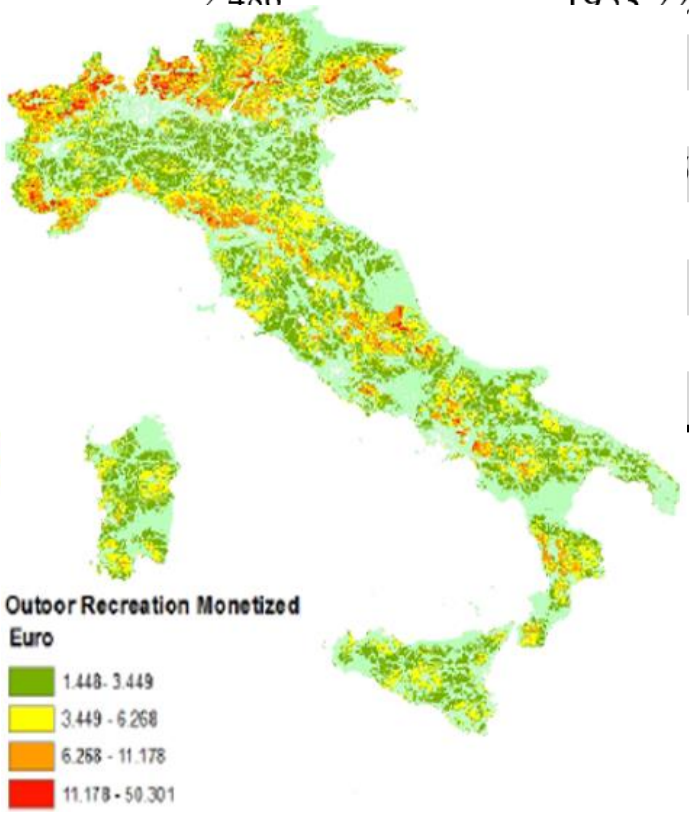


ARIES example: Italy recreation accounts



Ecosystem Units	Outdoor Recreation (# of visits, 2018)	Outdoor Recreation Gasoline-fueled (M€, 2018)	Outdoor Recreation Electric-fueled (M€, 2018)
Green urban areas	634.981	0,66	0,52
Cropland	882.060.376	2.486	1953,22
G			
Heathla			
Woodla			
W			
River			





Outdoor recreation supply (upper left) & demand (lower right) for Veneto region

How can ARIES assist in ecosystem accounting?

- Ecosystem condition through remote sensing data
- Capacity, physical supply & use through ES models that account for use & flow
- Carbon & biodiversity through modeling
- Monetary accounts in combination with valuation data