



Ecosystem accounting in WAVES

March 2017 – EO4EA, Copenhagen



Wealth Accounting and the Valuation of Ecosystem Services
www.wavespartnership.org

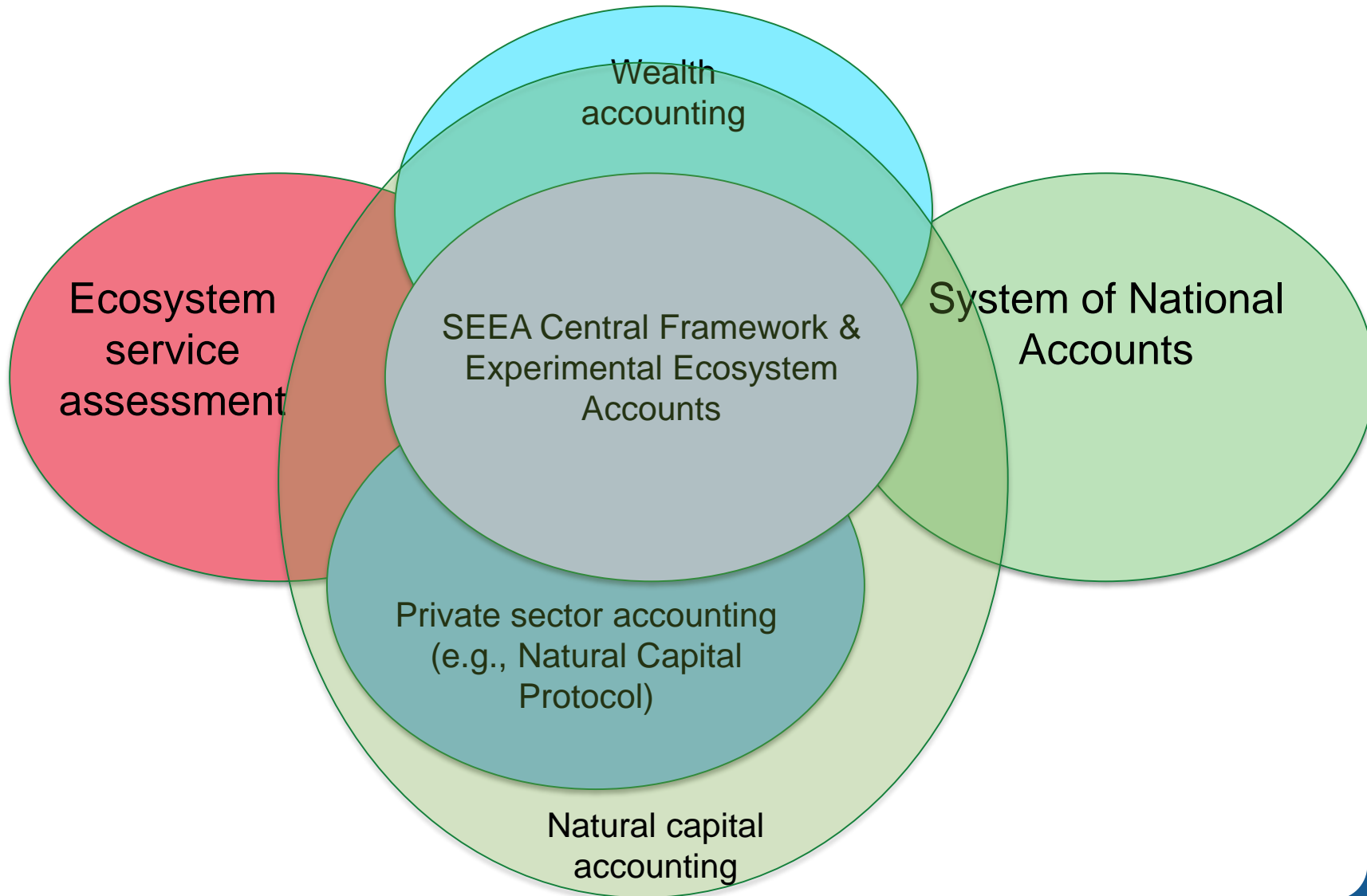


Wealth Accounting & Valuation of Ecosystem Services (WAVES)

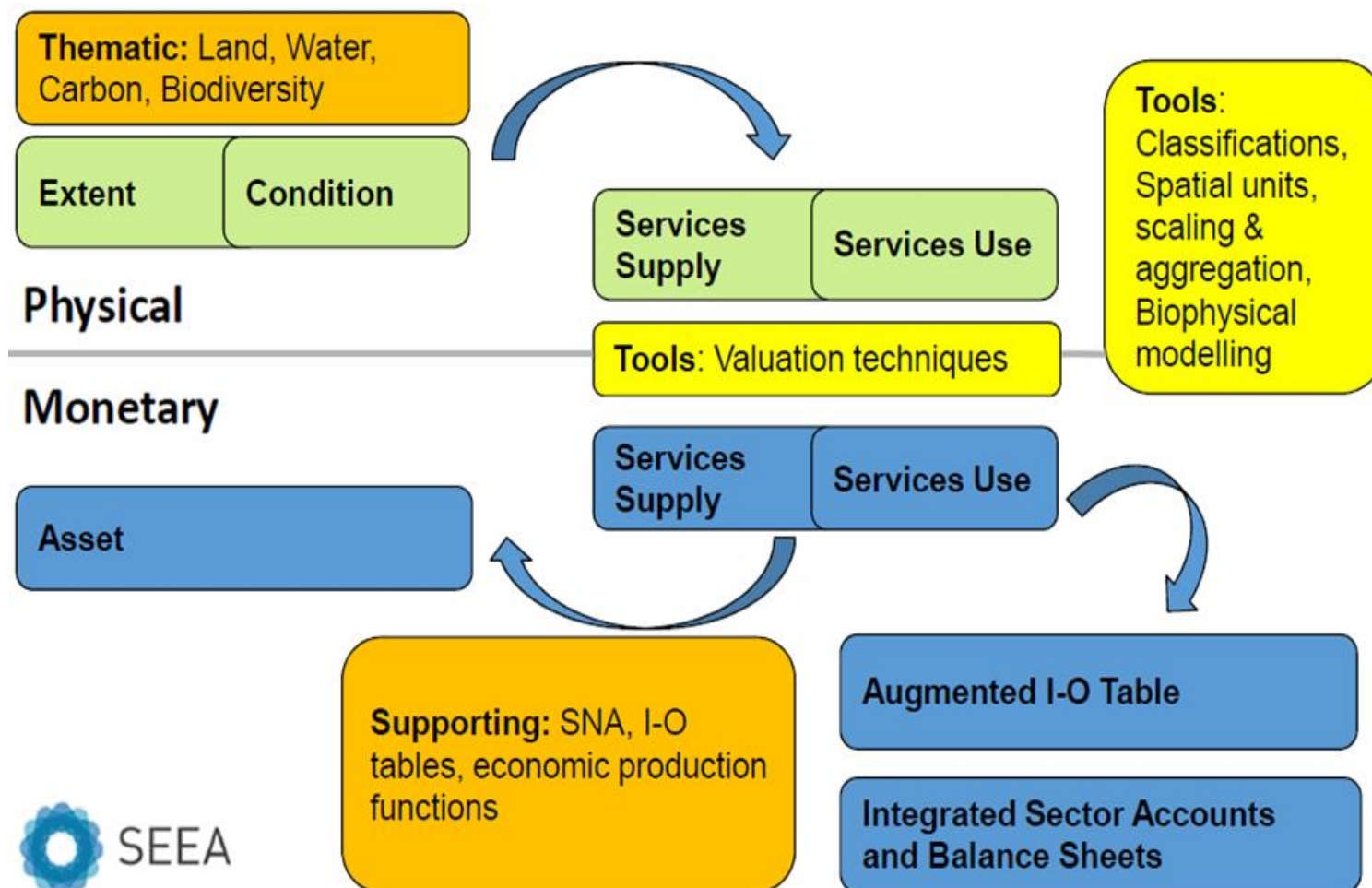
1. Support to Core Implementing Countries. *Goal:* institutionalization within countries and World Bank lending practices.
 1. 2012-2016: Botswana, Colombia, Costa Rica, Madagascar, Philippines
 2. 2014-2018: Guatemala, Indonesia, **Rwanda**
 3. 2017-2020: Kyrgyzstan, Zambia
2. Support to Regional Communities of Practice. *Goal:* Promote South-South learning & advancement of ecosystem accounting in practice.
3. Global Engagement. *Goal:* Advance SEEA-EEA methodology development.



Natural capital accounting: Overview



SEEA ecosystem accounting



ECOSYSTEM SERVICES SUPPLY TABLE

		Type of economic unit							Type of Ecosystem Unit											
		Forestry and fisheries	Electricity supply	Water collection, treatment and supply	Other industries	Households	Accumulation	Artificial surfaces	Herbaceous crops	Woody crops	Multiple or layered crops	Grassland	Tree-covered areas	Mangroves	Shrub-covered areas	Regularly flooded areas	Sparse natural vegetated areas	Terrestrial barren land		Permanent snow and glaciers

ECOSYSTEM SERVICES USE TABLE

Ecosystems
Products

	UNITS	Type of economic unit							Type of Ecosystem Unit															TOTAL USE
		Agriculture, forestry and fisheries	Electricity, gas supply	Water collection, treatment and supply	Other industries	Households	Accumulation	Rest of the world - Exports	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Ecosystem services		E							F															
Provisioning services																								
Regulating services																								
Cultural services																								
Products		G							H															



Example physical supply table (Box B): Rwanda

2000 supply table								
	Ecosystem unit							
	Dense forest	Moderate forest	Sparse forest	Open grassland	Open shrubland	Annual cropland	Wetland	Urban
Ecosystem extent (ha)	63,064	148,898	538,383	233,393	149,821	1,121,563	79,932	13,842
Carbon storage (T)	22,768,810	52,516,363	107,276,231	31,845,202	24,711,872	138,781,305	57,794,823	1,548,593
Sediment export (T)	348,268	5,235,141	24,010,088	6,905,971	3,098,308	289,788,826	248,456	248,054
Sediment retention (T)	119,303,545	318,193,367	833,895,150	108,068,181	70,104,490	1,033,791,570	4,188,476	4,975,842
Water yield (m ³)	433,127,105	675,422,864	1,820,487,794	275,875,943	340,620,152	3,242,666,951	13,090,582	29,843,038
Local recharge (m ³)	584,670,945	1,107,854,012	3,283,620,853	753,860,586	533,756,117	5,094,105,381	32,240,012	32,397,690
Quick flow (m ³)	20,379,630	69,493,699	332,703,897	130,133,849	105,684,723	1,558,132,384	408,018,611	21,798,437
2010 supply table								
	Ecosystem unit							
	Dense forest	Moderate forest	Sparse forest	Open grassland	Open shrubland	Annual cropland	Wetland	Urban
Ecosystem extent (ha)	48,329	123,335	581,245	81,861	245,939	1,110,862	104,780	20,642
Carbon storage (T)	17,478,290	43,586,850	115,995,428	11,196,105	40,621,360	137,425,032	75,866,271	2,289,468
Sediment export (T)	31,678	2,718,453	22,353,080	2,000,941	5,766,659	219,733,981	599,303	377,502
Sediment retention (T)	80,333,674	261,235,533	1,044,345,106	33,081,222	134,484,492	999,587,859	11,363,169	6,757,248
Water yield (m ³)	348,739,235	630,745,434	1,786,893,995	95,262,872	614,197,296	3,382,183,386	19,809,555	47,818,161
Local recharge (m ³)	470,386,845	992,130,254	3,373,405,985	252,194,154	915,615,103	5,143,688,530	41,781,132	51,269,495
Quick flow (m ³)	13,168,120	48,383,862	315,668,930	41,889,915	168,347,511	1,607,232,475	538,414,475	33,431,297

Current status

Progress on Ecosystem Accounts in WAVES, March 2017

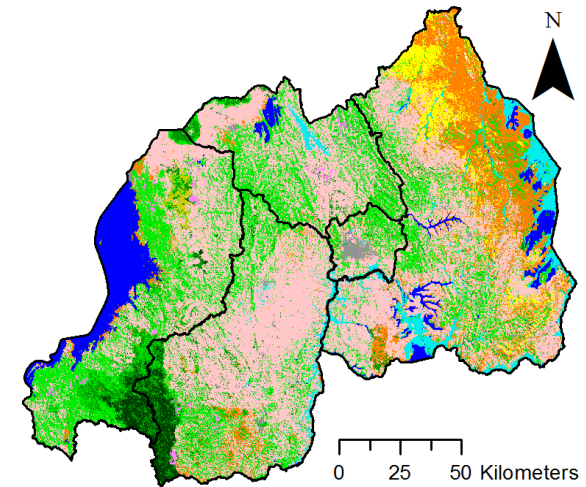
	Ecosystem extent	Ecosystem condition	Physical supply & use	Monetary supply & use
Colombia				
Costa Rica				
Guatemala				
Indonesia				
Philippines				
Rwanda				
	National-scale, complete			Subnational-scale, complete
	National-scale, in progress			Subnational-scale, in progress

Current status

Progress on Ecosystem Accounts in WAVES, March 2017											
	Ecosystem services treated in SEEA Ecosystem Accounts						Ecosystem services treated in SNA/SEEA Central Framework (to which SEEA-EEA adds mapping)				
	Carbon sequestration & storage	Erosion control	Water supply	Water regulation	Riverine flood protection	Coastal flood protection	Recreation & tourism	Timber	Nontimber forest products	Fisheries	Agriculture
Colombia	△	△	△				△	△	△	△	
Costa Rica	○		○				○	○			○
Guatemala	●		●					●	●	●	
Indonesia											
Philippines	△	△	△	△	△	○	△			△	△
Rwanda	○	○	○	○							
●	National-scale, complete		Subnational-scale, complete								
○	National-scale, in progress		Subnational-scale, in progress								

Ecosystem accounting in Rwanda

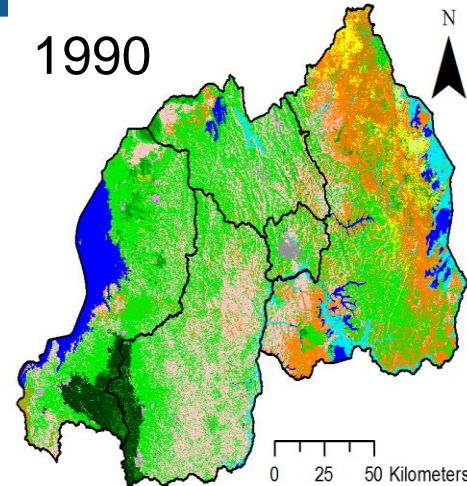
- SERVIR land cover data for 1990, 2000, 2010, (2015)
- National & regional data on soils, climate, precipitation & streamflow, etc.
- Coupled with InVEST models for carbon storage, annual & seasonal water yield, sediment delivery ratio



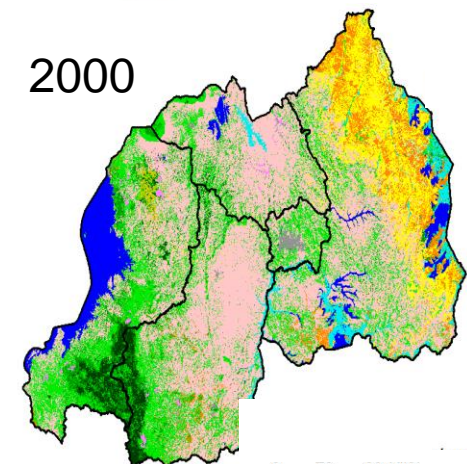
Rwanda land accounts

Land cover type	Trends	Geographic concentration of trends
Dense forest	Steady loss, 1990-2010 (likely converted to moderate forest)	South & West 1990-2000, North 2000-2010
Moderate forest	Substantial gain, 1990-2000	South; North to a lesser degree
Sparse forest	Substantial loss, esp. 1990-2000, mirroring expansion of annual cropland	Countrywide. Loss continued from 2000-2010, rebounded elsewhere (<i>Eucalyptus</i> ?)
Open grassland	Substantial gain 1990-2000, substantial loss 2000-2010 (mirrors shrubland trends)	Mostly East; lesser trends elsewhere
Shrubland	Substantial loss 1990-2000, substantial gain 2000-2010 (mirrors grassland trends)	Mostly East; lesser trends elsewhere
Annual cropland	Substantial gain, primarily 1990-2000	Countrywide
Wetlands	Relatively little change	Greatest in East; small trend in Kigali City (urbanization?)
Urban	Steady gain but from a small starting area	Mostly not in Kigali City; greatest in East

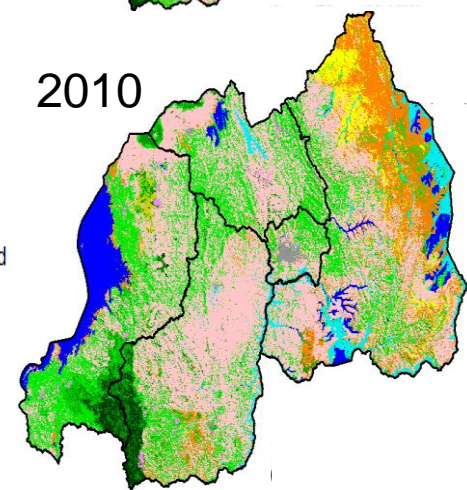
1990



2000



2010



Legend

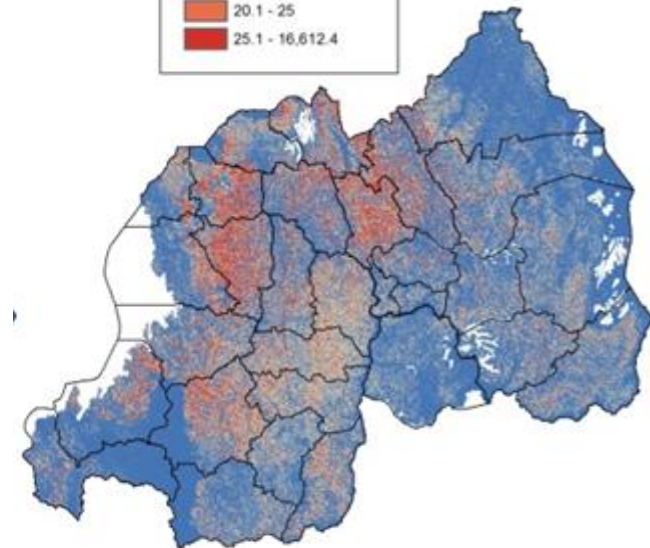
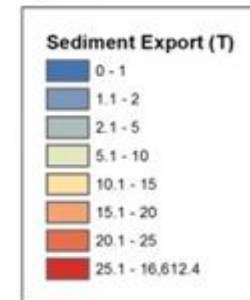
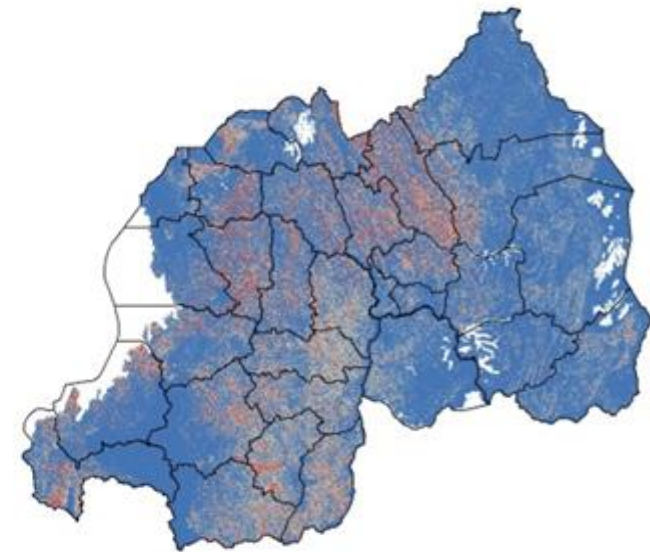


Sediment delivery results

1990

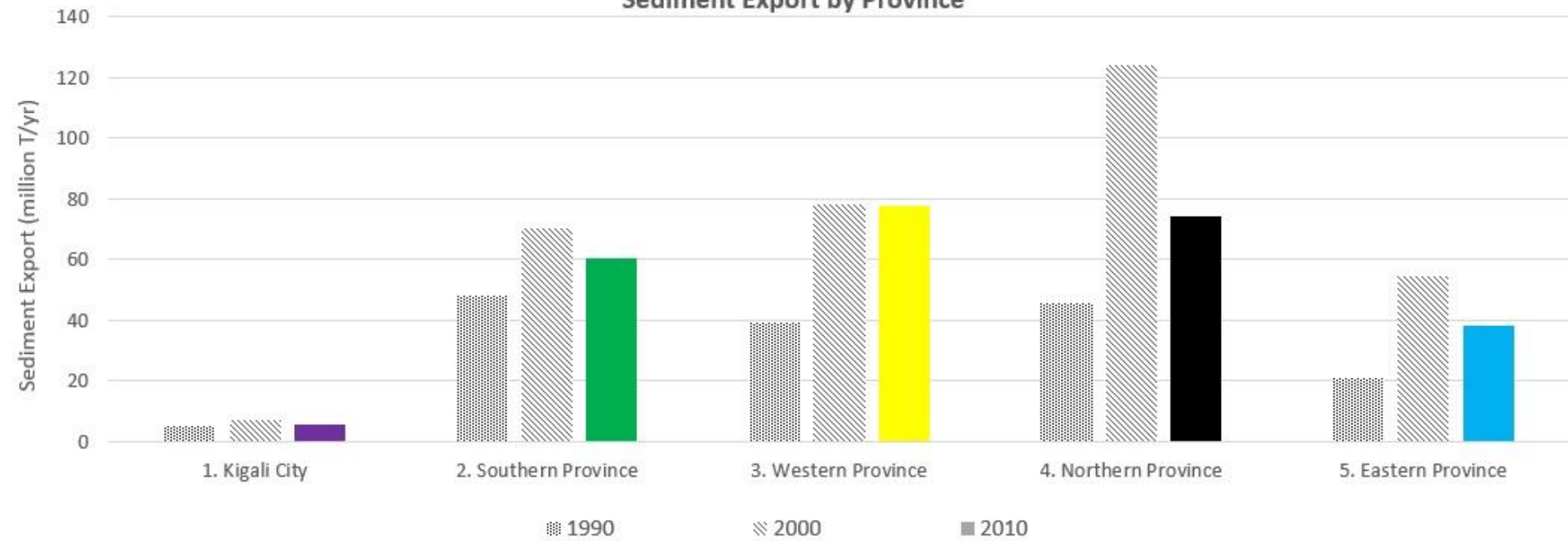
National sediment export accounts (T)

	0. National level
1990	159,157,842
Total additions	229,750,044
Total reductions	-54,276,154
2000	334,631,730
Total additions	85,199,829
Total reductions	-163,540,792
2010	256,311,761
Change, 1990-2010	97,153,919
% change	61.0%
Change, 1990-2000	175,473,887
% change	110.3%
Change, 2000-2010	-78,319,968
% change	-23.4%

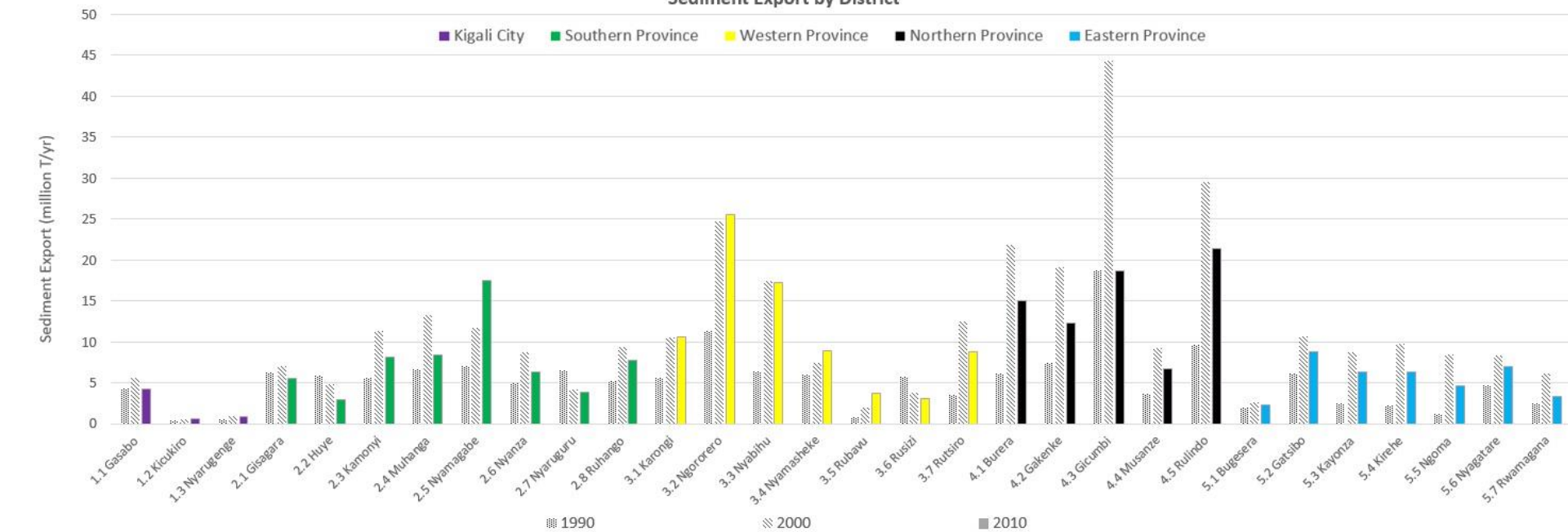


2010

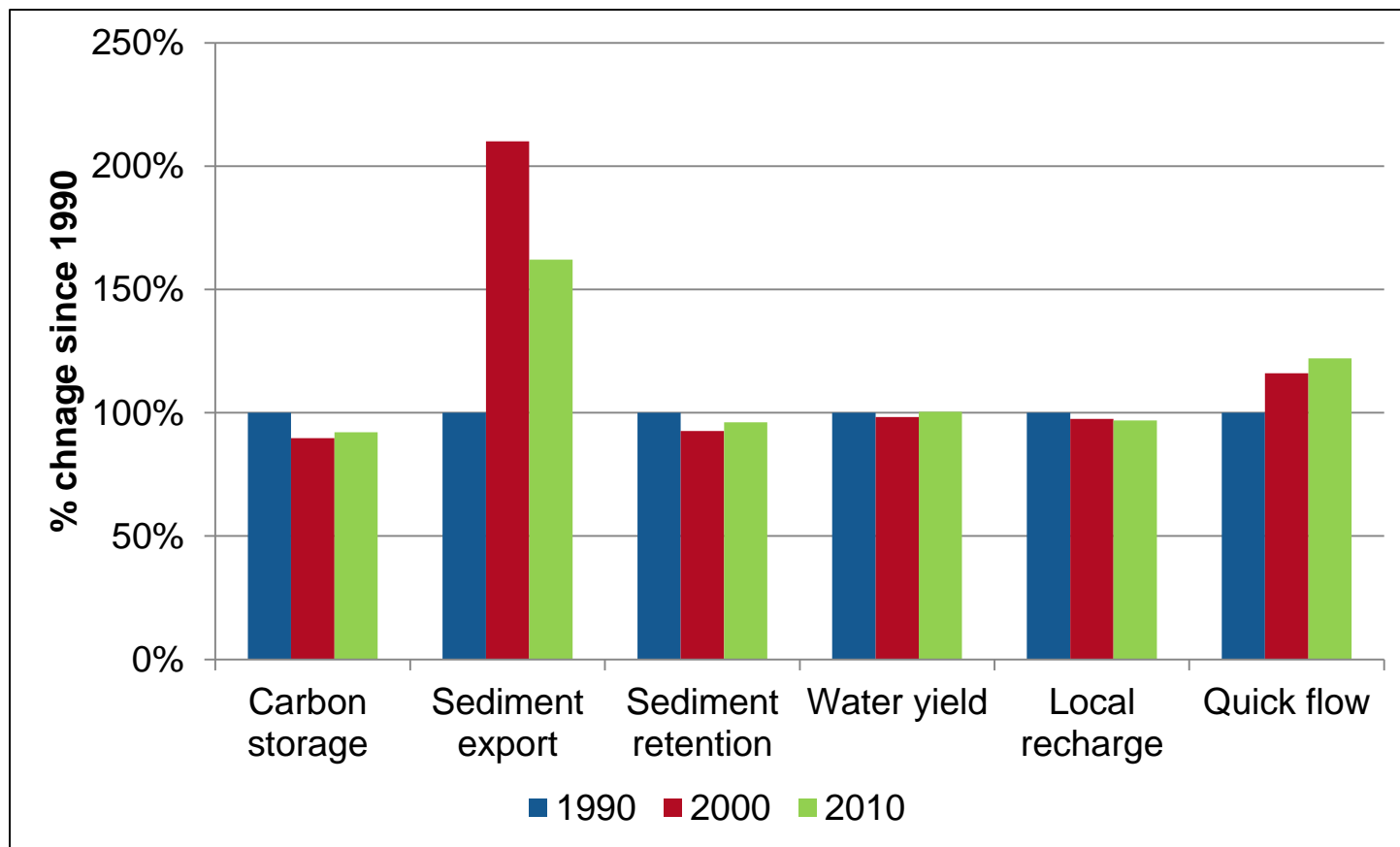
Sediment Export by Province



Sediment Export by District



Summary



- “Better” conditions with more carbon storage, sediment retention, local recharge; less sediment export, quick flow
- 2015 data ready in about a month

Analysis of water quantity, quality, & timing to dams and water treatment plants

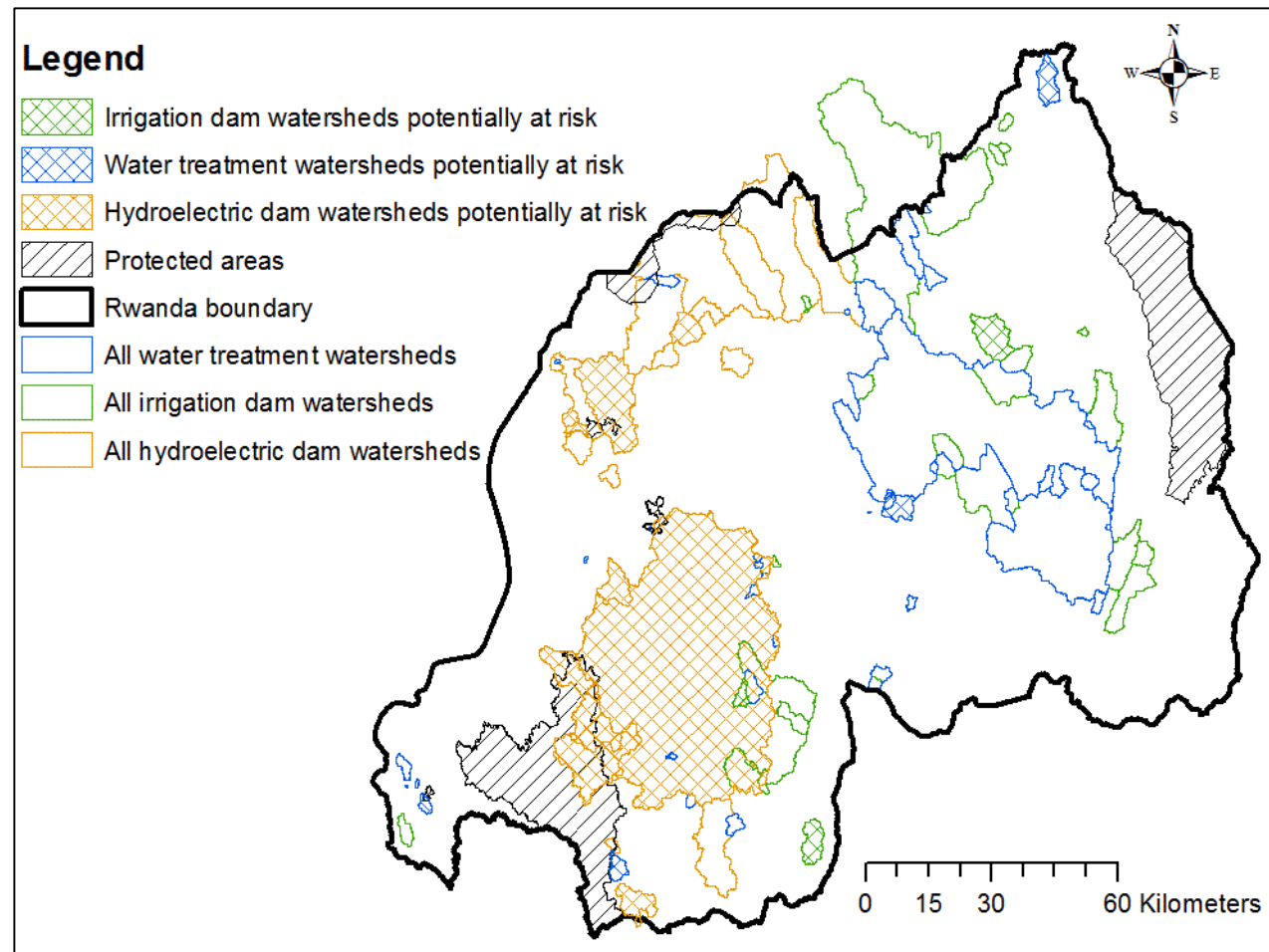
For 39 water treatment plants, 33 irrigation dam sites, 24 hydroelectric dam sites:

- Delineate their upstream watersheds
- Sum quick flow and sediment export in 2000 and 2010
- Identify watersheds where water quality (sediment) and timing (quick flow) are improving or declining
- Need to make sure our dam/treatment plant locations are correct
- Could later extend analysis to 333 microhydro sites



Analysis of water quantity, quality, & timing to dams and water treatment plants

Potential to inform source water protection, payments for watershed services



Summary: Use of EO data for EA

Theme	Data source	Comments
Land cover	RCMRD (SERVIR)	1990, 2000, 2010 data, Landsat-derived. 2015 data in preparation
Soils	ISRIC	Known limitations
Precipitation	East Anglia CRU, WorldClim	Local data exist but would require heavier-duty interpolation
Streamflow	RNRA	Heavy cleaning & preprocessing required
Potential & actual ET	MODIS; CGIAR (PET)	
Elevation	SRTM	
Parameter values for models	Various field studies	Better coefficients from field studies always welcome!

ECOSYSTEM SERVICES SUPPLY TABLE – Physical

		Type of economic unit							Type of Ecosystem Unit															
		stry and fisheries	upply	, treatment and supply				l - Imports					ed crops			as		reas			d areas	vegetated areas	n land	and glaciers

ECOSYSTEM SERVICES USE TABLE – Physical

Ecosy	F	F	C	Prod		UNITS	Type of economic unit							Type of Ecosystem Unit										TOTAL USE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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ECOSYSTEM SERVICES SUPPLY TABLE – Monetary

		Type of economic unit							Type of Ecosystem Unit														
		Industry and fisheries	Electricity supply	Water collection, treatment and supply				Imports					Grasslands		Woods	Urban areas	Vegetated areas	Barren land	Ice and glaciers	Water bodies	Coastal and inter-tidal areas	Marine areas	

ECOSYSTEM SERVICES USE TABLE

		UNITS	Type of economic unit							Type of Ecosystem Unit															TOTAL USE
			Agriculture, forestry and fisheries	Electricity, gas supply	Water collection, treatment and supply	Other industries	Households	Accumulation	Rest of the world - Exports	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Ecosystem services			Nonmarket valuation							F															
Provisioning services																									
Regulating services																									
Cultural services																									
Products			From National Accounts							H															



Remaining issues/“Wish list”

1. *In situ* data for model calibration (stream gages & water quality)
2. Monitoring ecosystem condition
3. Ecosystem extent vs. land cover extent
 - E.g., Radar RS to distinguish plantations from forest cover in the Philippines
4. Integration with land use data (i.e., beneficiaries)/ economic sectoral data
5. Calibration data (e.g., Masocha et al. in press) – “Remote sensing of surface water quality in relation to catchment condition in Zimbabwe
6. Updates to accounts (e.g., SERVIR/RCMRD “Tracking the changing landscape of Eastern and Southern Africa”)
7. Ways to speed the process (later today)