Ecosystem service accounts - Indicators

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Potential indicators on physical ecosystem

Physical ecosystem services flow indicators	Further description	S
Amount of biomass generated	Biomass provisioning services	Ecosy accou
Water abstracted for use by household and industry (proxy measure)	Water supply services	Ecosy accou
Tonnes of carbon retained (captured and stored/trend in the carbon sequestered)	Global climate regulation services	Ecosy accou
Tonnes of airborne pollutants captured (e.g., PM10; PM2.5)	Air filtration services	Ecosy accou
Tonnes of waterborne pollutants removed (e.g., chemical oxygen demand) from wastewater	Water purification services	Ecosy accou
Number of properties/ km of coast/shoreline/riparian zone protected; change in degree of risk	Flood mitigation services	Ecosy accou
Number of tourist/recreation visits	Recreation-related services	Ecosy accou

Essential Ecosystem Service Variable Classes (EESV classes)	EESV class definition
Ecological supply	The ecosystem structure and functions that underlie the potential capacity of ecosystems to provide ecosystem services.
Anthropogenic contribution	The efforts that humans invest to enhance ecological supply and to make use of ecosystem services. Anthropogenic contributions and ecological supply interact through the process of co-production.
Demand	Explicitly or implicitly expressed human desire or need for an ecosystem service, in terms of its quantity or quality, irrespective of whether awareness exists about such need.
Use	Active or passive appropriation of an ecosystem service by people.
Instrumental values	The importance of an ecosystem service to societies or individuals as a means to achieve a specific end (e.g. some dimension of human well-being).
Relational values	The importance ascribed to how ecosystems contribute to desirable and meaningful interactions between humans and nature and between humans in relation to nature.

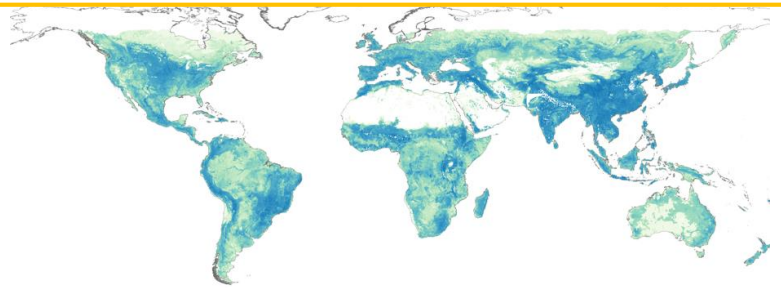
EBV or Indicator	METRIC	Number of candidate products in EBV2020	Ecosystem Services		
			Provisioning	Regulating	Cultural
Ecological Supply	Water quality: nitrogen retention	1		x	
Ecological Supply	Water quality: sediment retention	1		x	
Ecological Supply	Water provision	1	-		
Ecological Supply	Carbon storage	2		-	
Anthropological contribution to supply	Food production (plant-based?)	1	x		
Demand		0			
Use	Coastal risk reduction	1		x	
Use	Fisheries catches	1	x		
Use	Nature-based tourism	1			x
Use	River flood protection	1		x	
Use	Water quality regulation for downstream beneficiaries	1		x	
Instrumental value		0			
Relational value		0			
Other (ebv based indicator or cross-cutting)	Erosion control	1		x	
Other (ebv based indicator or cross-cutting)	Pest control	1		x	
Other (ebv based indicator or cross-cutting)	Pollination	2	-	x	

Indicators for ecosystem service accounts: examples from global modeling & national case studies

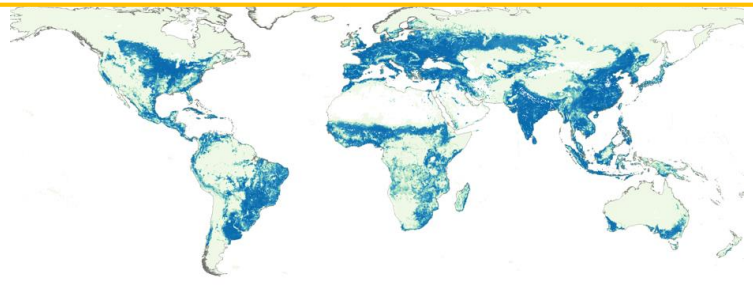
Asset value

max

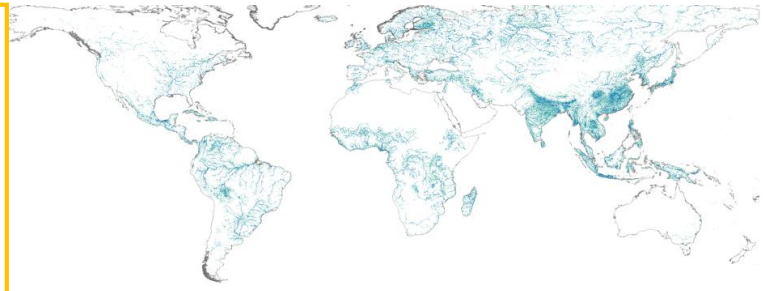
min



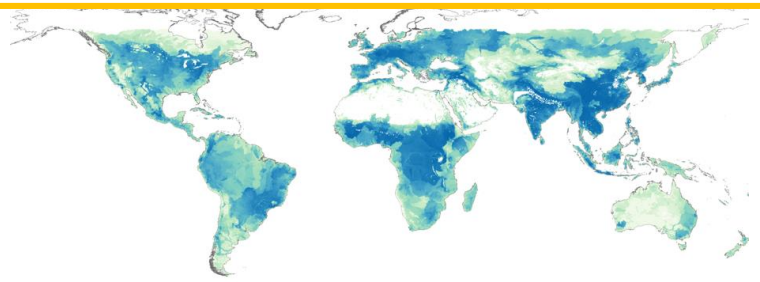
Sediment retention for downstream populations



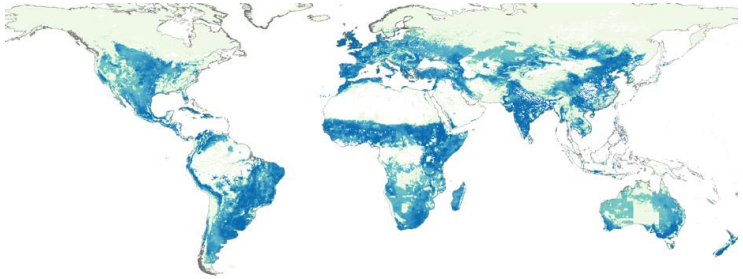
Pollination for crop production



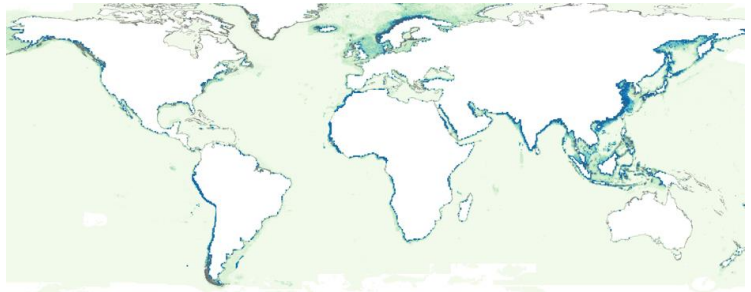
Riverine fish production



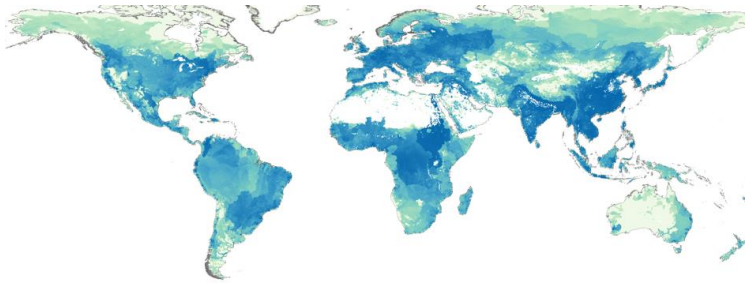
Nitrogen retention for downstream populations



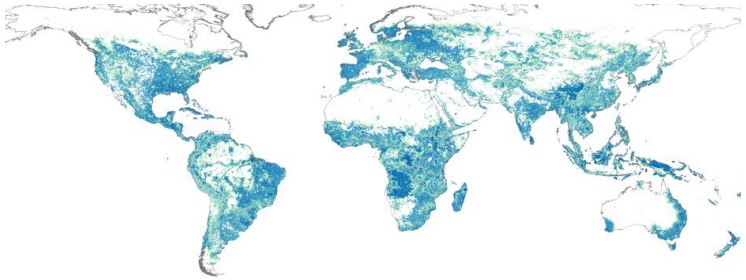
Forage for livestock grazing



Marine fish production

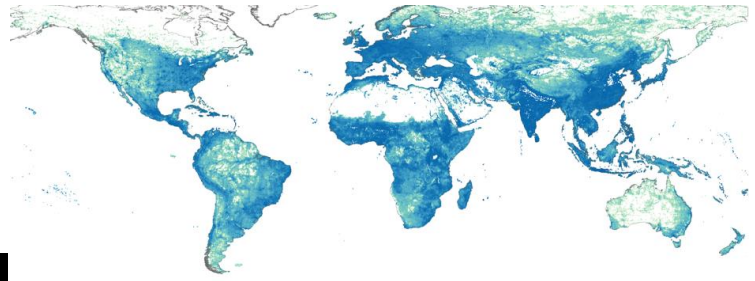


Flood mitigation for downstream populations

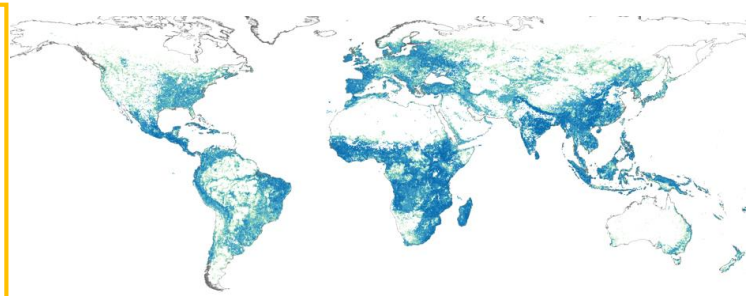


Timber production

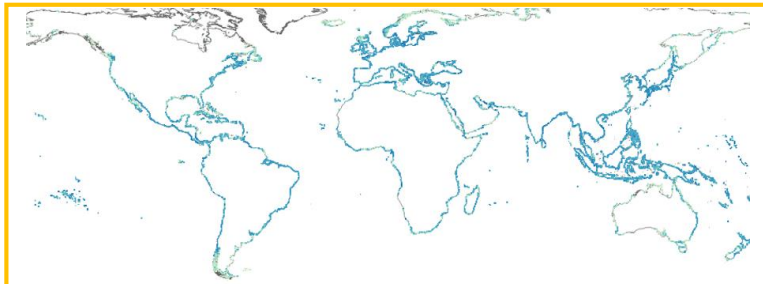
Coral reef tourism



Nature access (for recreation and gathering)



Fuelwood provision



Coastal risk reduction

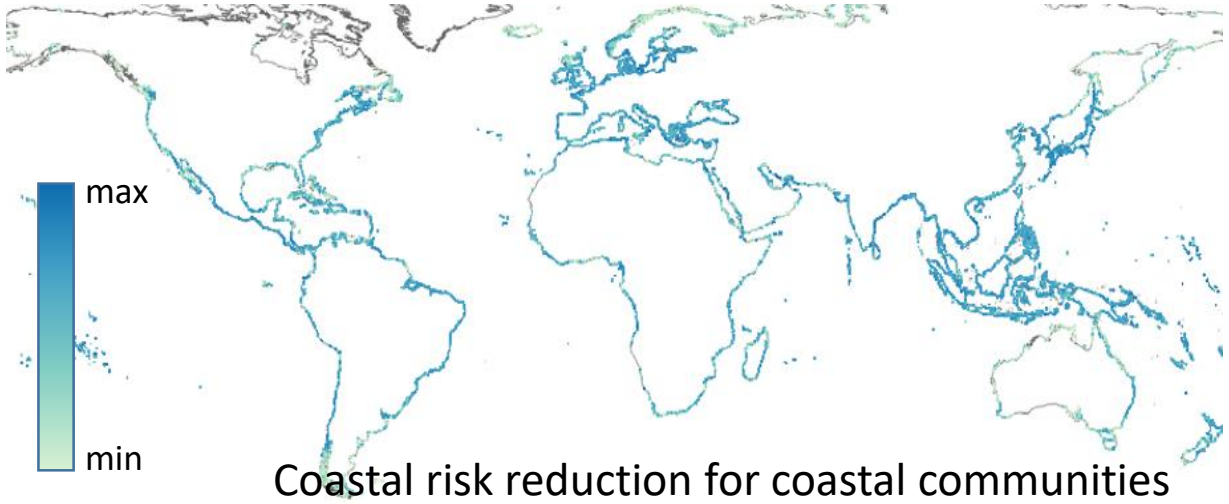
natural capital PROJECT

CONSERVATION INTERNATIONAL

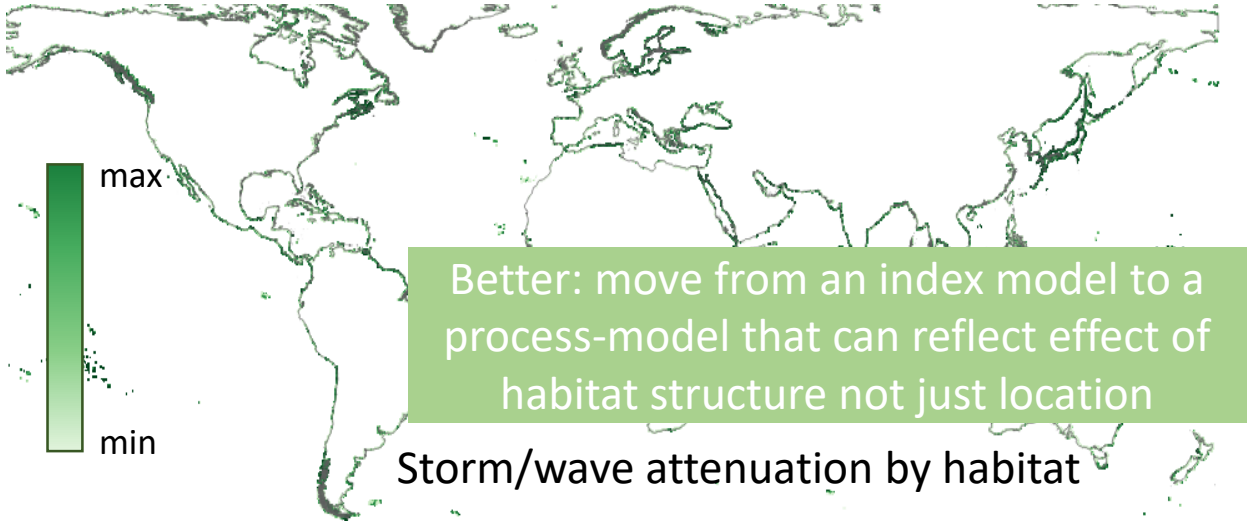
Use

Coastal risk reduction (flood mitigation)

Ecological supply



Coastal risk reduction for coastal communities



Storm/wave attenuation by habitat

Better: move from an index model to a process-model that can reflect effect of habitat structure not just location

People exposed to coastal risk, within

Better: high-resolution property/settlements

Anthropogenic contribution

(Substitute)
Sea walls

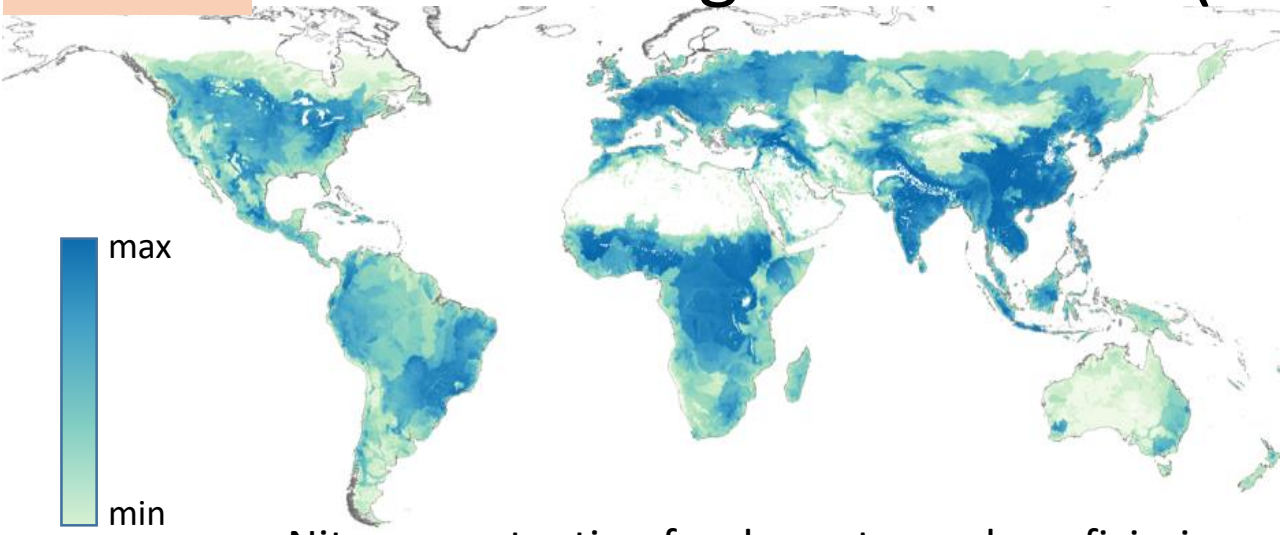
Demand

natural capital PROJECT

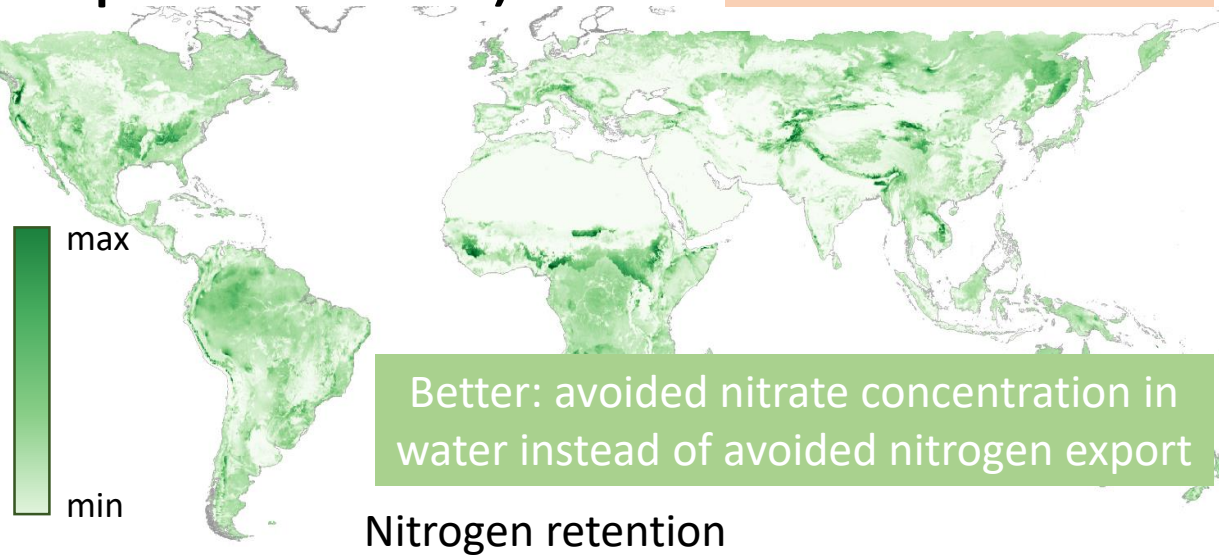
Use

Nitrogen retention (water purification)

Ecological supply

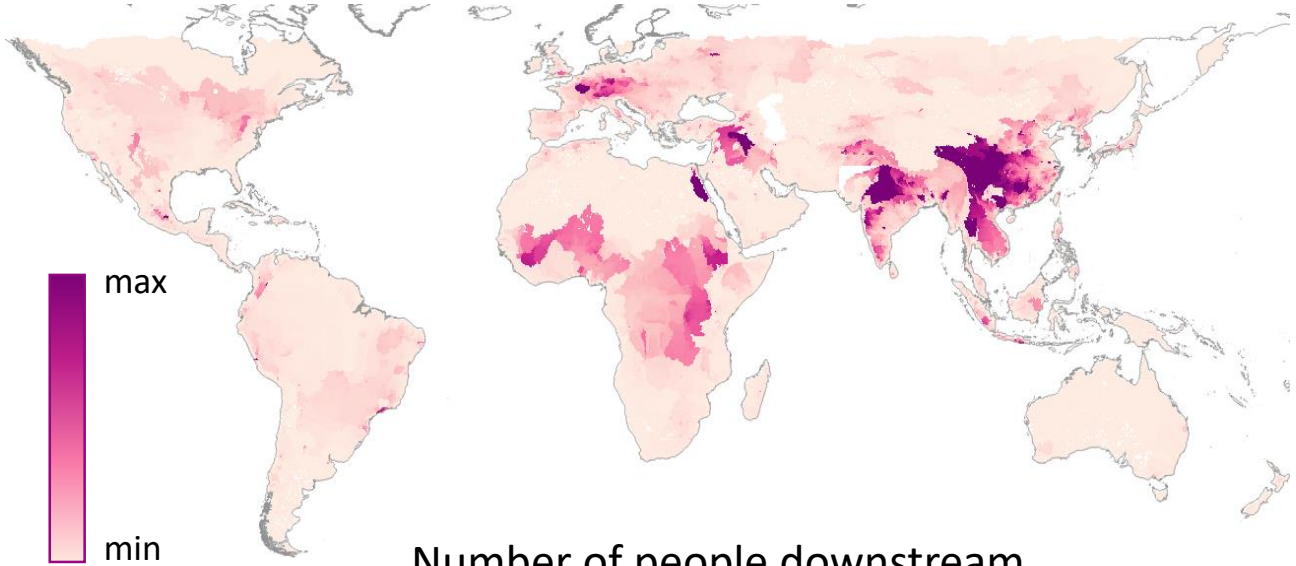


Nitrogen retention for downstream beneficiaries



Better: avoided nitrate concentration in water instead of avoided nitrogen export

Nitrogen retention



Number of people downstream

Better: people using untreated surface vs. groundwater

Demand

Anthropogenic contribution

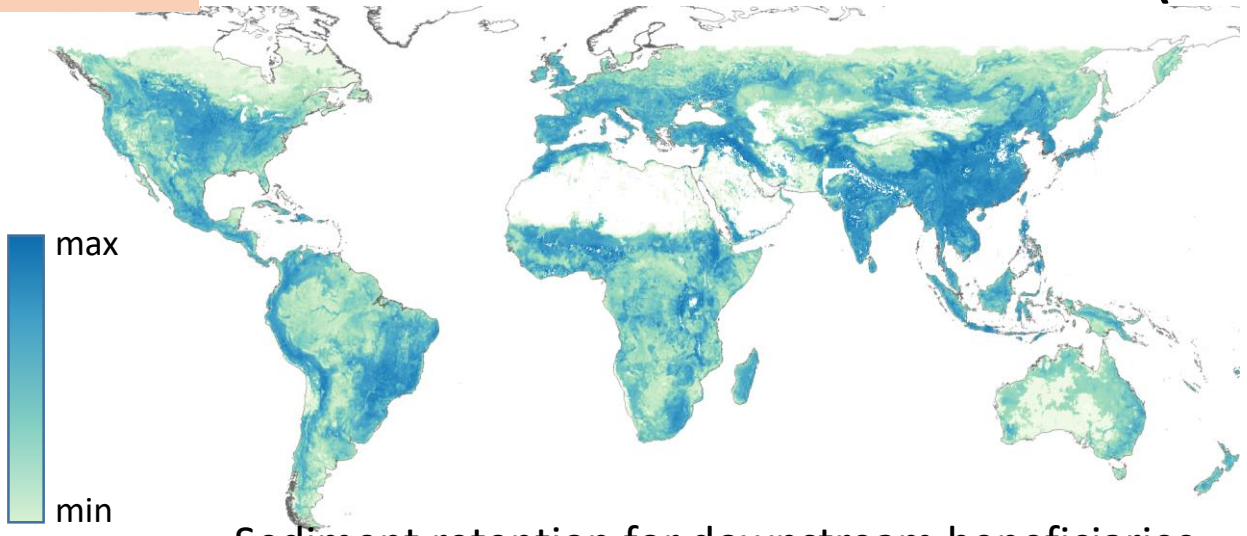
(Substitute)
Water treatment plants

natural capital PROJECT

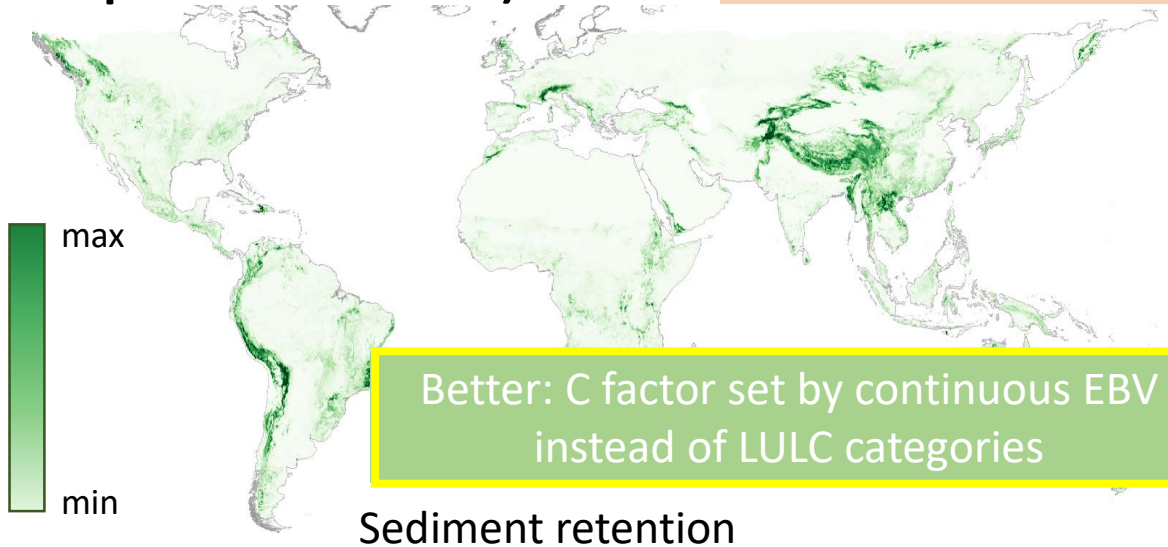
Use

Sediment retention (water purification)

Ecological supply

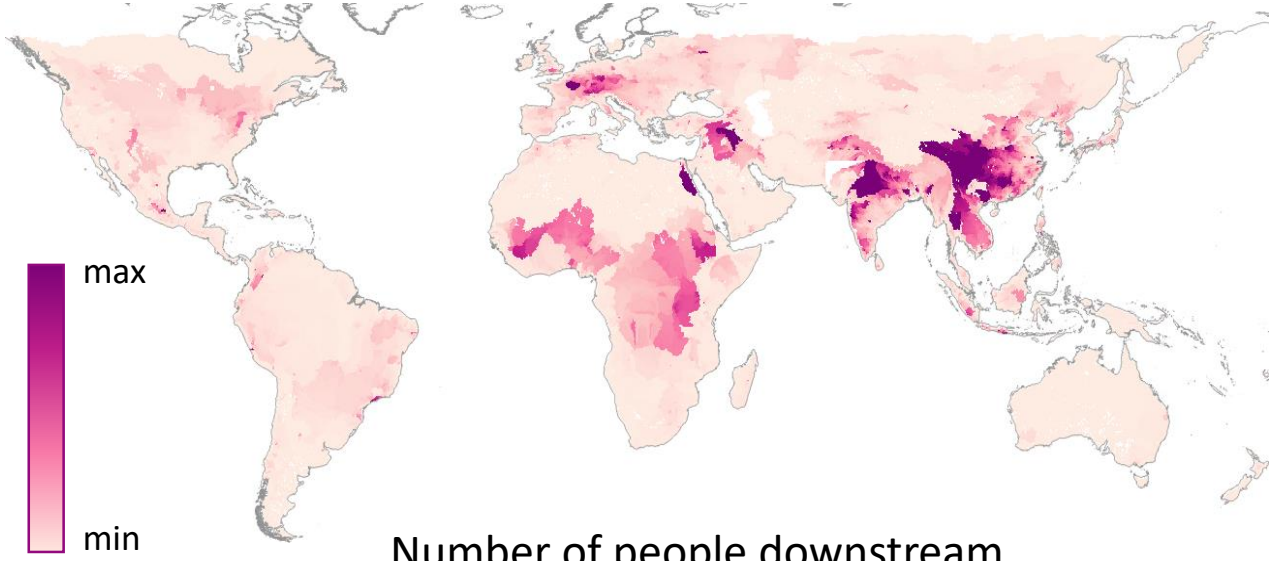


Sediment retention for downstream beneficiaries



Sediment retention

Better: C factor set by continuous EBV instead of LULC categories



Number of people downstream

Better: reservoirs, especially with information about size

Anthropogenic contribution

(Substitute)
Sediment traps, dredging

Demand

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Case study: Costa Rica

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NASA

GEO

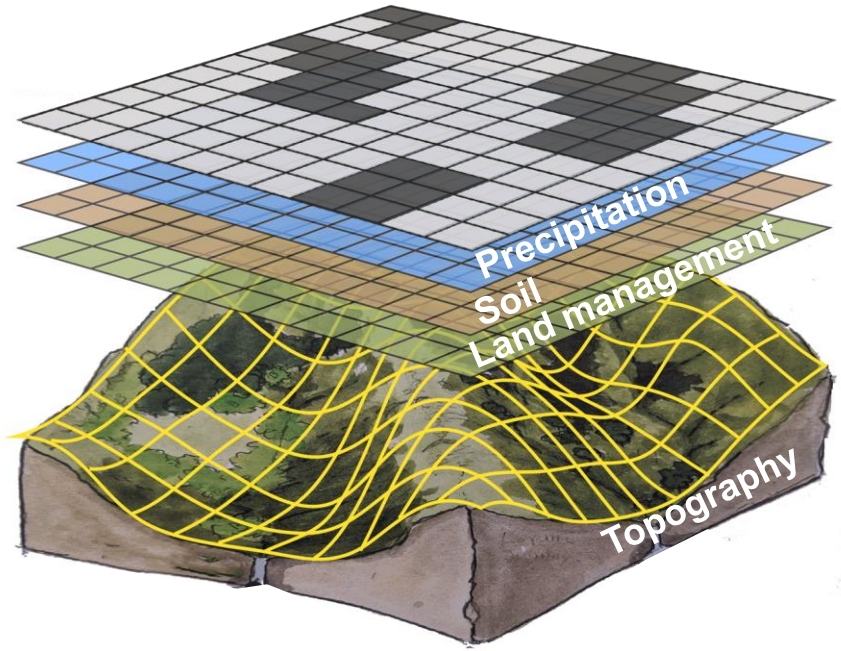
SIMOCUTE

MINAE Ministerio de Ambiente y Energía

BC CR BANCO CENTRAL DE COSTA RICA

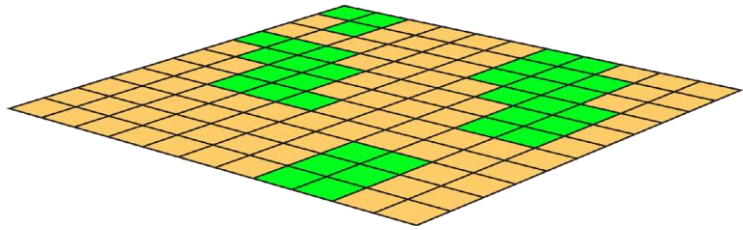
Enhancing sediment modeling with Earth observations

Land cover



LULC	C factor
Pasture	High
Forest	Low

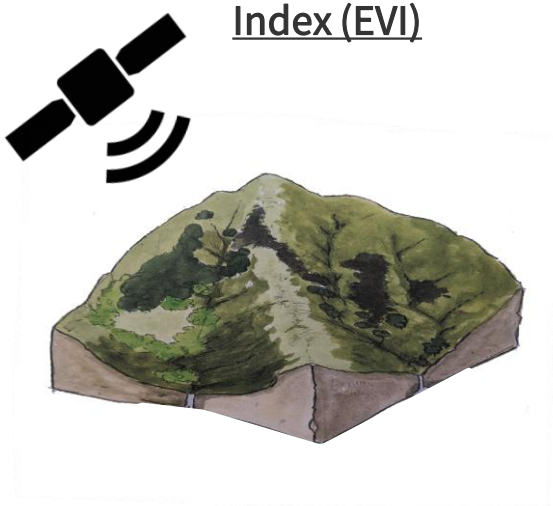
Categorical C factor (LULC)



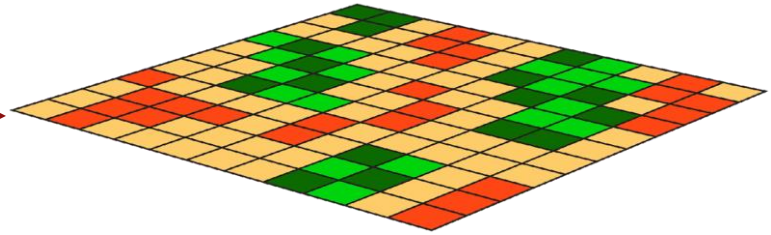
High

Low

Enhanced Vegetation Index (EVI)



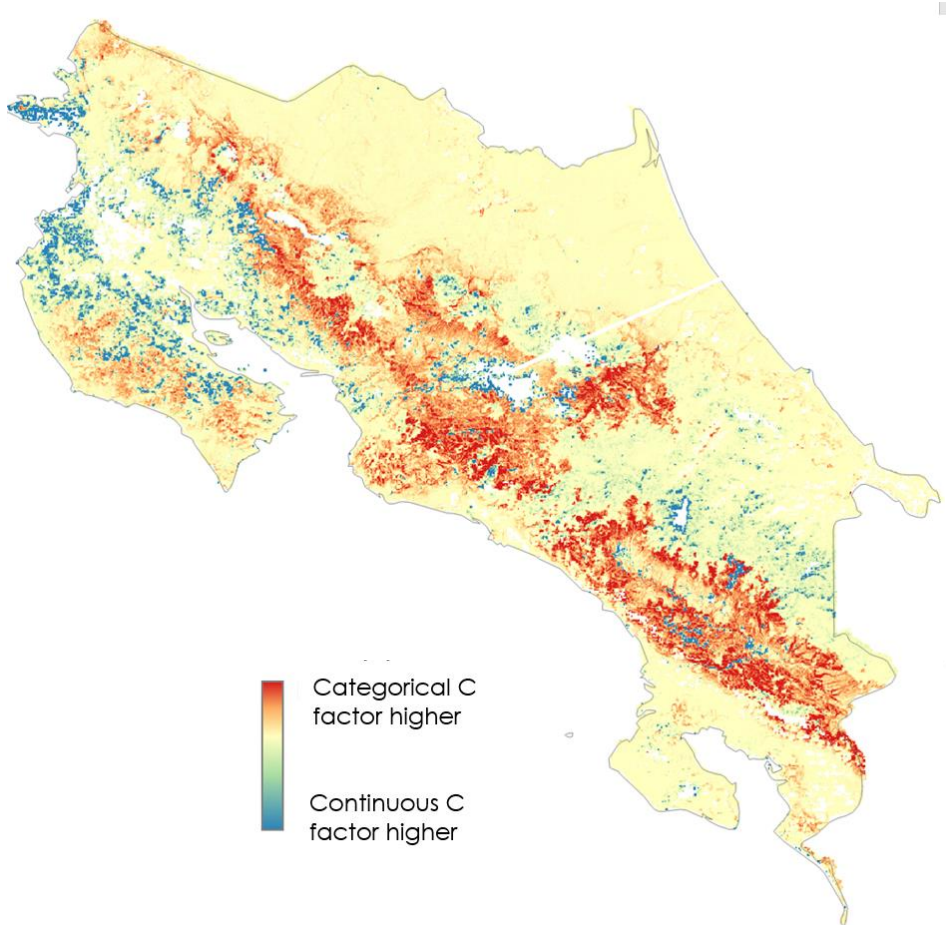
Continuous C factor (EVI)



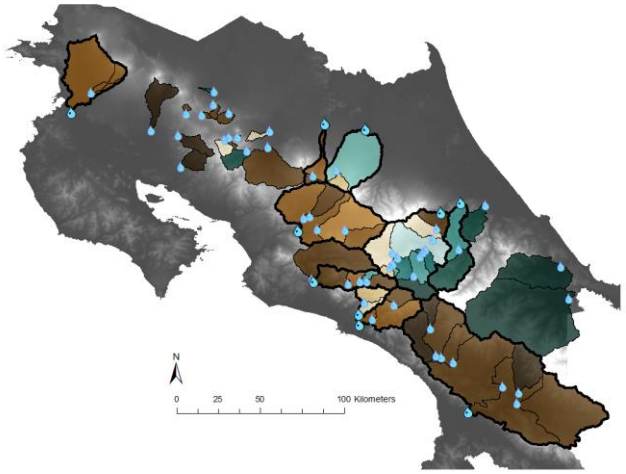
High

Low

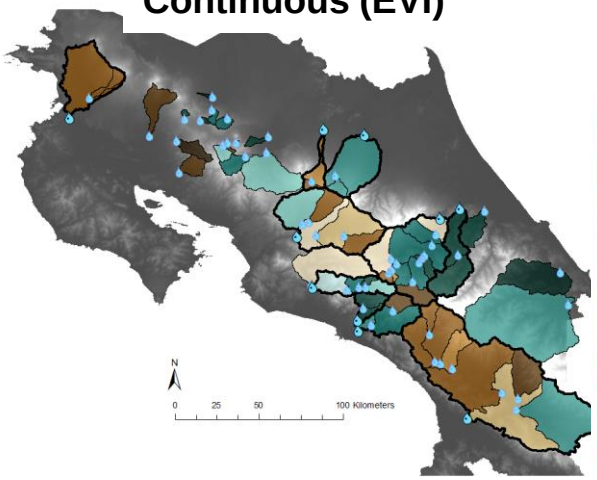
Enhancing sediment modeling with Earth observations



Categorical (LULC)



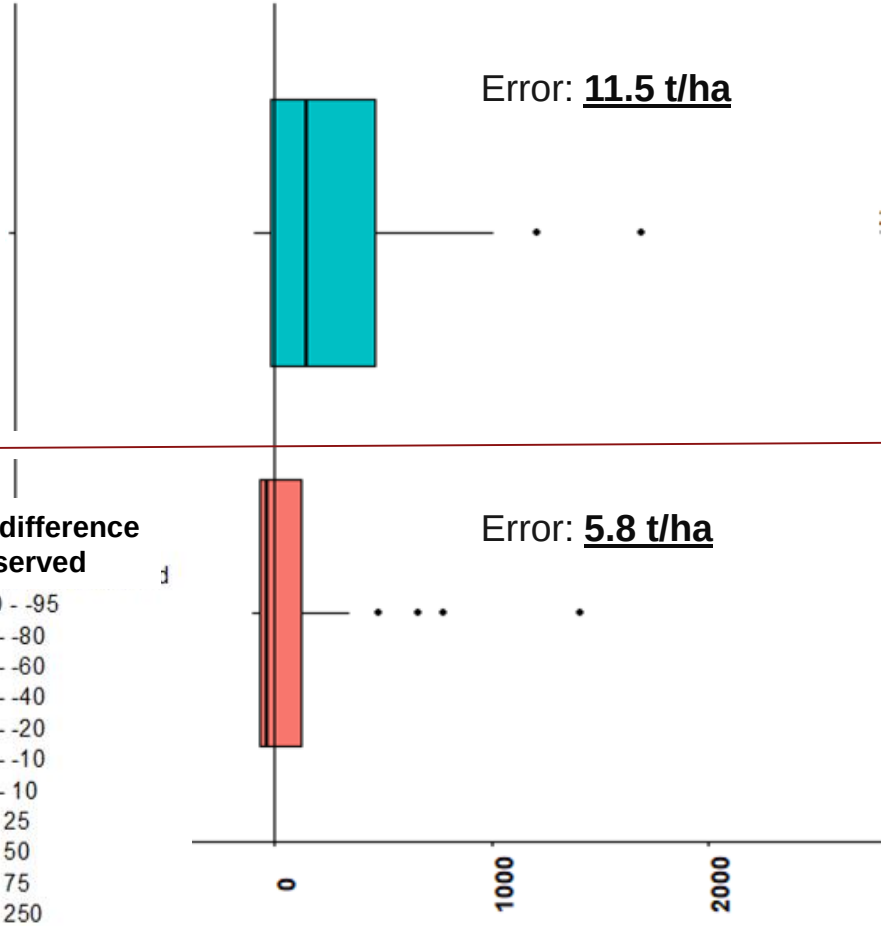
Continuous (EVI)



Percent difference from observed

-100 - -95
-95 - -80
-80 - -60
-60 - -40
-40 - -20
-20 - -10
-10 - 10
10 - 25
25 - 50
50 - 75
75 - 250
250 -1,000
>1,000
Hydrological Station

49 watersheds



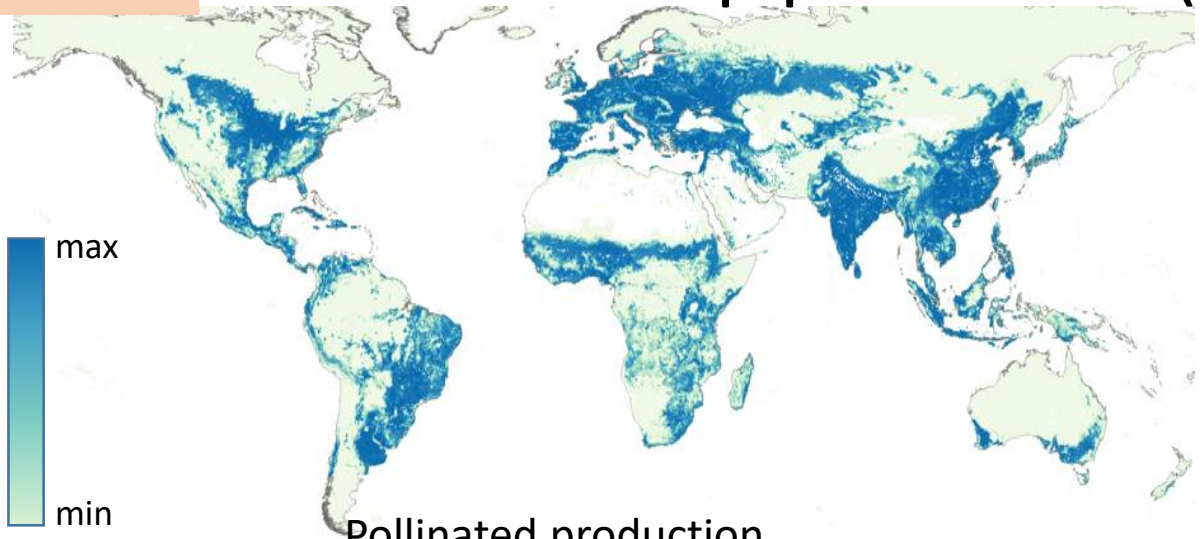
Ecological supply

natural capital PROJECT

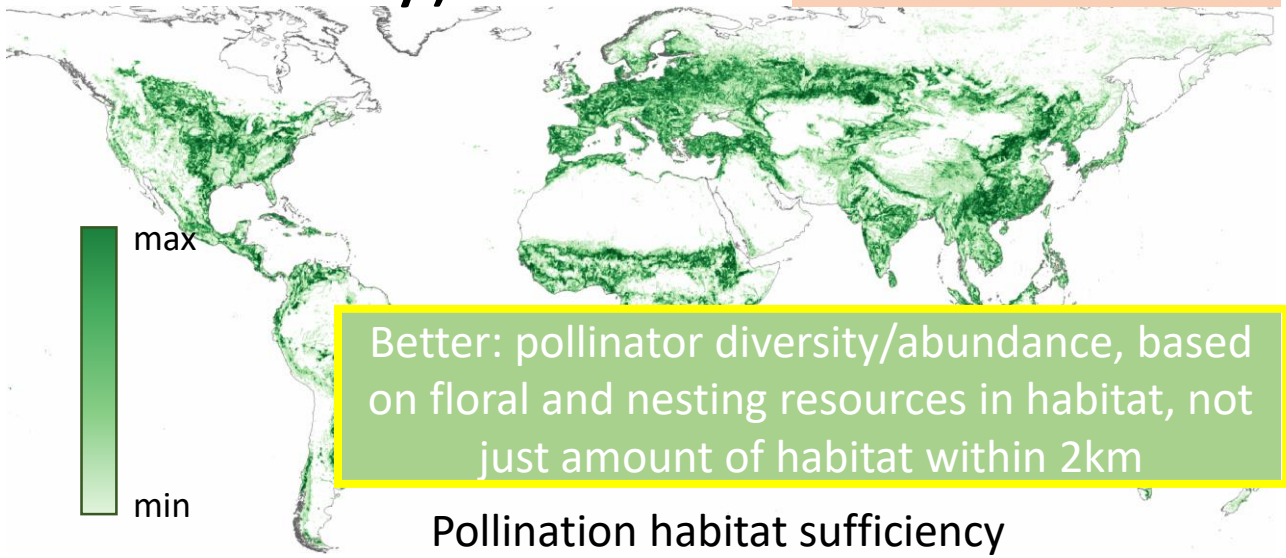
Use

Crop pollination (food security)

Ecological supply

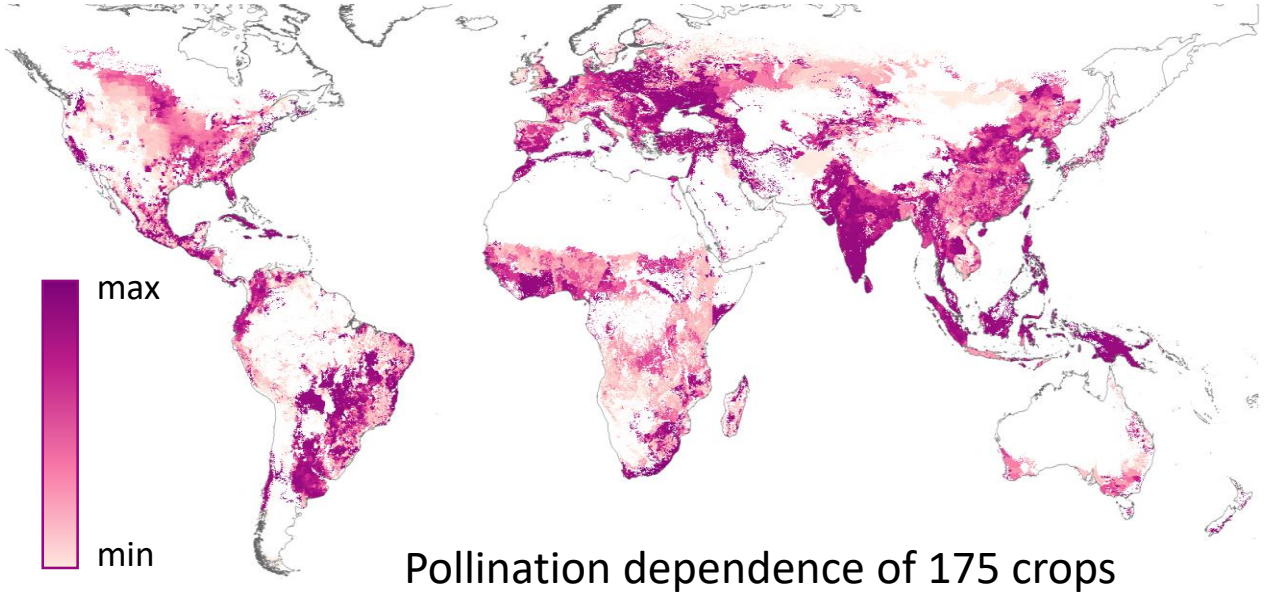


Pollinated production



Better: pollinator diversity/abundance, based on floral and nesting resources in habitat, not just amount of habitat within 2km

Pollination habitat sufficiency



Pollination dependence of 175 crops

Better: updated! (these data are from year 2000)

Demand

Anthropogenic contribution

(Substitute)
Managed honeybees

Coffee account

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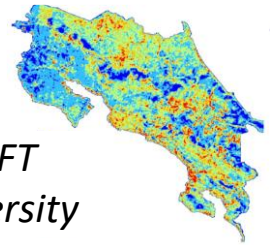
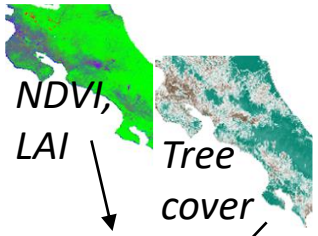
What pollinators are likely to be present?

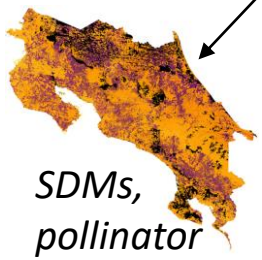


EFT diversity



NDVI, LAI

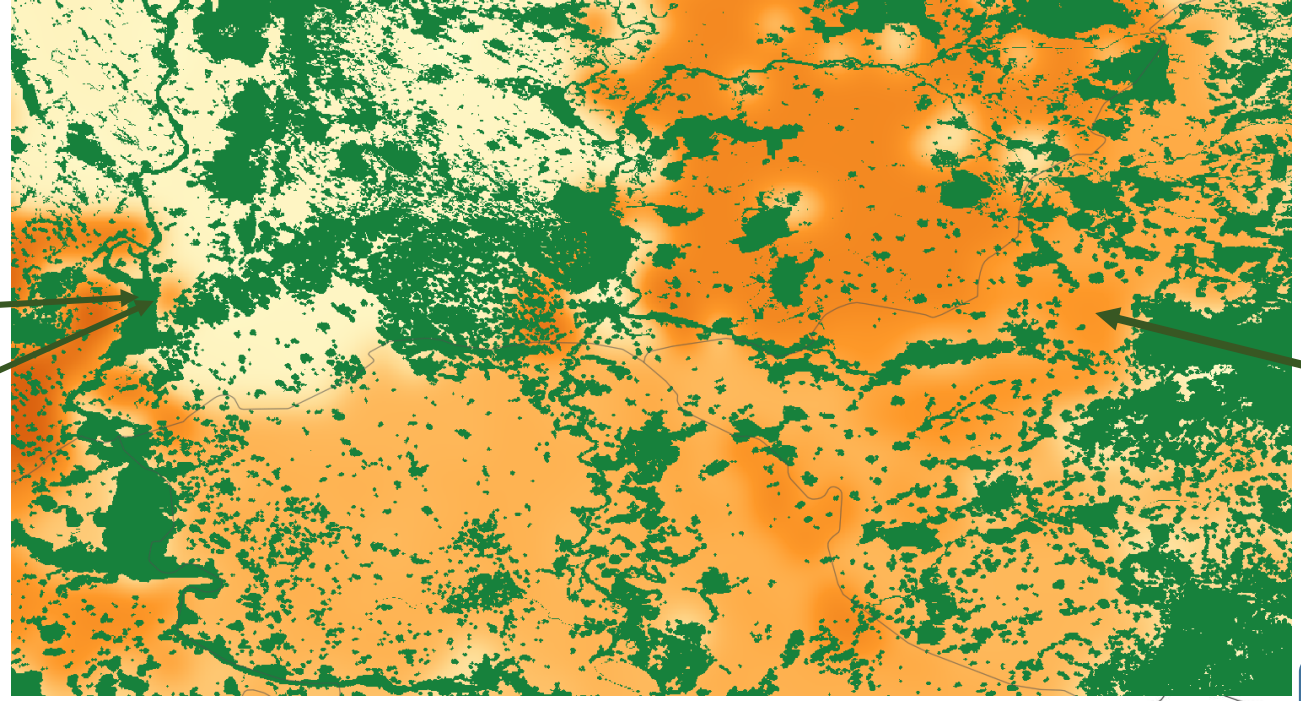
Tree cover



SDMs, pollinator richness

Nesting habitat

Floral resources

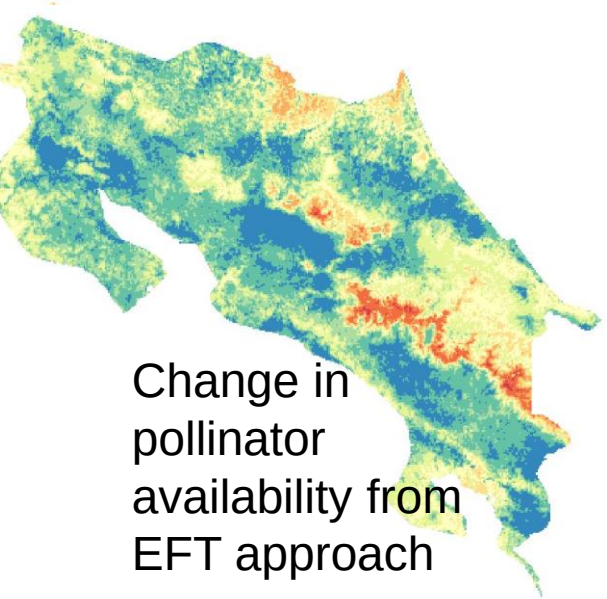


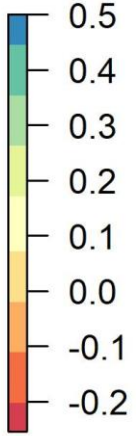
Potential pollination-dependent production

Low High

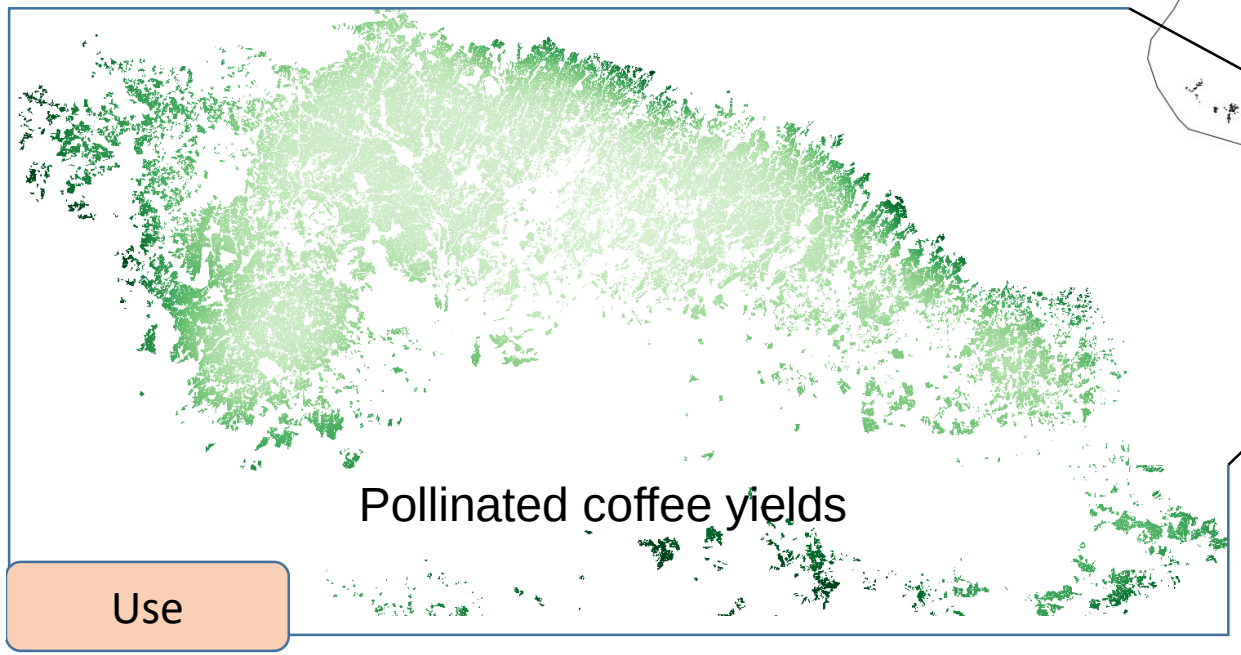
Ecological supply

Demand

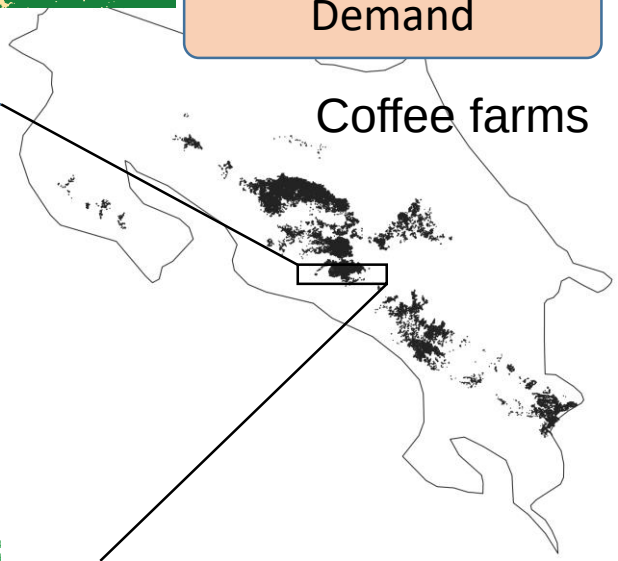




Change in pollinator availability from EFT approach



Pollinated coffee yields



Coffee farms

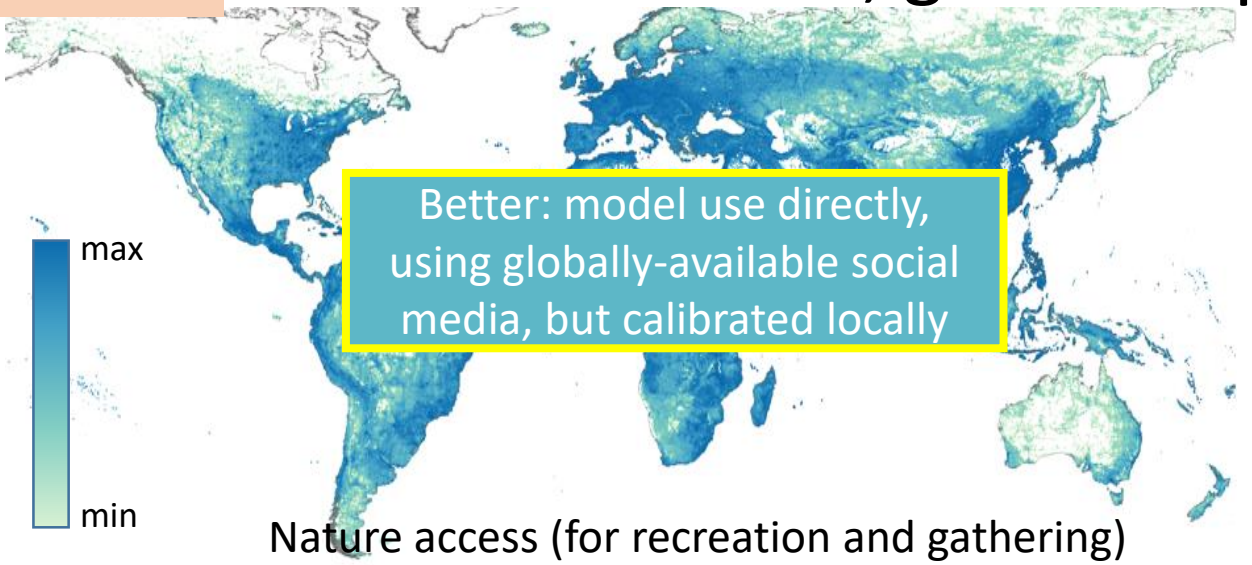
Use

natural capital PROJECT

Use

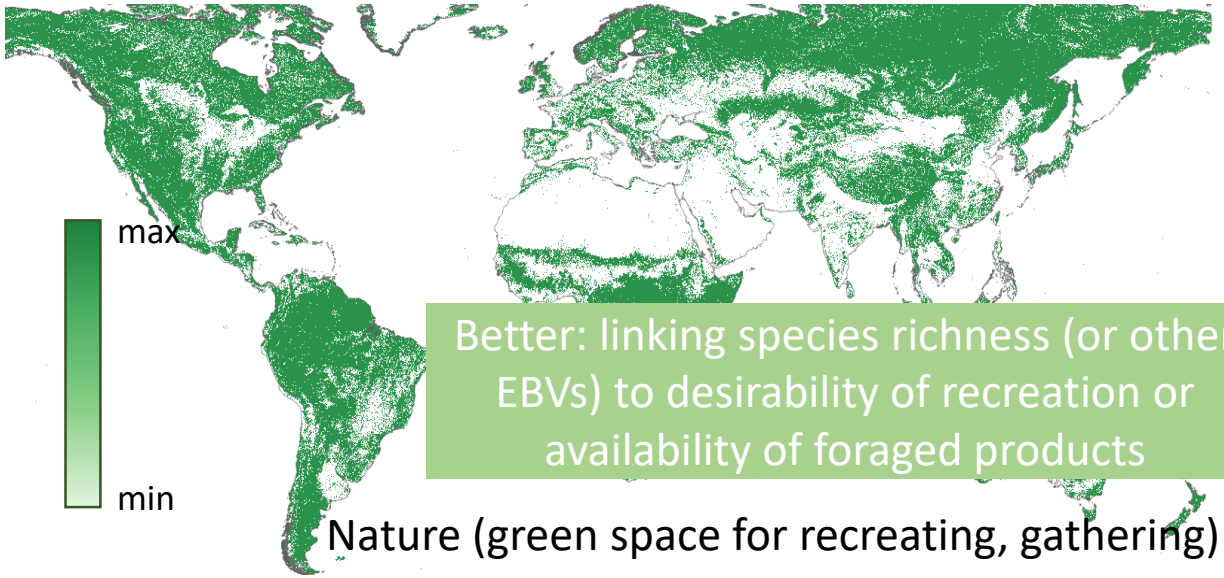
Recreation, gathered products (health)

Ecological supply



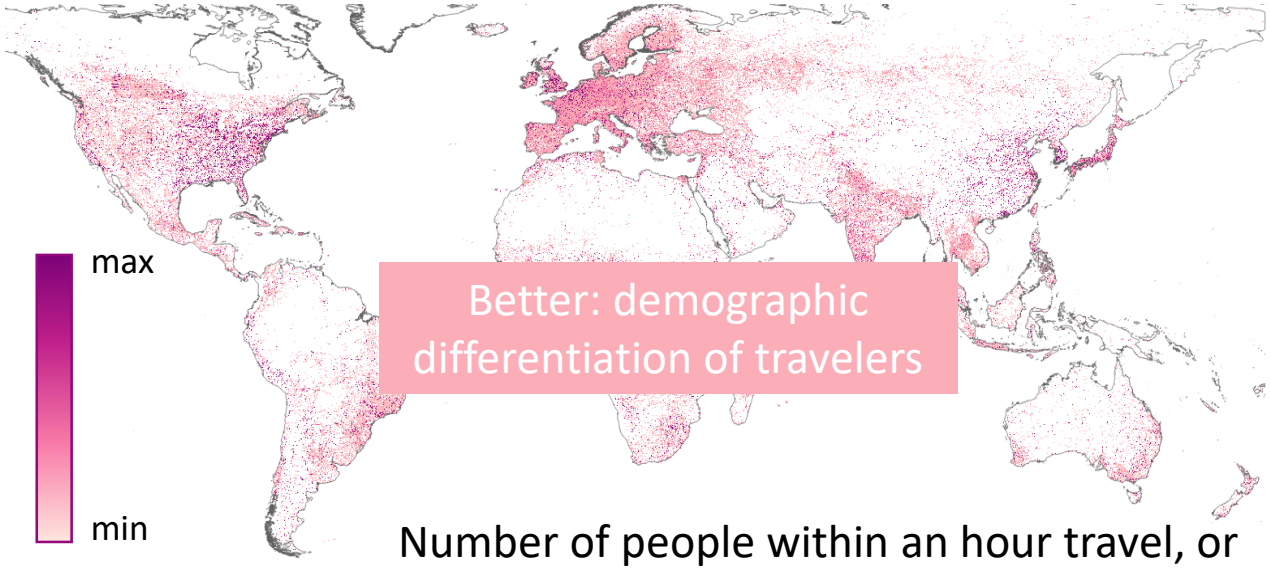
Better: model use directly, using globally-available social media, but calibrated locally

Nature access (for recreation and gathering)



Better: linking species richness (or other EBVs) to desirability of recreation or availability of foraged products

Nature (green space for recreating, gathering)



Better: demographic differentiation of travelers

Number of people within an hour travel, or number of people x inverse of travel time

Anthropogenic contribution

Roads, hotels, other amenities

Tourism account

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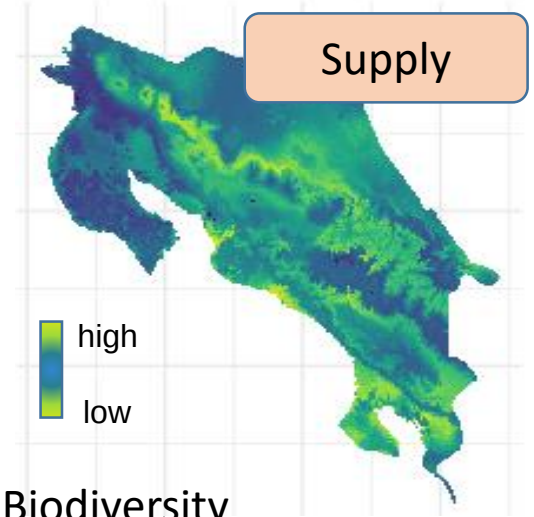
Demand

Predictor variables

Supply



Biodiversity

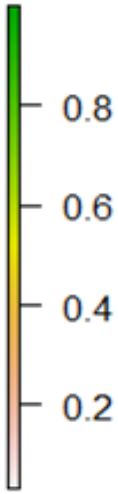
(+ other covariates: access, amenities, climate)

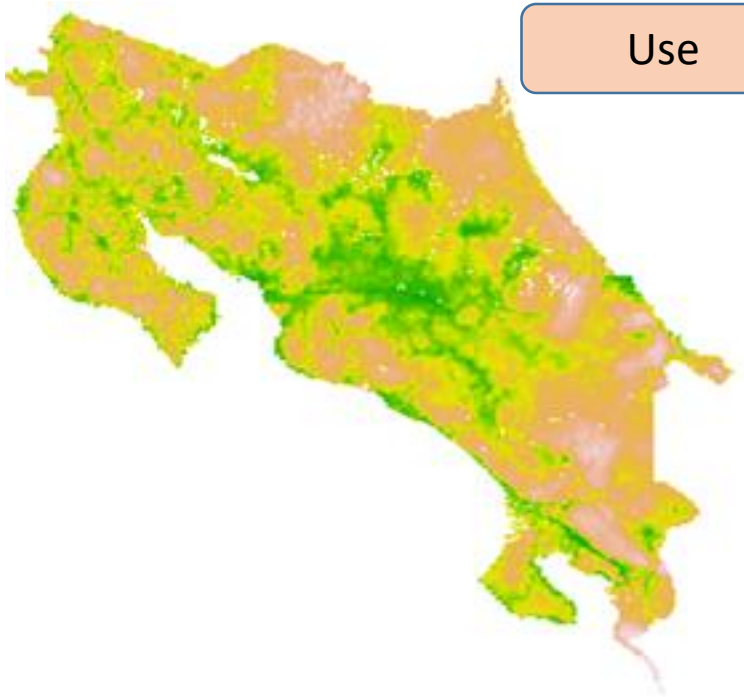
Visitation patterns

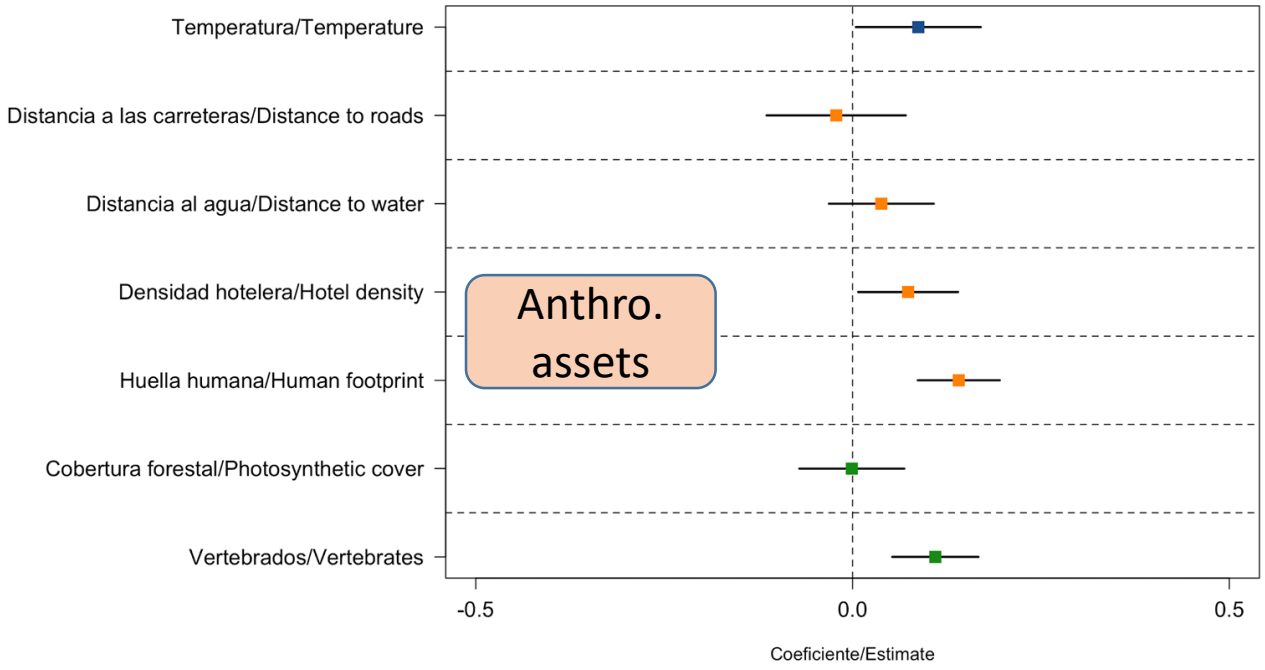
eBird

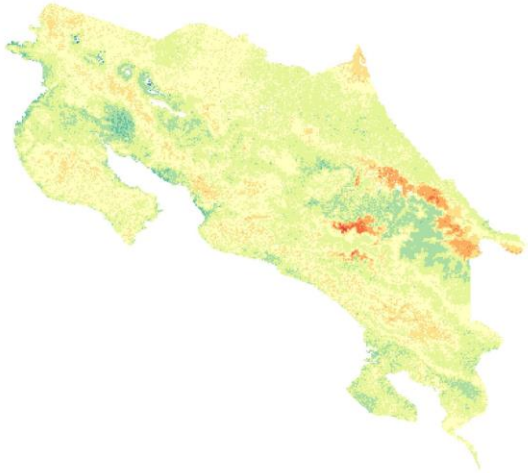
Tourism predicted (from biodiversity)

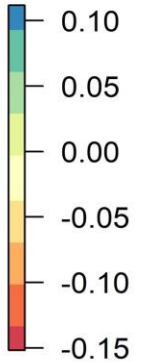
Use











Underestimate tourism without biodiversity

Overestimate tourism without biodiversity

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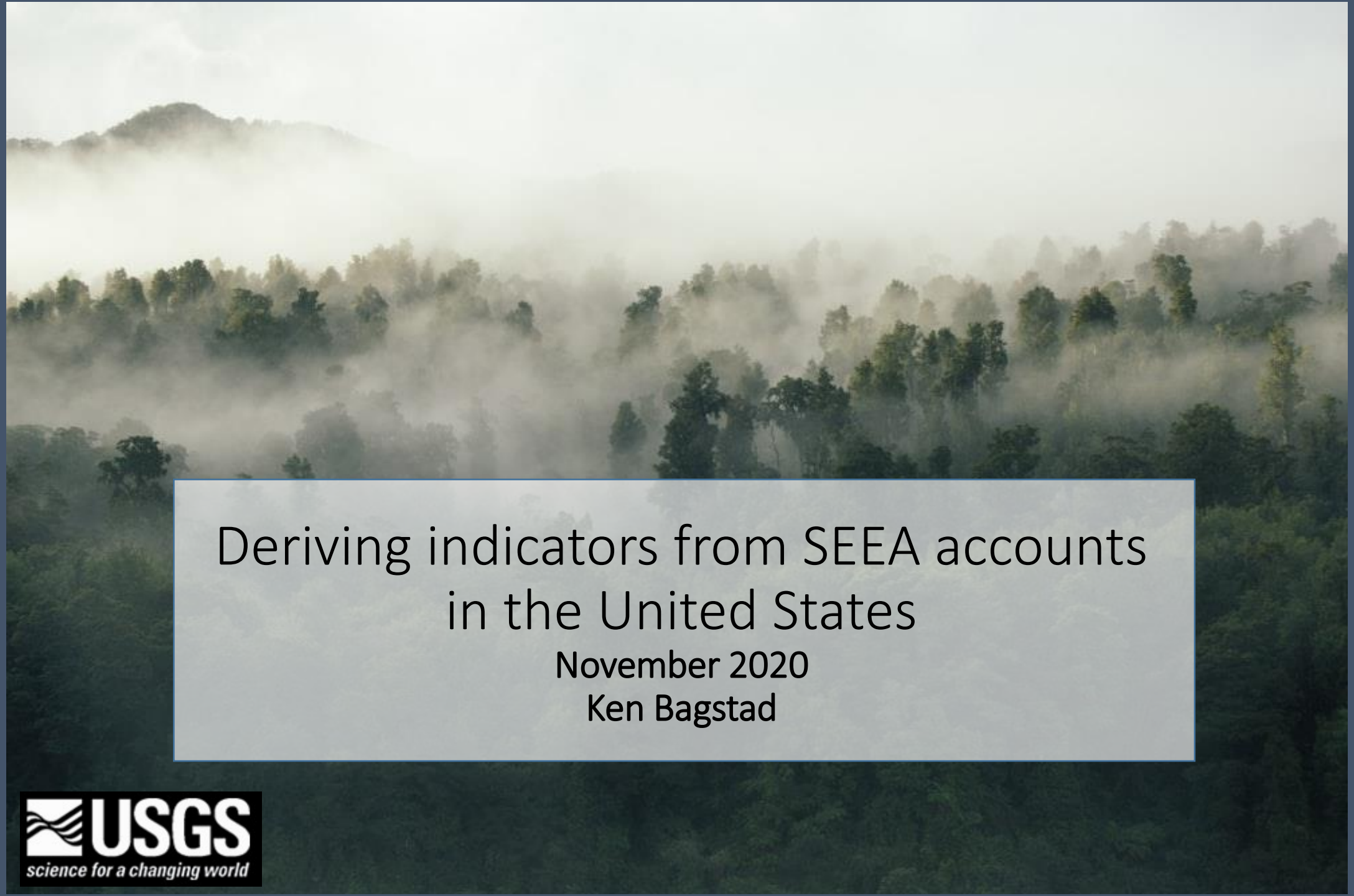


Deriving indicators from SEEA accounts in the United States

November 2020

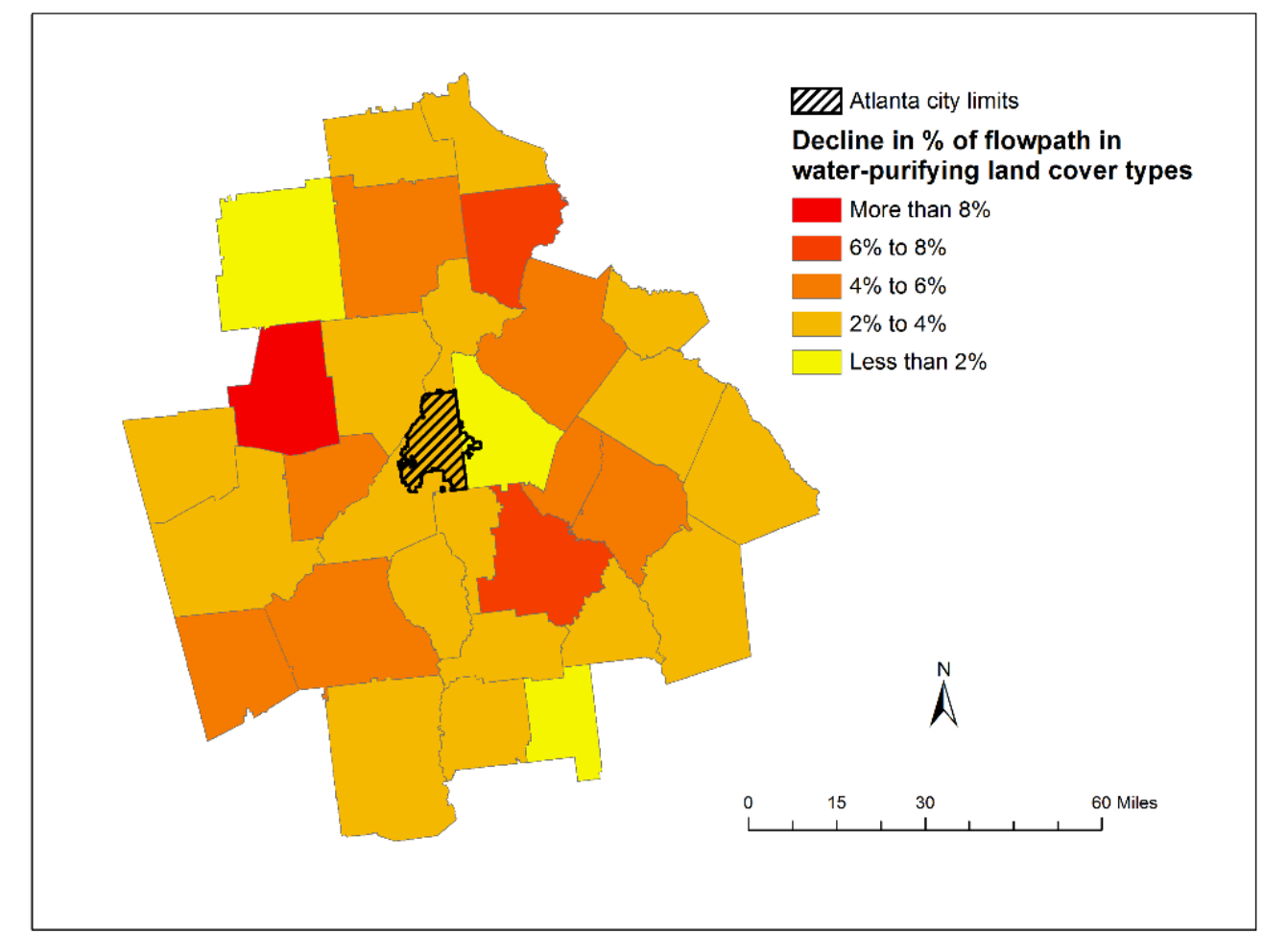
Ken Bagstad

USGS
science for a changing world

Overview of current U.S. SEEA accounts

Account type	Extent	EAAs reported	Scope	Analysis years	Reference
Land	50 states	State	Land cover, use, value	2000-2016	Wentland et al. 2020
Water	50 states	State	Water use, productivity, emissions, quality	2000-2015	Bagstad et al. 2020
Ecosystems	10 states, U.S. Southeast	State	Carbon storage, crop pollination, air purification, water purification, recreational birdwatching, avian biodiversity	2001-2011	Warnell et al. 2020
Urban ecosystems	768 cities with population > 50,000	City	Urban heat mitigation, rainfall interception	2011-2016	Heris et al. in revision

Combined presentation for 27-county Atlanta, Georgia Metropolitan Statistical Area

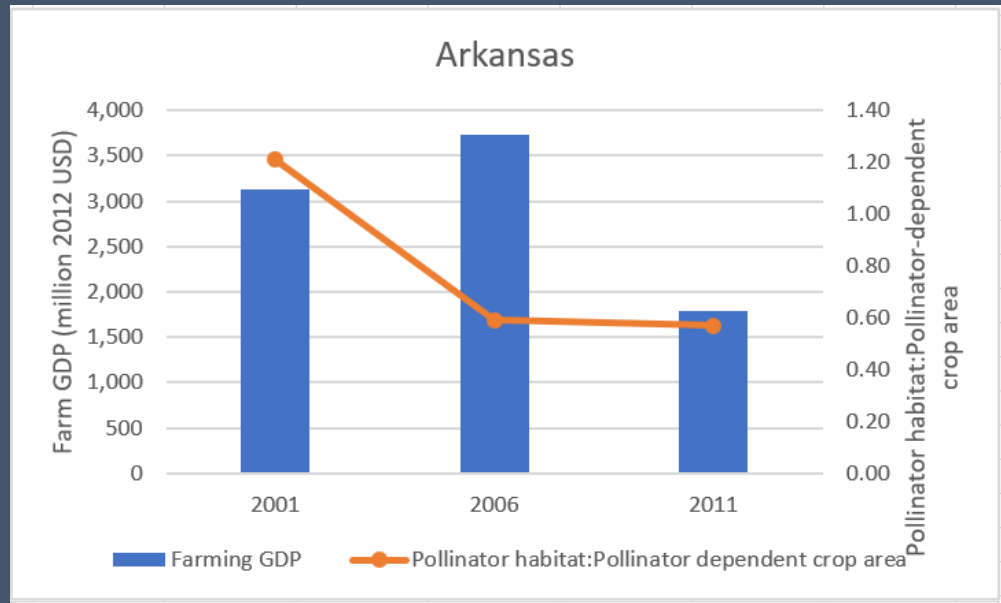


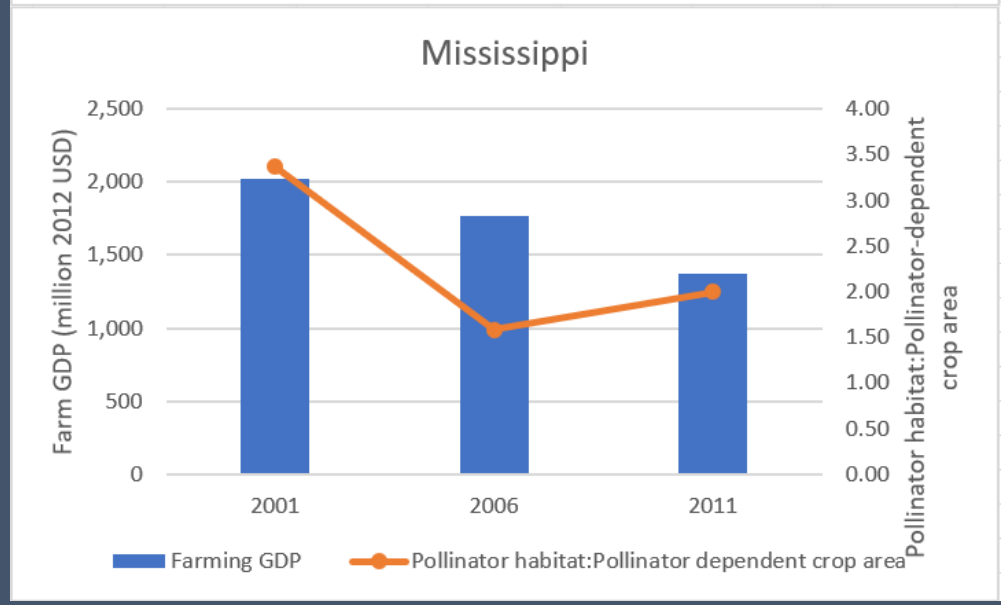
Account	Metric		% change, 2001–2011
Land accounts[1]	Developed land cover		17.2%
	Agricultural land cover		−6.3%
	Forested land cover		−9.3%
	Other land cover		18.6%
Water accounts	Total water use (million gallons/day, 2000–2010)[2]		−57.8%
	Water productivity ($/100 gallons water use, 2000–2010)[3]		153.3%
	% of water-quality monitoring sites reporting significant declines, 2002–2012)[4]	Nitrate (n = 7)	57%
		Specific conductance (n = 6)	67%
		Total suspended solids (n = 4)	25%
Ecosystem accounts[5]	% of flowpath in purifying land cover		−18.2%
	Mean annual concentration, CO (2010–2015)		21.3%
	Mean annual concentration, NO_2 (2010–2015)		−0.8%
	Mean annual concentration, O_3 (2010–2015)		−2.7%
	Mean annual concentration, PM_{10} (2010–2015)		−18.2%
	Mean annual concentration, $PM_{2.5}$ (2010–2015)		−10.2%
	Mean annual concentration, SO_2 (2010–2015)		−57.0%
	Mean annual removal rates, CO (2010–2015)		25.3%
	Mean annual removal rates, NO_2 (2010–2015)		9.1%
	Mean annual removal rates, O_3 (2010–2015)		−2.7%
	Mean annual removal rates, PM_{10} (2010–2015)		−20.5%
	Mean annual removal rates, $PM_{2.5}$ (2010–2015)		11.0%
	Mean annual removal rates, SO_2 (2010–2015)		−49.2%
	Total precipitation		31.9%
	Temperature		6.9%
	Recreational birding-days		209.6%
	Carbon storage (2001–2010)		−1.6%
Urban ecosystem accounts[6]	Energy savings due to cooling effect of urban trees		2%
	Rainfall intercepted by urban trees		−8%
Economic accounts[7]	GDP, all industries		8.8%
Population (2000–2010)[8]			24.0%

Crop pollination & agriculture

	GDP from farms, million 2012 USD	Pollinator habitat: Pollinator-dependent crop area
Alabama	1,099	7.96
Arkansas	1,788	0.57
Florida	4,493	3.22
Georgia	2,727	3.22
Louisiana	1,381	1.51
Mississippi	1,376	2.00
Missouri	3,859	1.25
North Carolina	3,210	5.84
South Carolina	768	7.95
Tennessee	1,517	3.01

Improved indicators will be possible in future national pollination accounts





SDG 11: Make cities & human settlements inclusive, safe, resilient, & sustainable

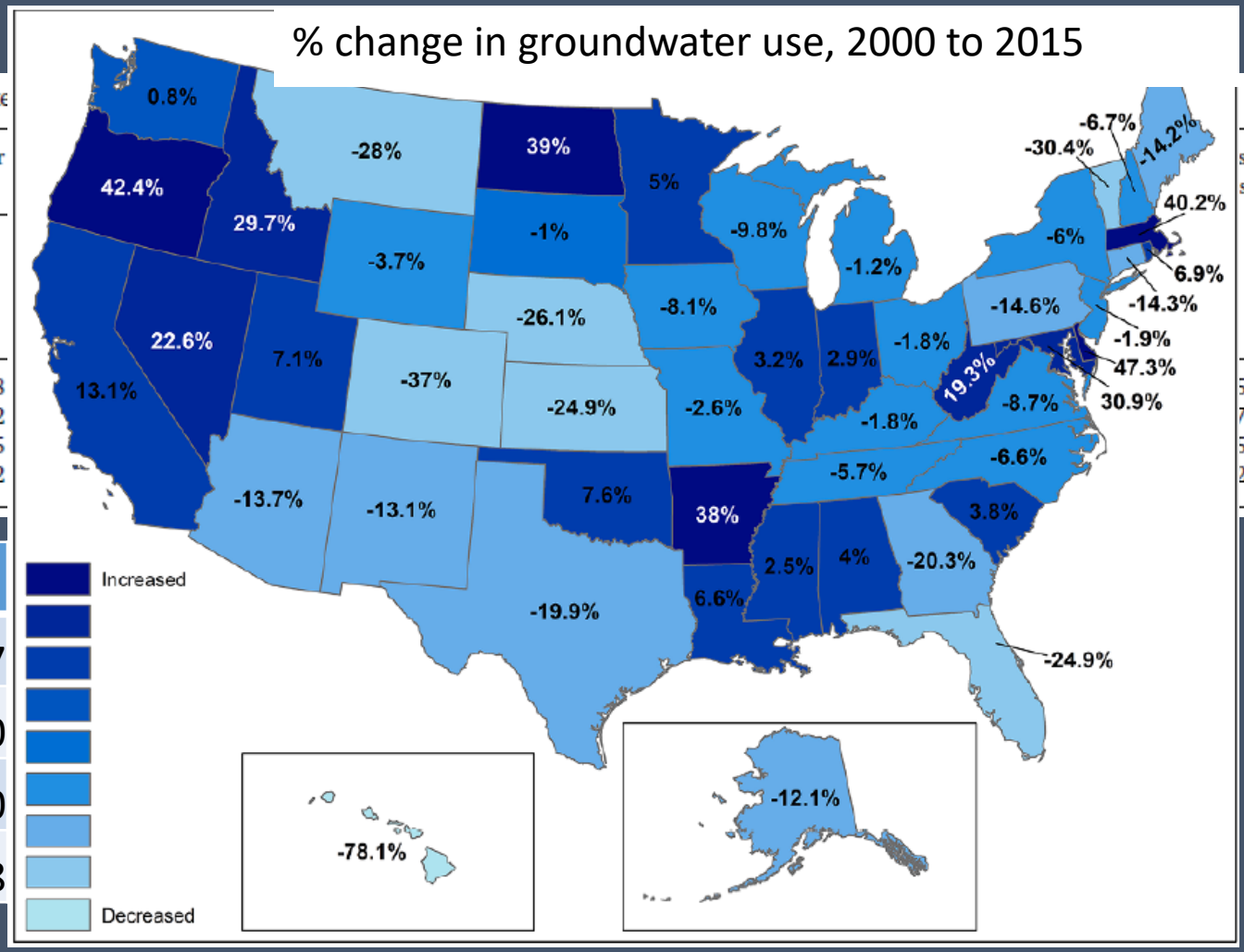
City	Population	Housing Units	City Area (acre)	Average Cooling Energy Use (KBTU)	Electricity Cost ($/ KWh)	Energy Savings (million $)						Interception (10^6 m^3 water)									
						2011			2016			2011					2016				
						Lower CI (95%)	Mean	Upper CI (95%)	Lower CI (95%)	Mean	Upper CI (95%)	Copernicus LAI	i-Tree LAI Average	% Intercepted (Average)	i-Tree +10%	Total Canopy Rain	Copernicus LAI	i-Tree LAI Average	% Intercepted (Average)	i-Tree +10%	Total Canopy Rain
New York, NY*	8,175,133	3,371,062	195,245	17	0.18	1.11	1.15	1.19	1.34	1.40	1.46	5.03	11.00	4.1%	12.02	268.51	5.17	11.41	6.4%	12.41	179.02
Los Angeles, CA	3,792,621	1,413,995	302,553	14	0.20	14.42	16.52	18.61	14.48	16.59	18.71	1.38	4.83	6.1%	5.20	79.43	0.96	3.48	5.3%	3.78	65.40
Chicago, IL*	2,695,598	1,194,337	147,920	15	0.13	2.32	2.42	2.52	2.33	2.42	2.52	1.31	4.25	6.2%	4.65	68.22	1.20	3.91	6.2%	4.27	63.30
Houston, TX	2,099,451	892,646	400,630	21	0.12	1.66	2.01	2.35	1.54	1.87	2.19	13.21	30.76	4.1%	33.59	754.09	18.56	42.10	2.5%	46.07	1,673.66
Philadelphia, PA*	1,526,006	670,171	90,344	27	0.14	0.98	1.05	1.12	1.00	1.07	1.14	3.46	6.29	4.2%	6.87	150.50	3.03	5.76	6.1%	6.28	94.66
Phoenix, AZ	1,445,632	590,149	331,486	30	0.12	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	9.1%	0.00	0.00	0.00	0.00	7.9%	0.00	0.00
San Antonio, TX	1,327,407	524,246	298,696	21	0.12	5.33	5.95	6.57	5.39	6.03	6.67	7.16	20.49	4.9%	22.32	415.52	13.37	39.09	3.1%	42.70	1,258.67
San Diego, CA	1,307,402	516,033	210,707	14	0.20	4.43	5.07	5.70	4.53	5.19	5.85	0.55	2.33	8.3%	2.51	27.91	0.48	2.05	7.8%	2.22	26.32
Dallas, TX	1,197,816	516,639	246,941	21	0.12	3.87	4.24	4.61	3.93	4.30	4.67	5.30	19.06	4.1%	20.84	468.81	8.96	30.47	3.7%	33.35	825.90
San Jose, CA	945,942	314,038	114,037	14	0.20	1.78	2.03	2.28	1.82	2.08	2.34	0.58	1.87	8.5%	2.03	22.03	0.52	1.60	5.8%	1.74	27.80
Jacksonville, FL	821,784	366,273	529,743	22	0.12	12.28	14.02	15.76	13.09	15.11	17.13	127.39	199.94	3.7%	218.42	5,429.57	132.27	204.71	3.6%	223.76	5,668.90
Indianapolis, IN*	820,445	379,856	235,536	23	0.12	5.73	6.18	6.63	5.78	6.24	6.69	13.82	25.80	5.5%	28.13	468.35	12.00	21.30	4.9%	23.23	431.59
San Francisco, CA*	805,235	376,942	30,433	14	0.20	0.09	0.10	0.10	0.10	0.10	0.11	0.16	0.38	7.3%	0.42	5.28	0.18	0.40	4.9%	0.44	8.08
Austin, TX	790,390	354,241	195,240	21	0.12	9.14	10.49	11.85	9.21	10.59	11.97	10.12	28.99	6.8%	31.41	425.63	18.28	54.78	3.5%	59.72	1,549.90
Columbus, OH*	787,033	370,965	142,787	20	0.12	2.12	2.30	2.49	2.09	2.27	2.44	6.29	13.18	5.7%	14.39	232.98	5.18	10.72	7.0%	11.68	152.35
Fort Worth, TX	741,206	291,086	222,632	21	0.12	2.04	2.25	2.46	2.09	2.30	2.51	2.56	9.81	4.5%	10.70	217.68	3.30	12.47	4.0%	13.63	309.81
Charlotte, NC	731,424	319,918	191,786	31	0.12	12.90	14.58	16.26	13.61	15.52	17.42	21.18	50.11	4.7%	54.79	1,060.76	20.49	47.01	4.9%	51.28	965.09
Detroit, MI*	713,777	349,170	89,042	14	0.15	0.78	0.82	0.87	0.78	0.83	0.88	1.74	4.61	6.4%	5.03	71.87	1.57	4.17	8.2%	4.54	51.06
Memphis, TN	646,889	291,883	207,362	33	0.11	4.90	5.29	5.69	5.02	5.44	5.87	19.66	39.38	3.8%	43.07	1,025.79	20.22	38.95	4.0%	42.60	980.79
Baltimore, MD*	620,961	296,685	52,068	20	0.13	1.15	1.28	1.41	1.15	1.29	1.42	2.37	4.84	4.8%	5.30	101.84	1.79	3.86	6.5%	4.22	59.58
Boston, MA*	617,594	272,481	31,956	16	0.23	1.49	1.62	1.76	1.65	1.81	1.98	1.37	3.14	6.1%	3.42	51.44	1.25	2.93	8.2%	3.19	35.84
Seattle, WA*	608,660	308,516	54,347	30	0.09	1.80	2.05	2.30	2.25	2.66	3.08	2.40	6.86	10.7%	7.46	64.04	2.24	6.48	8.3%	7.06	78.52
Washington, DC*	601,723	296,719	39,318	9	0.13	0.48	0.53	0.58	0.49	0.55	0.60	1.85	3.80	6.4%	4.14	59.76	1.66	3.57	7.6%	3.89	47.20
Nashville, TN*	601,222	272,622	317,983	33	0.11	6.37	7.25	8.14	6.44	7.36	8.27	79.79	118.78	4.2%	129.46	2,832.21	80.32	113.98	4.3%	124.52	2,632.47
Denver, CO	600,158	285,797	98,964	16	0.12	3.55	5.06	6.57	3.53	5.02	6.51	0.38	1.45	9.9%	1.57	14.55	0.36	1.33	9.9%	1.44	13.42
Louisville, KY*	597,337	270,928	219,016	28	0.10	2.71	2.96	3.21	2.76	3.01	3.27	31.13	47.93	4.2%	52.40	1,148.26	29.59	44.52	5.2%	48.61	864.38
Milwaukee, WI*	594,833	255,569	61,927	14	0.14	1.42	1.49	1.56	1.48	1.55	1.63	1.43	4.41	7.9%	4.81	55.84	1.65	5.13	7.9%	5.60	64.78
Portland, OR*	583,776	265,439	92,855	19	0.11	3.99	5.27	6.56	4.07	5.41	6.76	8.87	16.84	9.2%	18.34	182.31	8.79	17.15	6.5%	18.74	261.96
Las Vegas, NV	583,756	243,701	86,955	25	0.12	0.54	0.70	0.86	0.54	0.70	0.86	0.00	0.01	17.2%	0.01	0.08	0.00	0.02	10.5%	0.02	0.14
Oklahoma City, OK	579,999	256,930	397,326	34	0.10	4.73	5.24	5.75	4.78	5.29	5.81	15.33	36.21	4.4%	39.41	820.27	19.40	44.98	5.0%	49.07	899.91
Albuquerque, NM	545,852	239,166	121,308	17	0.13	3.97	8.23	12.49	3.95	8.23	12.51	0.11	0.77	11.9%	0.83	6.44	0.17	1.06	11.9%	1.15	8.88

U.S. water use

National water use for 2000 to 2015 by North American Industry Classification Syste

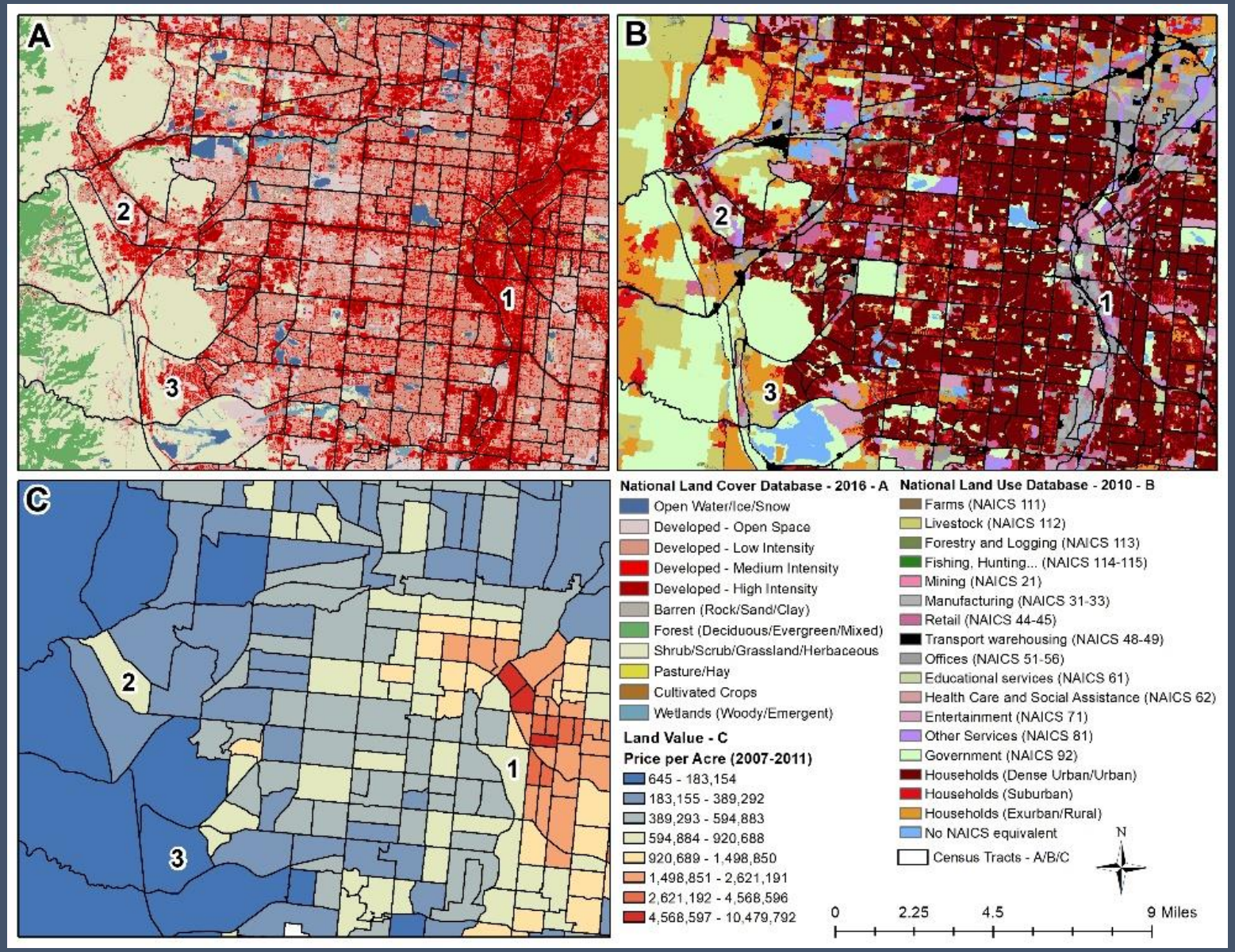
Year	11. Agriculture, Forestry, Fishing, and Hunting			21. Mining	2211. Electric Power
	111. Crop Production (Irrigation)	112. Animal Production (Livestock)	1125. Aquaculture		Thermoelectric Power (Once-through cooling)
2000	137,064.3	2,362.1	5,792.9	4,129.6	174,307.8
2005	125,219.2	2,140.8	8,828.5	3,828.3	182,557.2
2010	113,929.3	1,993.4	8,946.3	3,965.3	150,525.5
2015	116,611.7	2,093.8	7,450.0	3,996.4	126,110.2

Year	Population	Gallons water use/capita
2000	281,710,909	549,907
2005	294,993,511	521,360
2010	309,011,475	431,900
2015	320,878,310	379,138



Land accounts

- Combined fine-grained presentation of land cover, use, value can support various analyses



Links to Essential ES Variables

EESV class	Urban heat mitigation	Urban rainfall interception	Air purification	Recreational birdwatching	Crop pollination
Ecological supply	Trees that evapotranspire water & provide shade	Trees that intercept excess rainfall	Trees and shrubs that filter air pollutants	Bird habitat quantity, quality, configuration	Pollinator habitat quality & configuration
Anthropogenic contribution	Planted trees in urban settings	Planted trees in urban settings, other natural retention/detention features	Planted trees in urban settings	Infrastructure & equipment needed for birdwatching	Presence of pollinator-dependent crops
Demand	More comfortable conditions during warm/hot times of year	Reduced urban stormwater runoff	Air that's safe to breathe	Time outdoors watching/ connecting with wildlife	Pollination-dependent crops
Use	Reduced discomfort under hot conditions (less air conditioning need, greater outdoor activity, etc.)	Using water safe for recreation, drinking, aquatic life, etc.	Breathing air	Viewing birds	Pollinated crops
Instrumental values	Thermal comfort	Clean water	Air that's safe to breathe		Nourishment
Relational values				Connection to nature	

System of Environmental Economic Accounting

Break-out group discussion questions

United Nations

Potential indicators on physical ecosystem services flows

Physical ecosystem services flow indicators	Further description	Spatial unit	Disaggregation	Unit of measurement
Amount of biomass generated	Biomass provisioning services	Ecosystem accounting area	Ecosystem type; Type of biomass	Tonnes
Water abstracted for use by household and industry (proxy measure)	Water supply services	Ecosystem accounting area	Ecosystem type	Cubic metres
Tonnes of carbon retained (captured and stored/trend in the carbon sequestered)	Global climate regulation services	Ecosystem accounting area	Ecosystem type	Tonnes
Tonnes of airborne pollutants captured (e.g., PM10; PM2.5)	Air filtration services	Ecosystem accounting area	Ecosystem type; type of pollutant	Tonnes
Tonnes of waterborne pollutants removed (e.g., chemical oxygen demand) from wastewater	Water purification services	Ecosystem accounting area	Ecosystem type, type of pollutant	Tonnes
Number of properties/ km of coast/shoreline/riparian zone protected; change in degree of risk	Flood mitigation services	Ecosystem accounting area	Ecosystem type	Count/km
Number of tourist/recreation visits	Recreation-related services	Ecosystem accounting area	Ecosystem type	Count

Potential indicators on monetary ecosystem services flows account and ecosystem asset accounts

Monetary indicators	Further description	Spatial unit	Disaggregation	Unit of measurement
Gross Ecosystem Product (GEP)	The economic value added of all ecosystem services generated	Ecosystem accounting area	Ecosystem type, ecosystem services classes	Local currency
Value of ecosystem services linked to industry value added	Value added of industries with direct inputs of ecosystem services	Ecosystem accounting area	Ecosystem type	Percentage
Monetary ecosystem asset value		Ecosystem accounting area	Ecosystem type, per capita by administrative areas, planning areas	Local currency
Ecosystem asset value as a percentage of total national wealth		Ecosystem accounting area	Ecosystem type	Percentage
Cost of degradation		Ecosystem accounting area	Ecosystem type, per capita by administrative areas, planning areas	Local currency

Questions for discussion

- Prioritization of indicators and feasibility assessment

- One of the basic premise of the chapter is the importance of a limited set of indicators that are feasible for countries to compile. Do the proposed indicators satisfy the feasibility requirement?
- Another importance premise is relevance. Are the proposed indicators considered as highly relevant to address the current global/national concerns?
- It was also suggested that representativity is another important principle, where the proposed indicators should represent the attribute for the whole population. Are the proposed indicators considered as representative?
- One of the value of the SEEA EA is on linking the state of ecosystem with socio-economic information. Any additional suggested indicator from the core accounts that can amplify this linkage?
- Based on above, what are the suggestions on proposed indicators from the core accounts that are considered as priority for compilation and dissemination?
- In the light of our discussion what changes might be made to the draft text in the SEEA EA?

Further discussion questions

- What is the suggested frequency for the compilation and dissemination of the proposed indicators (seasonal, annual, longer time interval)?
- For indicators that measures change, how to determine the opening stock (last year or a reference year)?
- What is the appropriate scale for reporting (integrated national, EAA like catchment area, finer scale)?
- Could the proposed indicators be compiled using national data sources?
- What are the potential and limitation in using earth observation data for indicator compilation?