System of Environmental Economic Accounting

Valuation – country experiences

(Level 2)

United Nations

Level 2:
Country examples

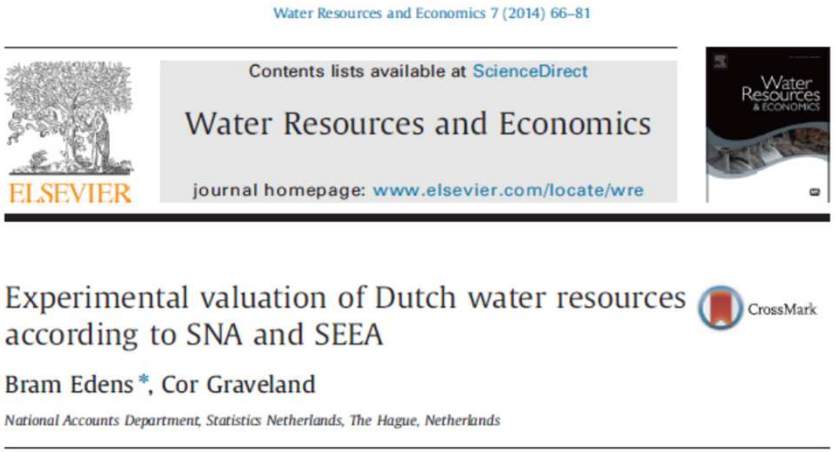
International experiences

Valuation experiences

- Netherlands – water resources
- Netherlands – ecosystem services
- EU – ES provided by lakes
- Canada
- South Africa
- China
- TEEB
- United Kingdom

Netherlands

- Objective: investigate methods to value water resources consistent with national accounts principles
- Using the measurement boundary of the System of Environmental Economic Accounting(SEEA) Central Framework
- Restrict to extractive use / provisioning services of various types of water resources
- Approximately 26 billion euros, or 10 % of value of natural capital currently in Dutch balance sheet



Water Resources and Economics 7 (2014) 66–81

Contents lists available at ScienceDirect

Water Resources and Economics

journal homepage: www.elsevier.com/locate/wre

Experimental valuation of Dutch water resources according to SNA and SEEA

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Netherlands

Table 1
Abstraction of water by Dutch economy, 2010.
Source: [14–16] with minor adjustments.

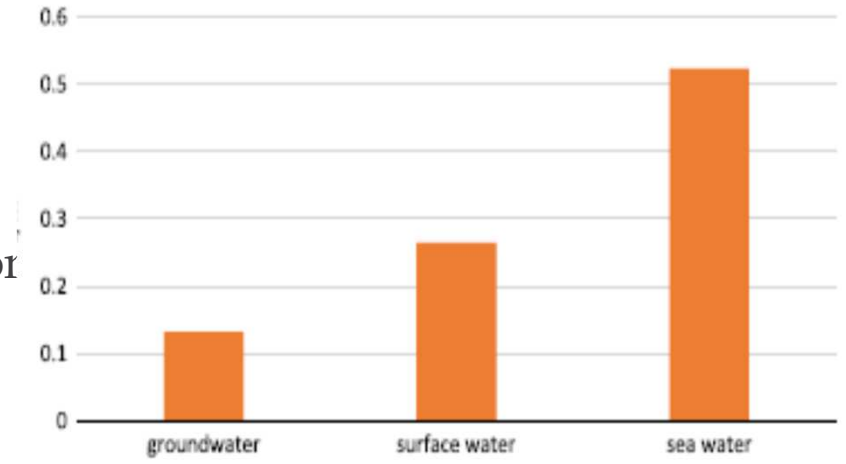
Water resource	Unit	Economic activity						
		Agriculture, forestry and fishing	Mining and quarrying	Manufacturing	Electricity and gas supply	Watersupply and waste management	Other	Total water use
Ground	mln m^3	96	0	142	5	763	.	1006
Cooling	mln m^3	.	0	65	0	.	.	65
Other use	mln m^3	96	0	77	5	763	.	941
Surface	mln m^3	26	1	3350	9693	1006	.	14,076
Fresh	mln m^3	26	1	804	–	1006	.	1837
Fresh – cooling	mln m^3	.	.	2273	5699	.	.	7972
Salt and brackish	mln m^3	.	.	273	3994	.	.	4267
Soil water	mln m^3	7076	–	–	–	–	.	7076
Total	mln m^3	7198	1	3492	9699	1769	.	22,159

Netherlands

RR problematic due to market conditior

Replacement costs techniques:

- Valuation of provisioning service of groundwater: using additional cleaning costs when using surface water
- Assuming that surface water is indeed available under comparable conditions for abstraction and transport and not subject to depletion
- The least cost alternative for using surface water for making drinking water would be to use desalination.
- Etc.



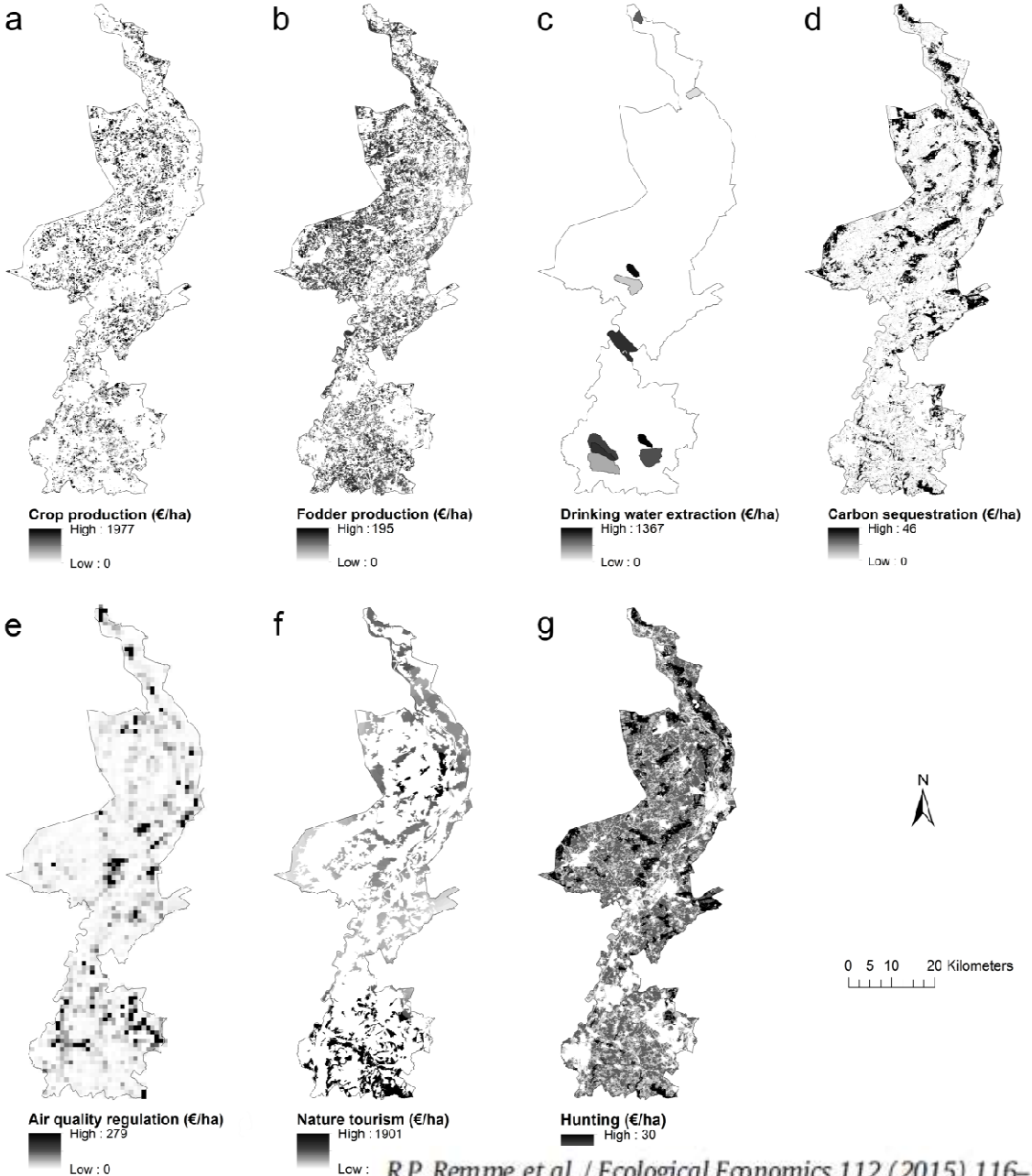
Operational costs of drinking water production for various water sources, 2010.

Source: PBL, RIVM, WUR, CICES 2014

Netherlands

- Limburg province:
- Biophysical model for 7 ecosystem services
- Spatially explicit!

(although resolution differs)



R.P. Remme et al. / Ecological Economics 112 (2015) 116–128

SEEA

Ecosystem services supply and use table

ECOSYSTEM SERVICES SUPPLY TABLE

	UNITS	Type of economic unit							Type of Ecosystem Unit															TOTAL SUPPLY
		Agriculture, forestry and fisheries	Electricity, gas supply	Water collection, treatment and supply	Other industries	Households	Accumulation	Rest of the world - Imports	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	Inland water bodies	Coastal water and inter-tidal areas	Sea and marine areas	
									1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Ecosystem services Provisioning services Regulating services Cultural services		A							B															
Products		C							D															

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	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	Inland water bodies	Coastal water and inter-tidal areas	Sea and marine areas	
									1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Ecosystem services Provisioning services Regulating services Cultural services		E							F															
Products		G							H															

SEEA

Netherlands

Ecosystem monetary supply table

- Values per ha (per ET)

		Non-perennial plants	Meadows (for grazing)	Hedgerows	Deciduous forest	Coniferous forest	Mixed forest	Heath land	Fresh water wetlands	Natural grassland	Public green space	Other unpaved terrain	River flood basin	Totals
extent	ha	53.629	27.066	2.940	11.414	7.091	10.437	2.149	936	3.121	4.761	22.591	14.126	220.922
Crops	€	35.303.100	-	-	-	-	-	-	-	-	-	-	-	37.908.400
Fodder	€	1.960.900	4.587.100	-	-	-	-	-	-	-	-	-	942.300	7.556.200
Meat (from game)	€	817.700	223.400	-	186.800	192.700	261.100	35.600	12.700	32.900	14.700	211.200	136.000	2.249.400
Ground water	€	3.861.200	1.802.300	193.900	824.200	63.500	218.700	57.300	11.200	295.700	192.600	1.041.100	545.700	11.602.800
Capture of PM10	€	301.200	173.700	30.400	200.200	185.700	200.700	27.200	2.400	46.700	78.100	258.200	85.900	2.275.900
Carbon sequestration	€	300	165.700	18.000	562.500	350.300	515.000	13.200	6.400	19.300	40.500	139.000	95.600	2.006.100
Nature tourism	€	4.410.000	6.349.100	2.357.700	6.930.100	3.162.500	5.443.100	917.000	392.800	2.488.900	625.900	2.870.600	3.162.100	41.816.200
Recreation (cycling)	€	NA												NA
	€	46.654.400	13.301.400	2.600.000	8.703.800	3.954.700	6.638.800	1.050.400	425.400	2.883.500	951.700	4.520.200	4.967.500	105.415.000
value per ha (excl. Amenity)	€/ha	870	491	884	763	558	636	489	454	924	200	200	352	477
value per ha (incl. Amenity)*	€/ha	870	491	884	1.193	988	1.066	489	454	924	688	220	352	553

SEEA

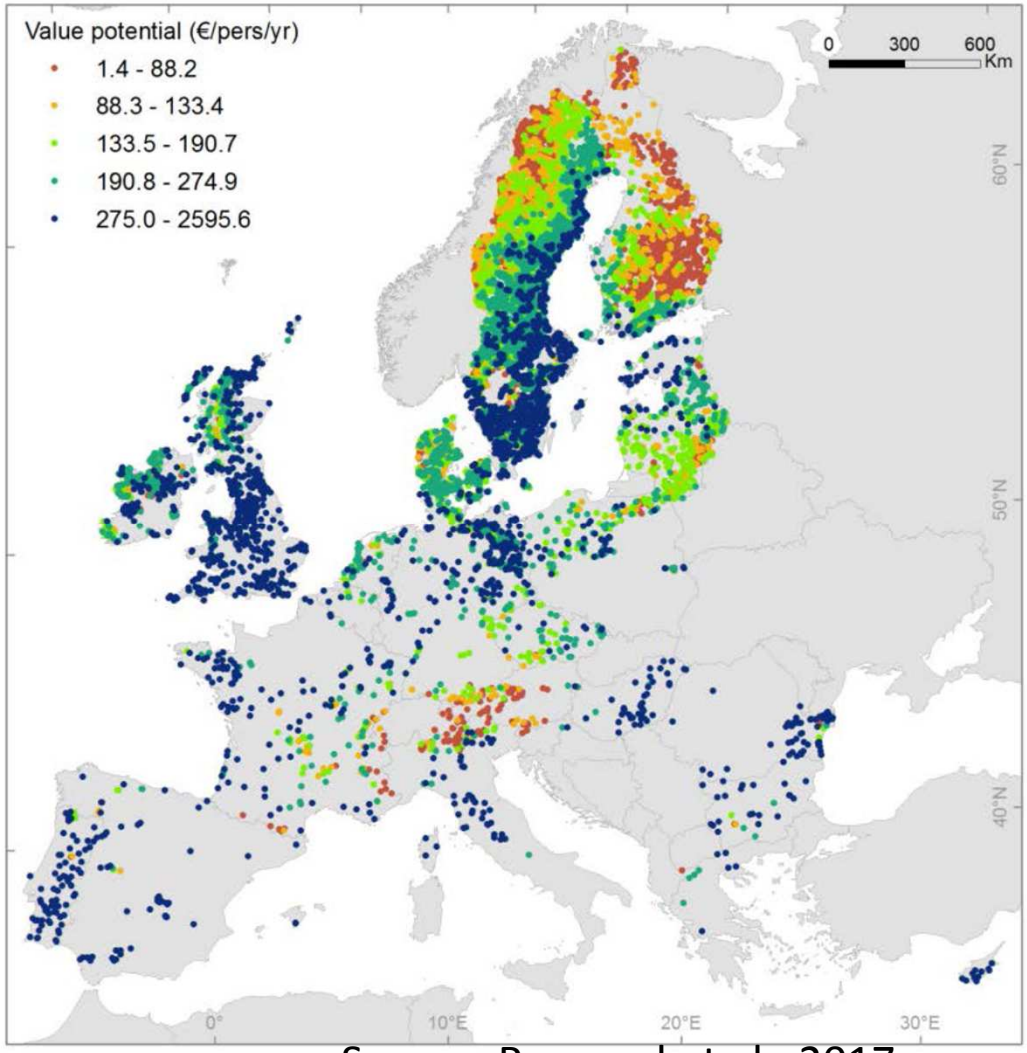
EU - value of ES by lakes

Assessment of the economic value of ecosystem services provided by lakes at European scale

- Meta-analytic spatially explicit benefit transfer (value function transfer)
- Based on new meta-database consisting of 107 observations for 35 distinct lakes in 12 countries delivering 8 different ES
- Value function transfer distinguishes between:
  - value of the biophysical potential to generate ecosystem services,
  - value the effective delivery of ES to local populations
- Spatially explicit combining a wide range of data sets (elevation; temperature; precipitation; population; areas; ecological status; lake density; GDP by NUTS3 region; area visible from lake)

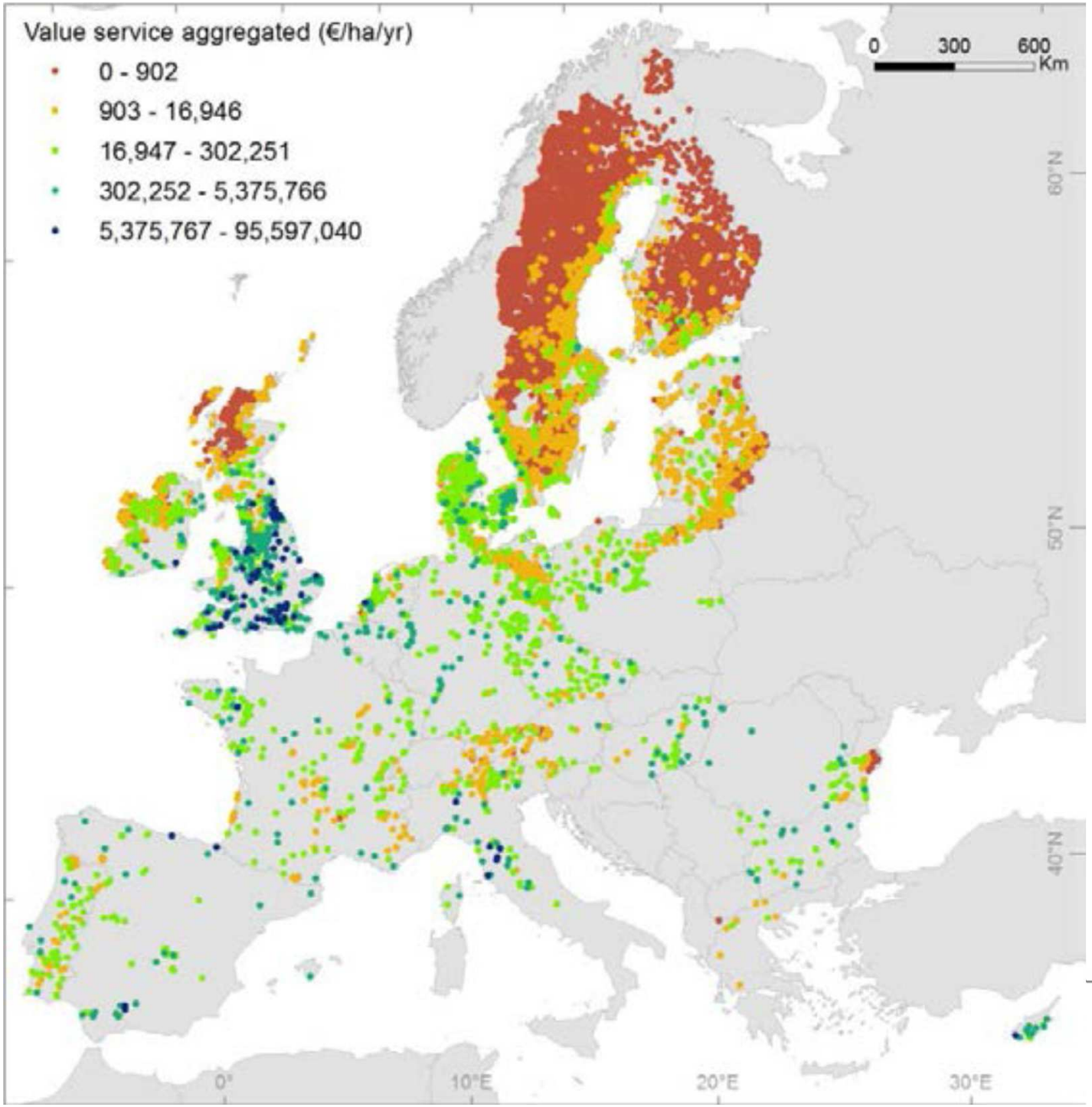
EU - Lakes

- Individual data per lake in the policy sample - each lake is represented by a dot.
- The total number of lake in the policy sample is 12,590 (about 65 % of total lake surface area in EU)



Source: Reynaud et al., 2017

SEEA



- High values in densely populated areas
- Low values also influenced by colder temperatures, and availability of substitute lakes

EU lakes

- Results:
  - European-wide estimate equal to 36.8 billion EUR per year.
  - Scenario analysis -> improvement of the ecological conditions of all European lakes (5 category scale) from bad/poor to moderate status -> aggregated benefit of 5.9 billion EUR per year
    - significantly higher than the cost of lake restoration reported in the literature.
  - Study grounds conservation and restoration measures of lakes on an economic analysis of the benefits they provide to citizens and, therefore, is relevant to the implementation of the EU water policy.

Finland

Ecosystem Services (xxxx) xxxx–xxxx

Contents lists available at ScienceDirect

Ecosystem Services

journal homepage: www.elsevier.com/locate/ecoser

Integrating spatial valuation of ecosystem services into regional planning and development

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- Assess a wide range of services in a spatially explicit way
- Focus is land use planning

SEEA

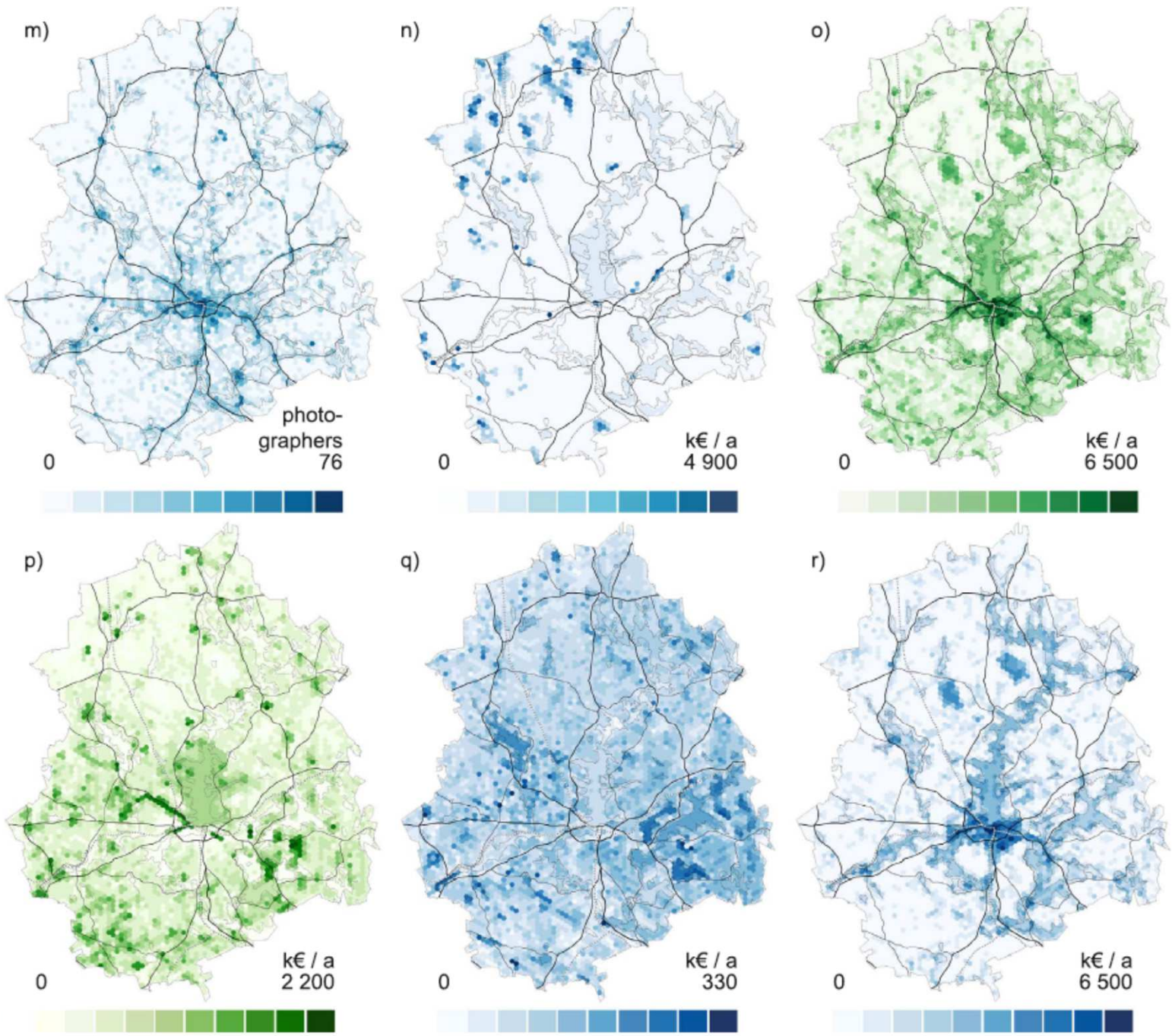


Fig. 5. (*continued*)

m) aesthetic nature interactions

(n) abiotic provision of hydropower, peat (energy and other uses) and wind power (potential),

o) ES total (excl. abiotic outputs),

p) total provision ES,

q) total regulation and maintenance ES,

r) r) total cultural ES.

- ES framework provided a workable foundation for spatial ES valuation.
- Results already affected the Tampere regional plan 2040 proposal, altering the plan towards a more comprehensive guidance solution for ecosystem service hot-spots.

Table 1
Current and potential annual rates and values for ES and abiotic natural outputs in the Tampere region. The potential value potentials and their probable impact on unit values have not been accounted for. NS=non-spatially valued ES.

Ecosystem service	Current rate p.a.	Value (M€/a)
Provision	**NA**	**380**
Cultivated crops	0.6–37 t/ha	48.5 + 22.3 NS
Reared animals	28 Mkg meat, 0.12 Mm^3 milk, 1.5 Mkg eggs	93.5
Wild plants for nutrition	0.5–1.5 Mkg	0.6–2.0+1.1 NS
Wild animals for nutrition	7 100 (*Cervidae*)+2.3 Mkg (fish, 15% freed)	2.7 (deer)+1.5 (other game) NS+5.7 (fish)
Surface water	16.8 Mm^3	16.8
Ground water	18.7 Mm^3	22.5
Fibers from wood	3.7 Mm^3	110
Bioenergy (wood)	1.3 Mm^3/2 600 GWh	54
Bioenergy (agro-)	NA	NA
Regulation and maintenance	**NA**	**79–96**
CO_2sequestration	3.4	31
Nutrient retention	54–61 t P, 0.9–1.2 Mt N	43–54
Pollination (demand-based)	NA	4.1–9.9 (incl. domestic needs) +1.1 (honey)
Cultural	**NA**	**306–434**
Close-to-home recreation and nature trips)	Close-to-home trips 33.6 M+2.8 M NS, nature trips 0.09 M	118–144+9.7–12 NS (close-to-home), 9.3–17 (nature trips)
Recreational values from holiday housing and waters (e.g. boating)	38.4 d/a or 18 trips/user/a (cottages). 20.8 trips/pers, 4.2 M trips (boating etc.)	83–120 (holiday housing) +42–58 (boating etc.)
Recreational value from hunting-gathering	10 000 hunters, 23.5 hunting days p.a. 168 000 fishers, 15.3 fishing days p.a.	6.3 (hunting)+12–33 (fishing) +12.9 (berries)+9.5 (fungi)
Bequest	NA	2.9 (METSO)–21.5 (WTP)
(Aesthetic) nature interactions	3.2 photos/user, 18 000 photos/a, 0.3 users/km^2	NA
Abiotic (non-ES)	**NA**	**44**
Hydropower	150 MW/548 GWh	21–24
Wind power	~ 0 GW h	0
Peat extraction	1.1 Mm^3/1.0 TWh (energy)+0.3 Mm^3 (other)	23
Total	**NA**	**760–910**
Total incl. abiotic	**NA**	**810–960**

SEEA

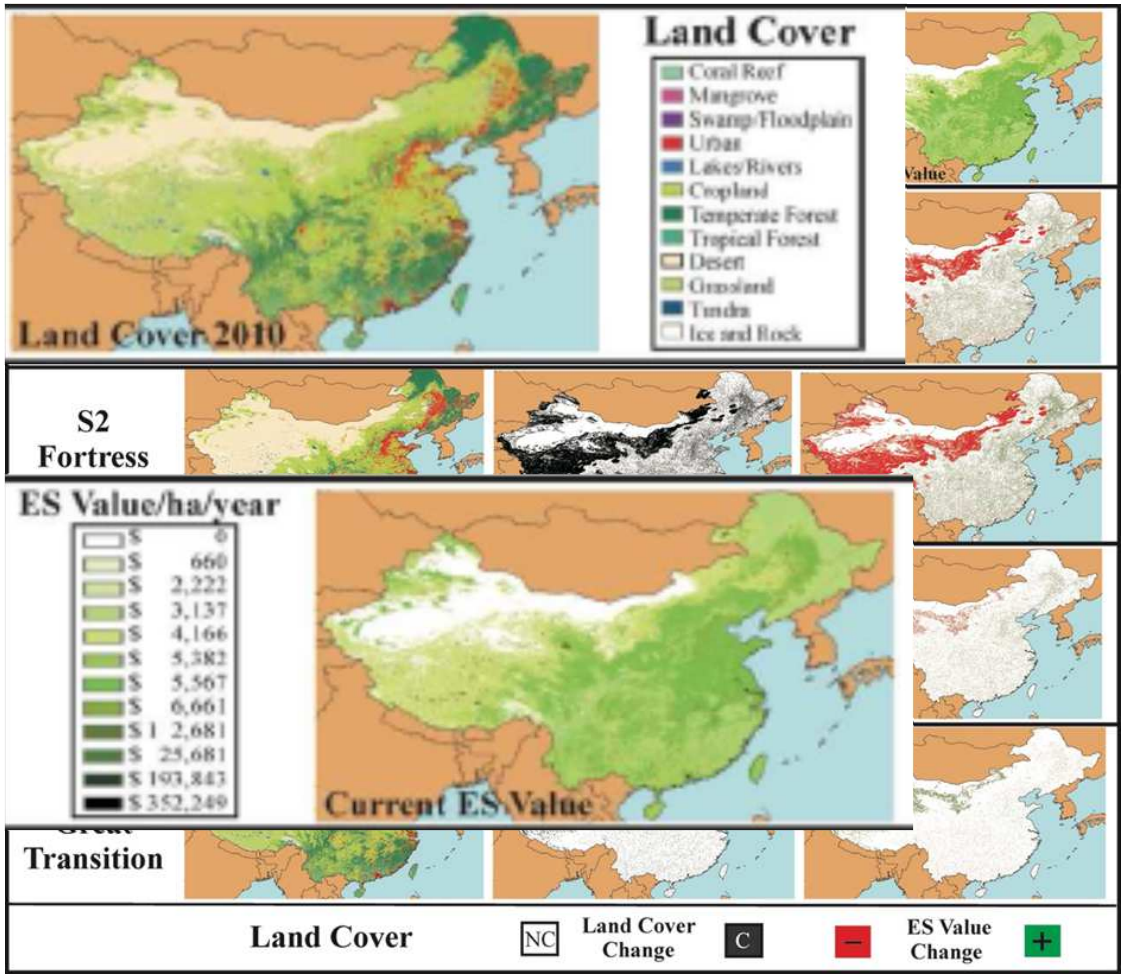
China

World:

GDP	91,679,969
ES	71,666,806

China:

GDP	13,810,256
ES	3,586,924



The future value of ecosystem services: Global scenarios and national implications – Kubiszewski et al. 2017

SEEA

Valuation of ES – South Africa

- 10 individual services were modelled and valued
- Using a range of techniques, but always local/national data

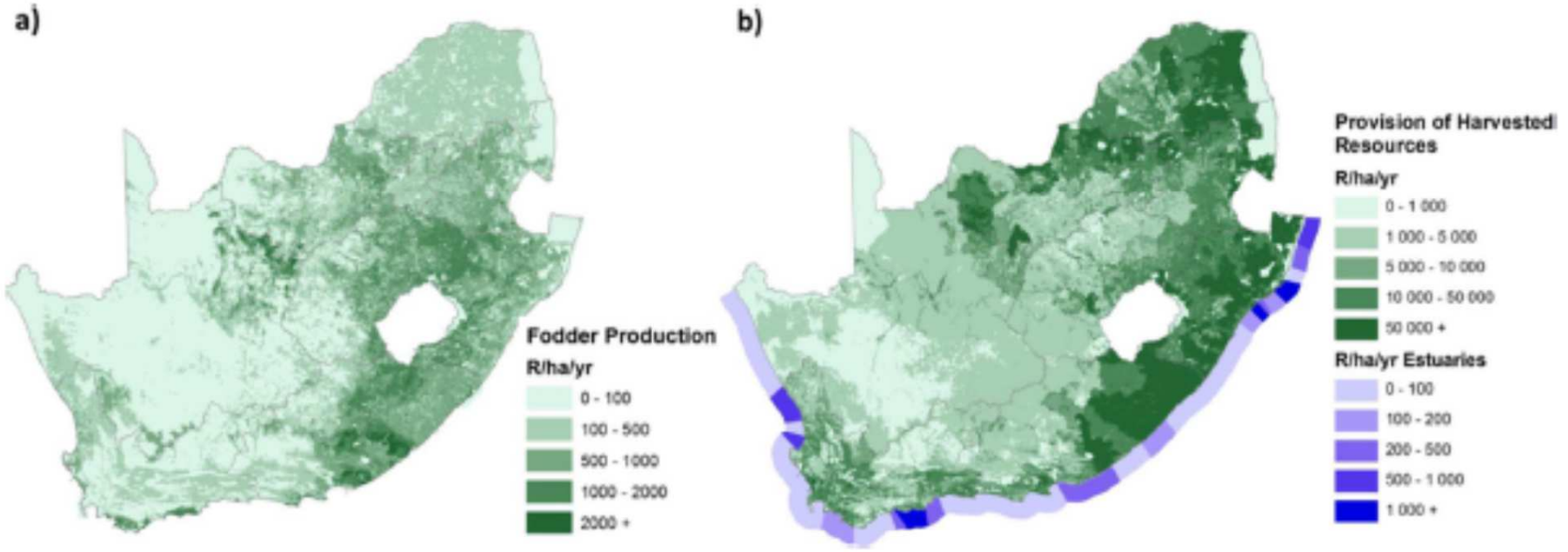
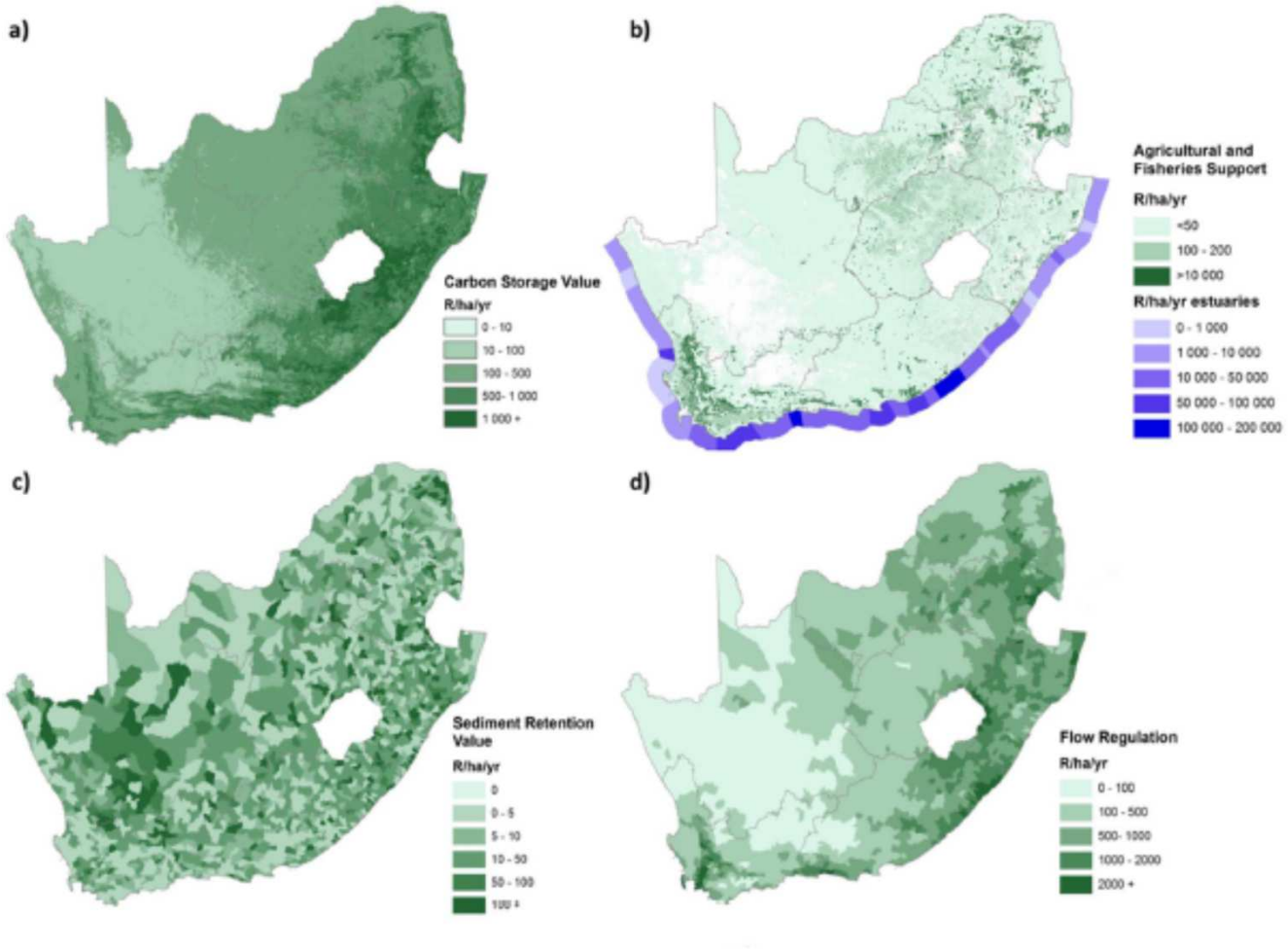


Fig. 3. Value of provisioning services in the form of (a) fodder production and (b) harvested natural resources, including instream water and estuarine/coastal resources.

Source: Turpie et al., 2017

SA - continued



Source: Turpie et al., 2017

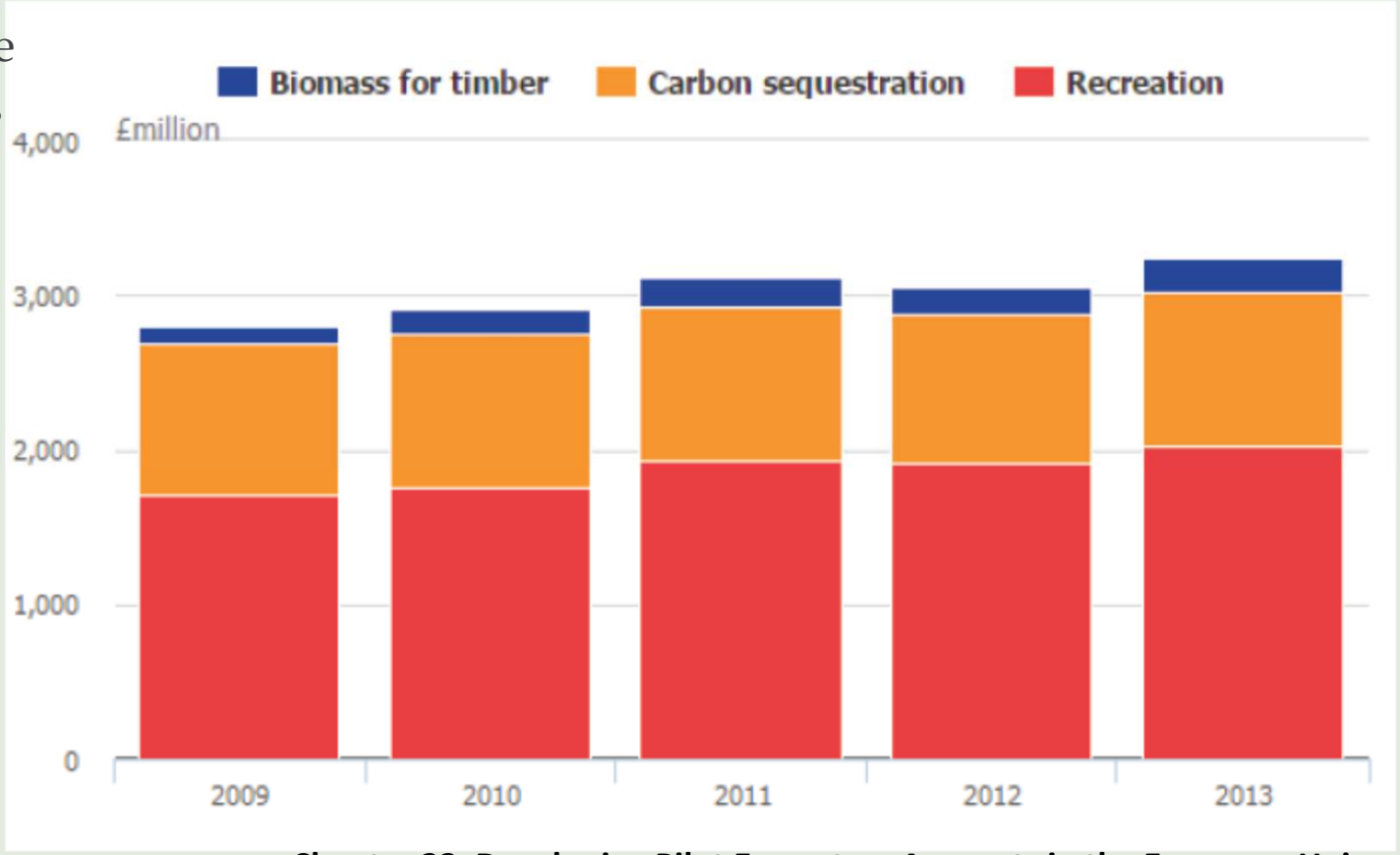
UK

- ET approach
- Also balance sheet values

Box 23.3 The value of a tree: ecosystem services in UK woodland

The UK Office for National Statistics (ONS Woodlands, 2015) studied the values of UK woodland ecosystems. The study considered three ecosystem services (timber production, carbon sequestration and recreation), calculating monetary flows for them. The results are presented in the graph below.

Similar work carried out in Germany, Spain and by EU-funded research projects indicate similar orders of magnitude.



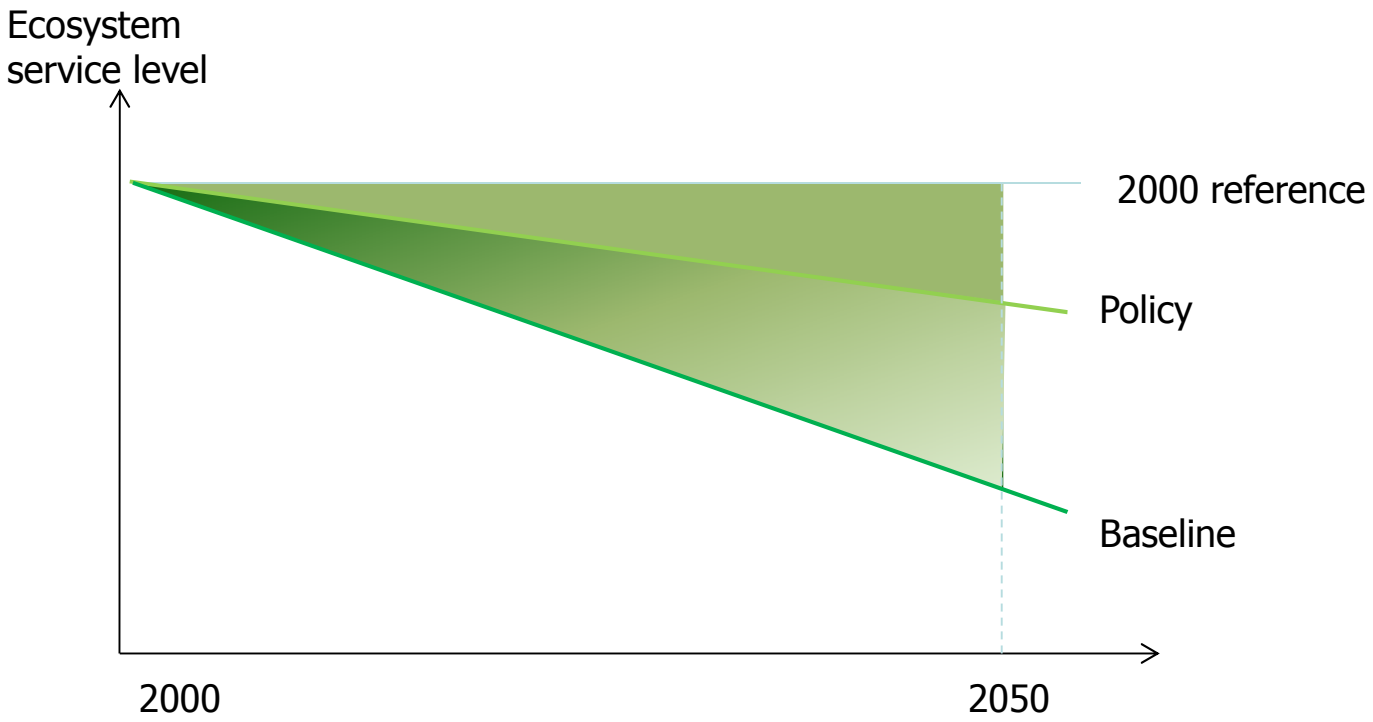
TEEB-funded assessment of global biodiversity losses/interventions

- Significant methodological concerns arise from trying to estimate the *total* value of biodiversity
- Approach of TEEB is to assess *policy interventions,* i.e. marginal changes

The Economics of Ecosystems & Biodiversity

Policy	Policy change	Time scale
Agricultural productivity: closing the yield gap	40% crop and 20% livestock productivity increase (compared to 25% baseline)	2050
Post-harvest sector	Reduce post harvest losses from 30 to 15%	2050
Global agricultural trade	Full trade liberalisation from 2020	2050
Reduced impact logging	Replacement of conventional logging with RIL	2050
Protected areas	Expansion of protected areas from 14% of total land area to: 1.20% of each eco-region 2.50% of each eco-region	2030
Reduced emissions from deforestation and forest degradation (REDD)	Protect from agricultural expansion: 1.All dense forest and 2.All forest and woodlands	2030
Bio-energy	Increase from 0.5 to 4 million km^2 for biomass	2050
Global dietary patterns	1. Global transition to 'healthy diet' 2. Complete substitution of meat with plant protein	2050

- TEEB Quantitative Assessment intends to measure costs and benefits of policy scenarios relative to baseline



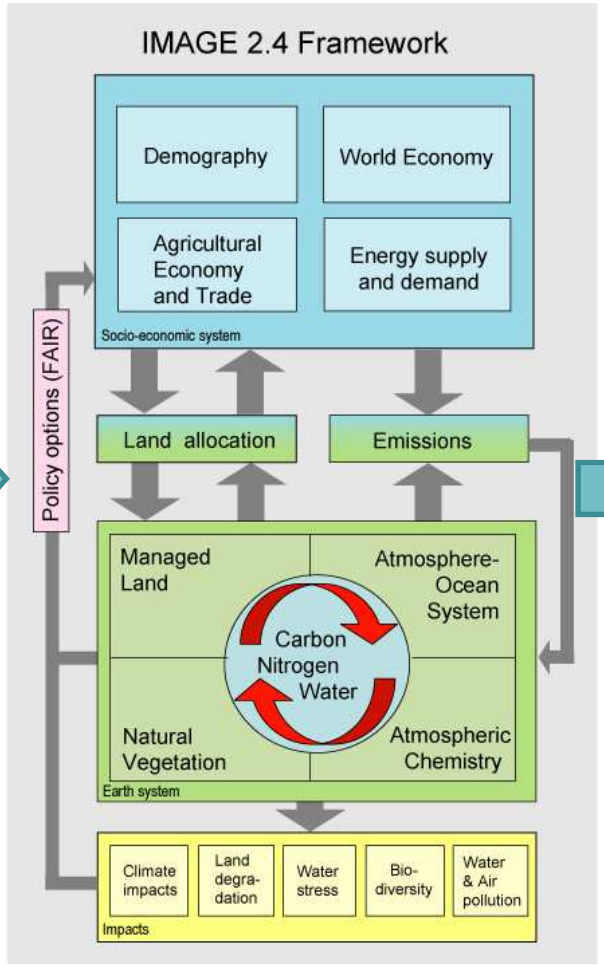
The Economics of Ecosystems & Biodiversity

Indirect Drivers (scenario)

- Population growth
- Economic growth

Policy response options

For example:
- Protected areas
- Agricultural yields



GLOBIO3

Environmental drivers

- Land use
- N deposition
- Infrastructure
- Fragmentation
- Climate change

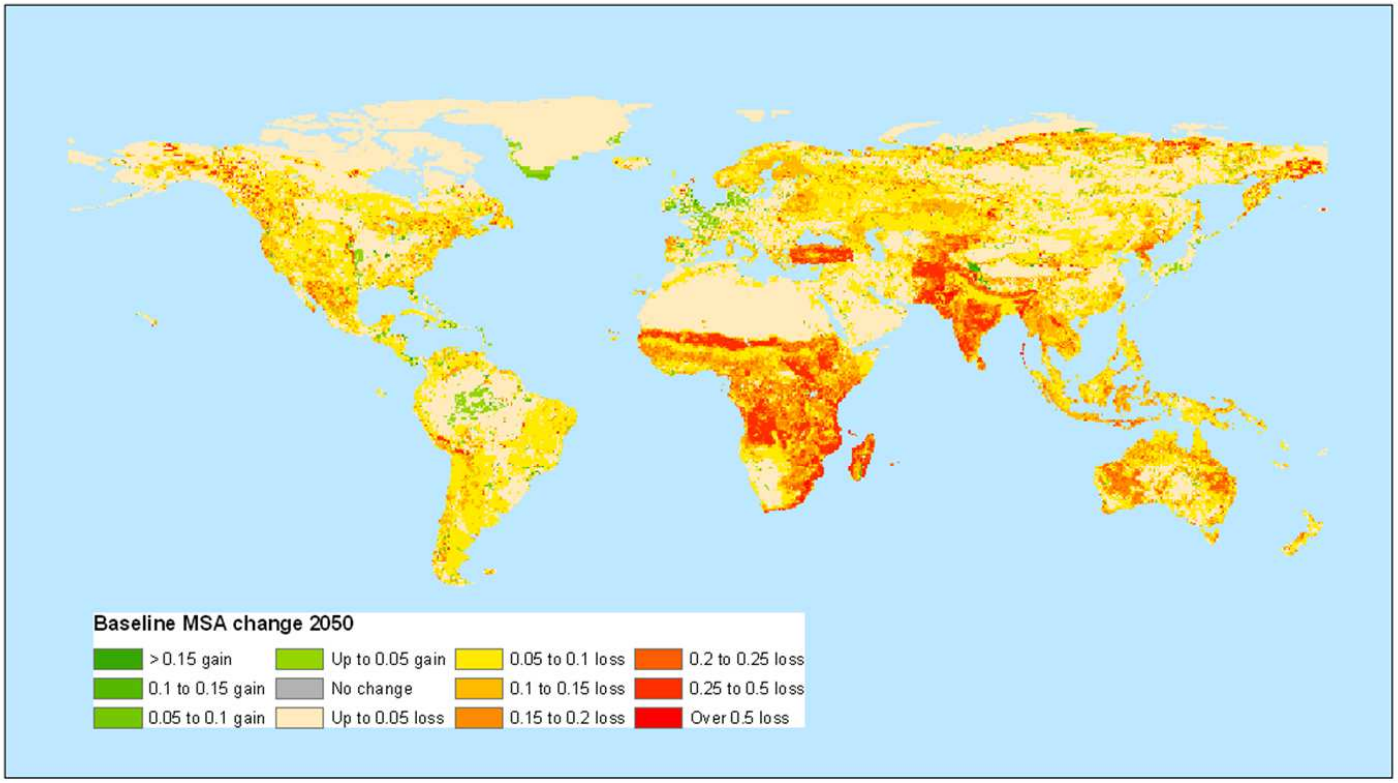
Cause-effect relationships

Biodiversity indicators

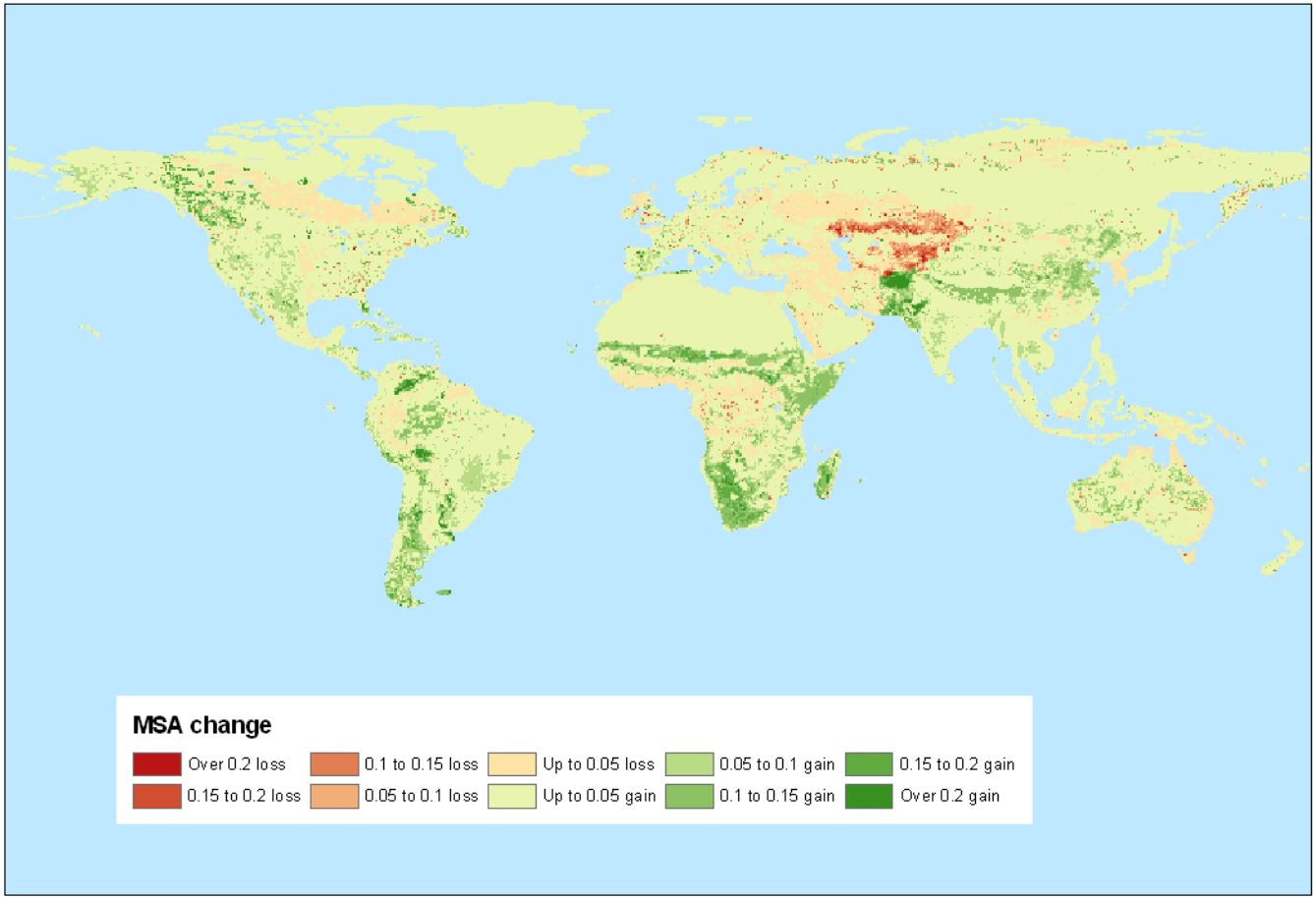
- MSA
- Ecosystem extent

- Baseline developed from OECD projections:
  - *World population* grows from 6 to 9 billion
  - Fourfold increase in *economic output* (~ 2.8% per annum)
  - *Per capita incomes* grow particularly in BRIC countries
  - *Agricultural productivity increases* at 1.8% per annum – does not keep pace with population or consumption patterns
  - No change in *environmental or trade legislation*
  - *Timber demand increases* with population and incomes
  - *Global mean temperature* increases to 1.6ºC above pre-industrial level
  - No change in *protected areas* (14%)

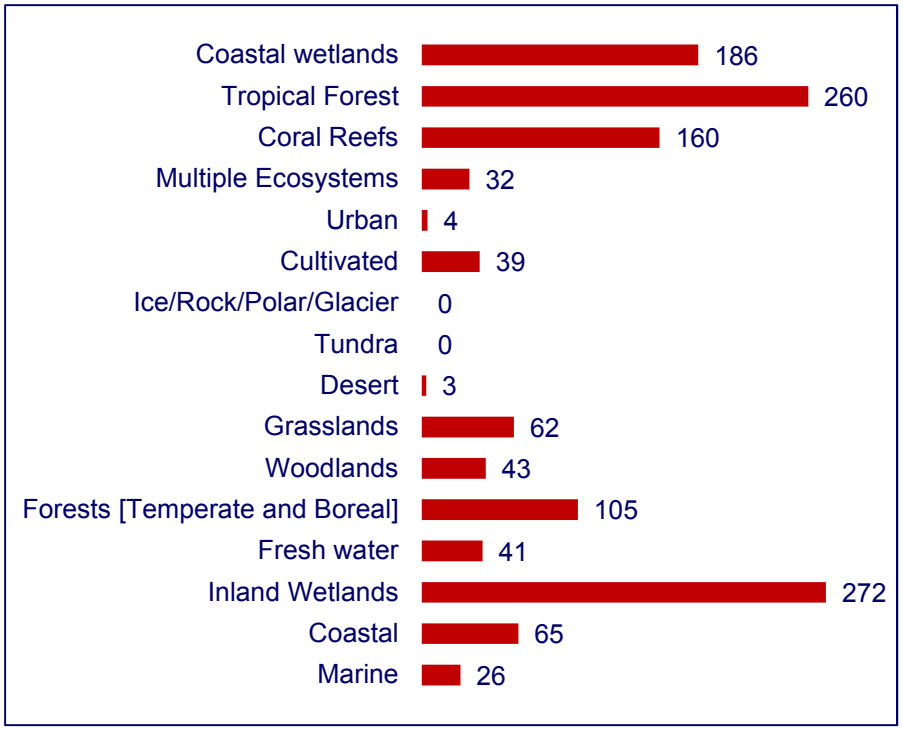
Biodiversity loss by 2050:
The Business As Usual baseline scenario

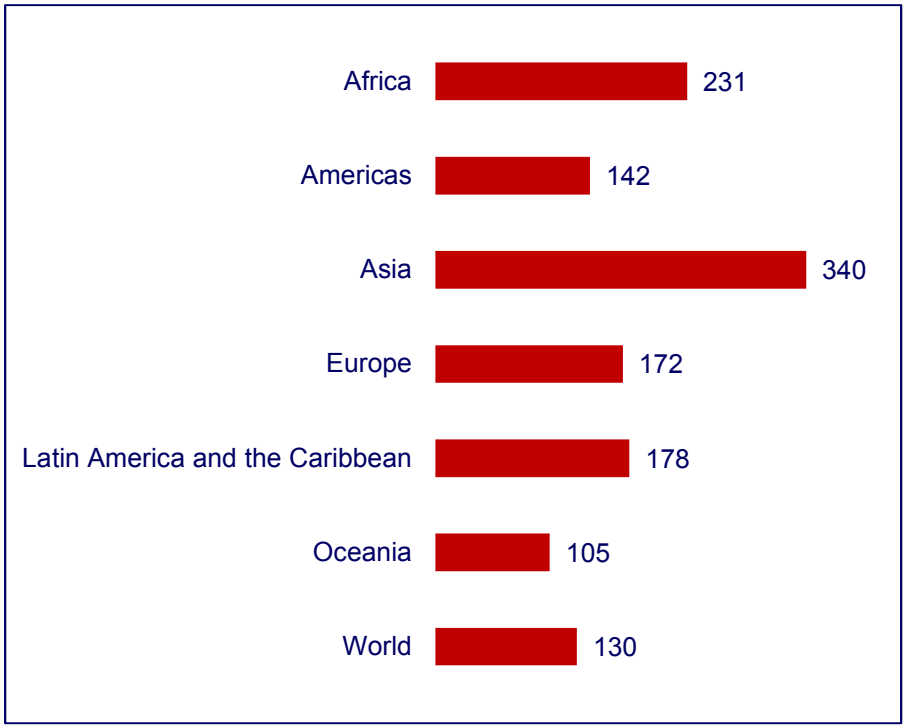


Reducing biodiversity loss in 2050 relative to BAU: Increased investment in Agricultural Productivity



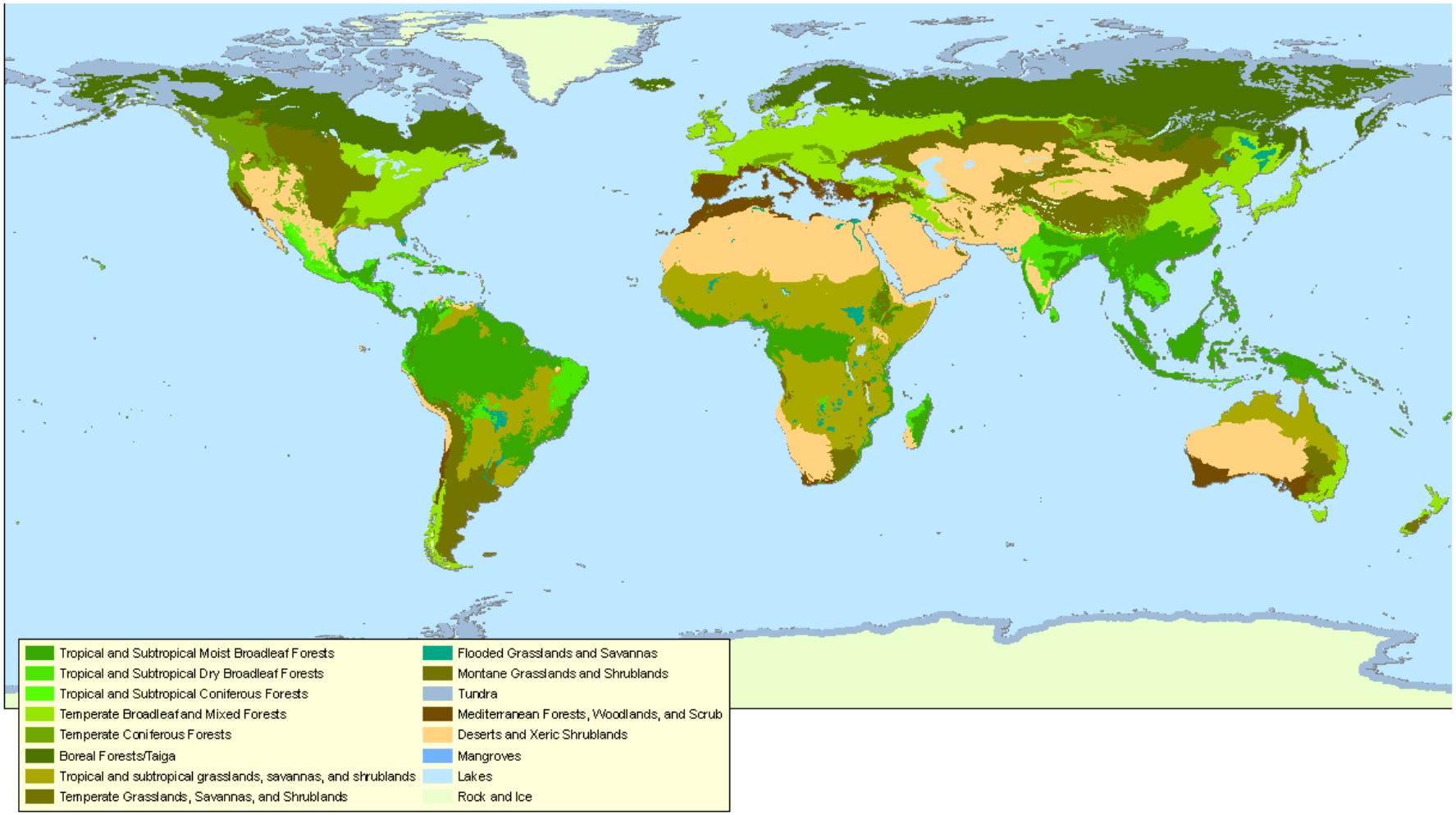
TEEB database 1298 individual value estimates



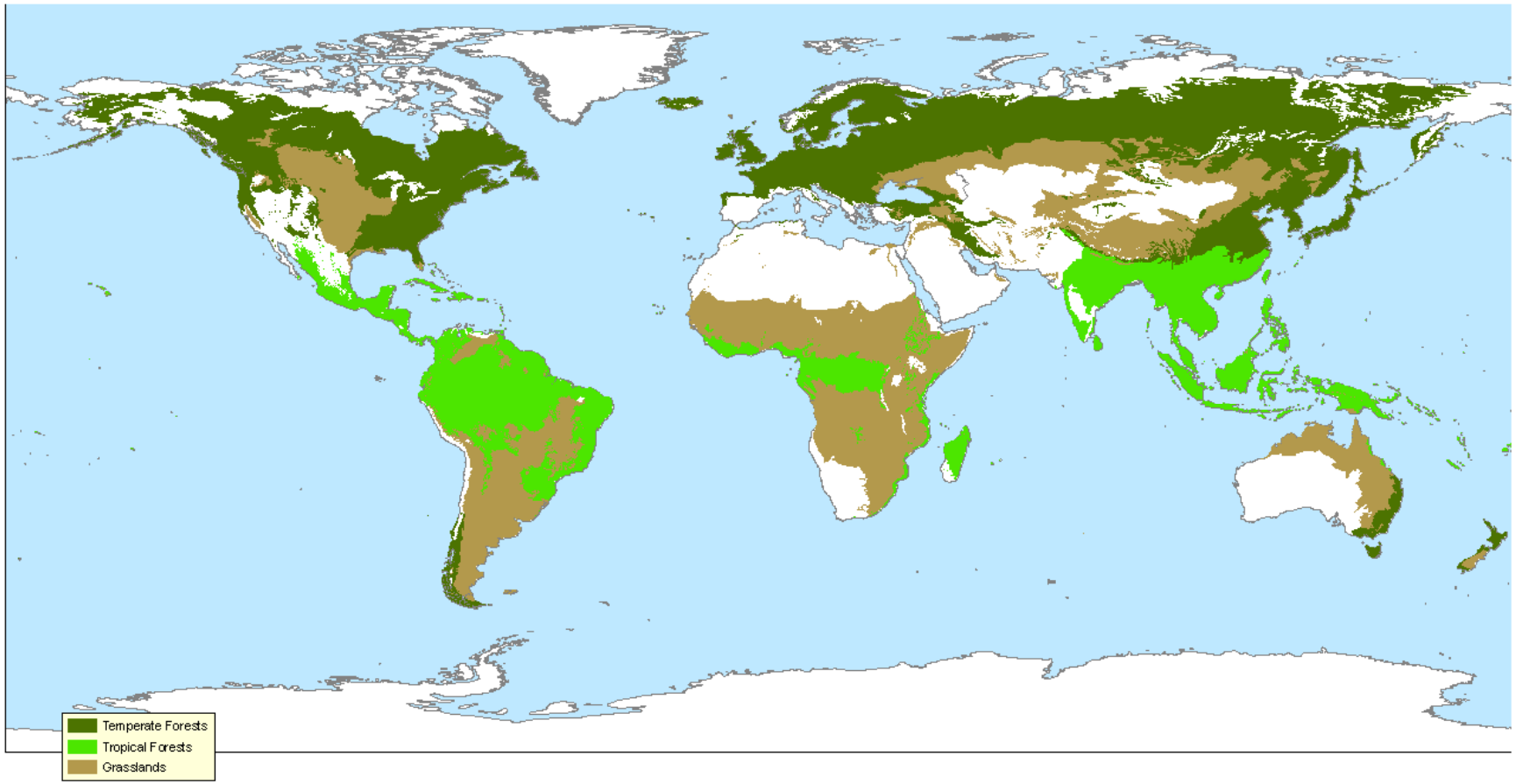


The Economics of Ecosystems & Biodiversity

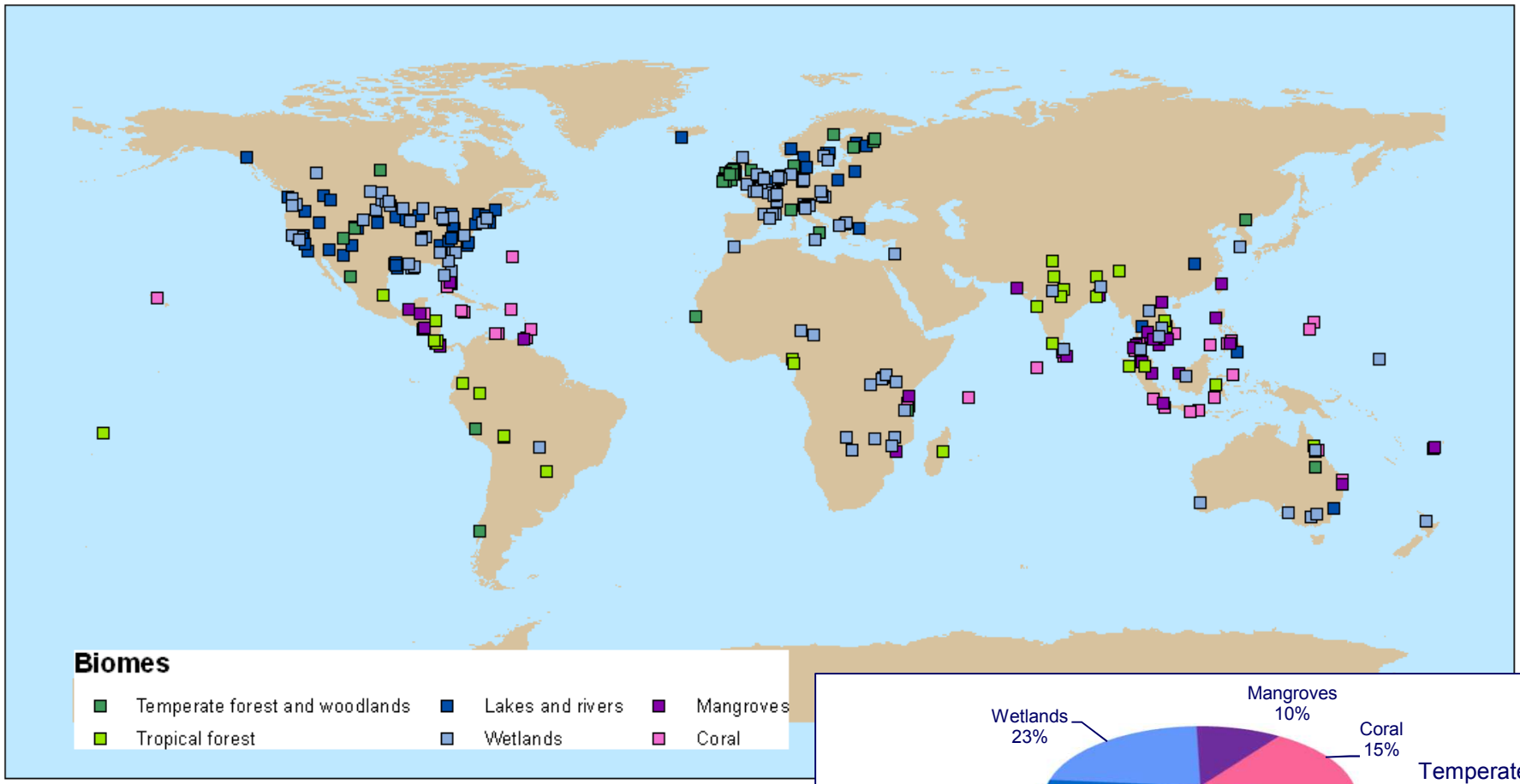
Global Biomes

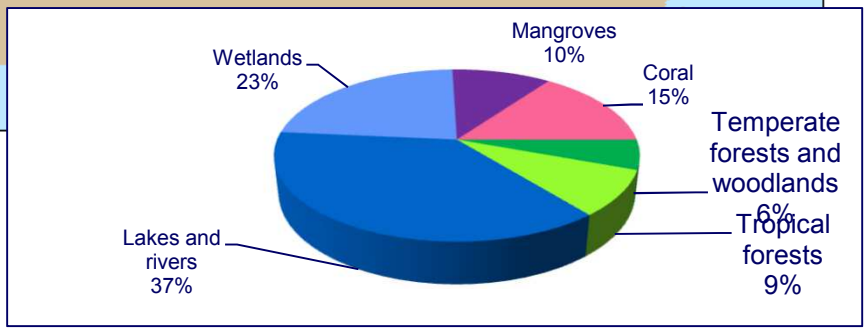


Terrestrial Biomes



Location of study sites





- Additional spatial data within 10, 20 and 50 km radii of each site:
  - Area (ha) of forest, lakes and rivers, mangrove, wetland, grassland, coral reef
  - Population density (person/km^2)
  - Gross cell product (2005$US) – measure of economic output
  - Urban area (ha)
  - Roads (km)
  - Net primary product (gC/m^2/yr)
  - Human appropriation of NPP (gC/m^2/yr)
  - Accessibility index - travel time to urban centres

Forest value functions

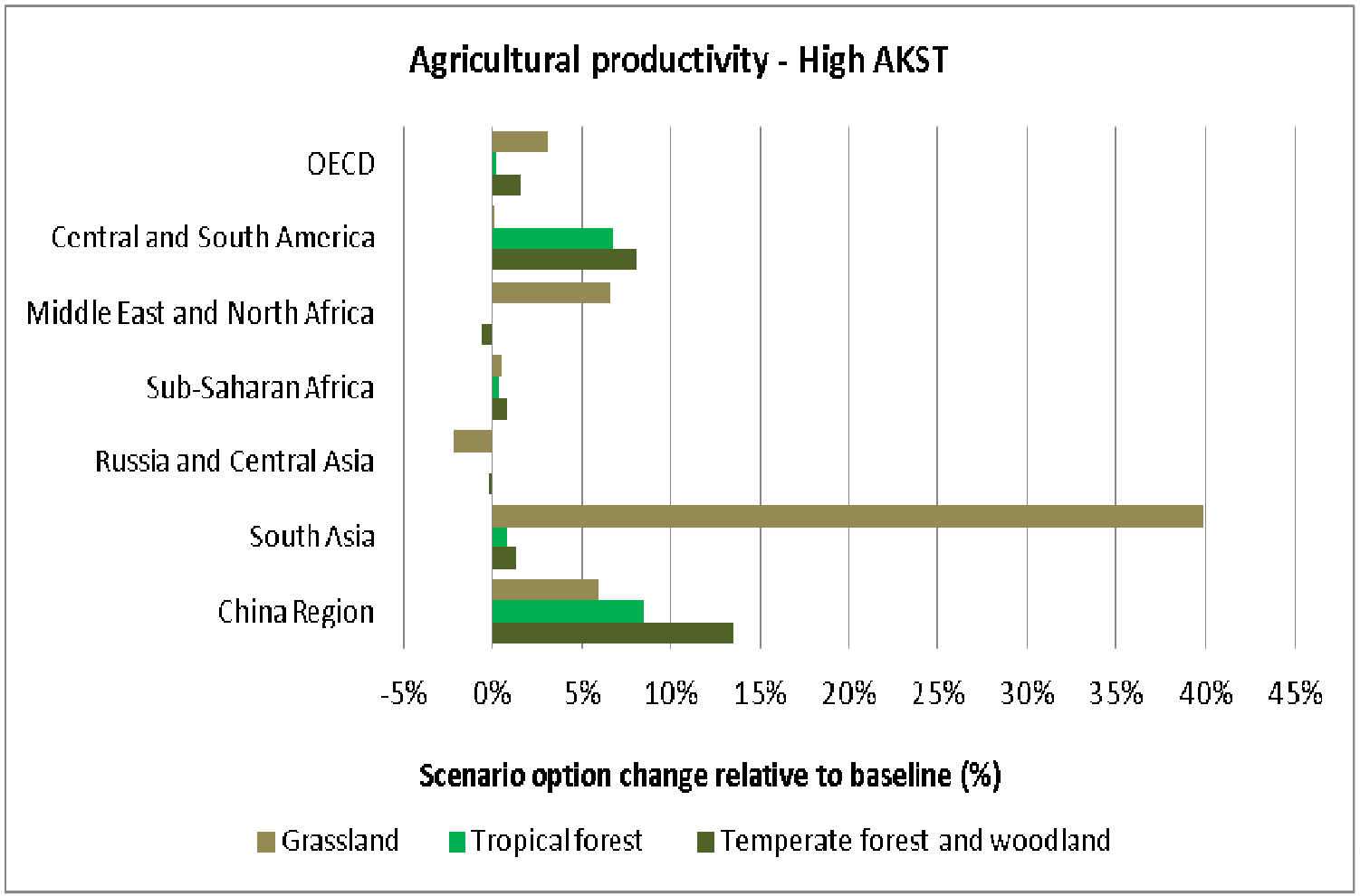
Temperate forest Variable	Beta	Std. Error	Sig.
Constant	28.627	6.124	0.000
Natural log of the study site area	-0.420	0.076	0.000
Natural log of Gross Cell Product within 50km radius	0.247	0.150	0.104
Natural log of urban area within 50km radius of study site	0.245	0.143	0.092
Natural log of human appropriation of NPP within 50km radius of study site	-1.610	0.417	0.000
N	69		
Adjusted R^2	0.348		

Tropical forest Variable	Beta	Std. Error	Sig.
Constant	12.960	4.071	0.002
Natural log of the study site area	-0.230	0.070	0.001
Natural log of Gross Cell Product within 50km radius	0.402	0.173	0.022
Natural log of urban area within 50km radius of study site	0.424	0.121	0.001
Natural log of human appropriation of NPP within 50km radius of study site	-0.394	0.292	0.181
Natural log of area of forest within 50km radius of study site	-0.336	0.202	0.100
Natural log of length of roads within 50km radius of study site	-0.204	0.131	0.124
N	102		
Adjusted R^2	0.392		

Grassland value function

Grassland			
Variable	Beta	Std. Error	Sig.
Constant	-2.366	5.094	0.444
Natural log of country level GDP per capita (PPP US$ 2007)	0.856	0.514	0.120
Natural log of area of grassland within 50km radius of study site	-0.029	0.142	0.839
Natural log of length of roads within 50km radius of study site	-0.225	0.213	0.309
Accessibility index	2.590	1.322	0.072
N	17		
Adjusted R^2	0.27		

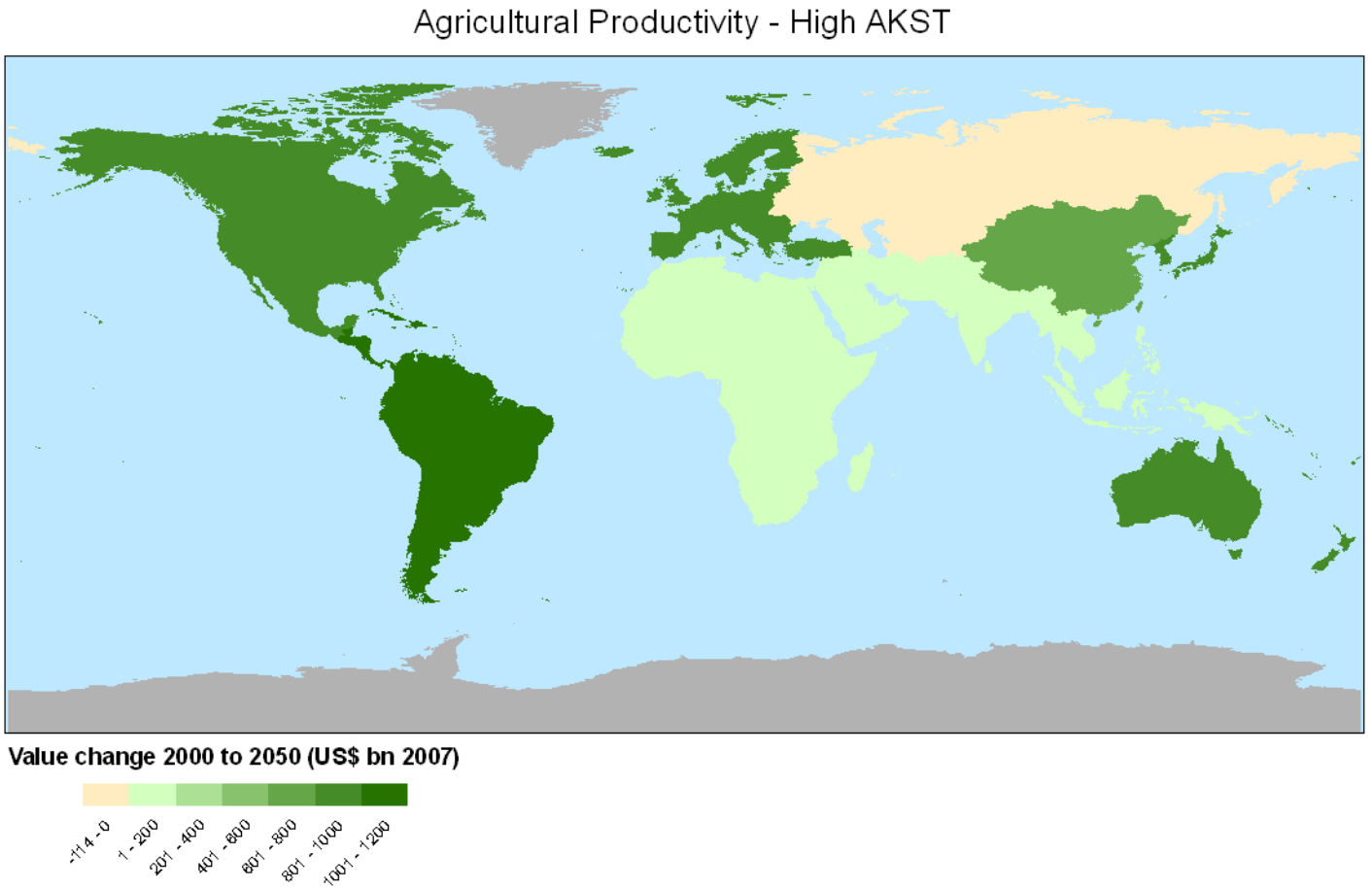
Change in biomes relative to BAU: Investment in agricultural productivity



Results by biome and by Image region:
Investment in agricultural productivity

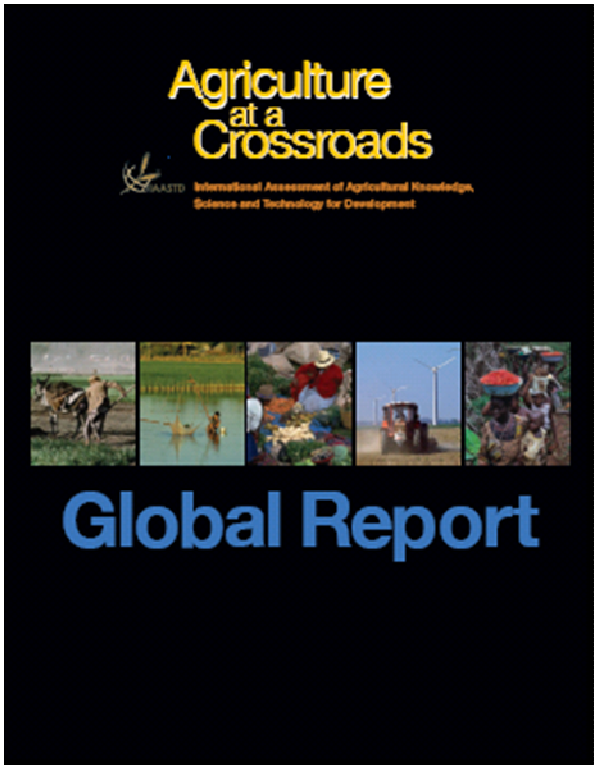
	Grassland			Temperate Forest			Tropical Forest		
	Change in area ('000 km^2)	Mean per ha value (US$ 2007)	Annual value (bn US$ 2007)	Change in area ('000 km^2)	Mean per ha value (US$ 2007)	Annual value (bn US$ 2007)	Change in area ('000 km^2)	Mean per ha value (US$ 2007)	Annual value (bn US$ 2007)
OECD	418.4	645.0	19.7	181.1	23,389.1	28.8	1.9	9,916.5	0.6
Central and South America	4.7	253.3	0.1	57.0	19,630.4	21.2	415.7	8,161.4	41.9
Middle East and North Africa	64.6	325.0	1.7	-0.4	18,264.7	-0.2			
Sub-Saharan Africa	35.2	63.6	0.2	2.4	9,033.3	0.2	21.1	3,897.4	0.8
Russia and Central Asia	-198.2	351.2	-4.1	-15.4	20,198.6	-2.1			
South Asia	461.1	146.1	4.3	5.5	10,886.6	1.5	20.7	7,376.6	3.2
China Region	81.5	232.2	1.5	210.0	17,515.3	40.2	8.0	8,370.8	1.7
Total	**867.3**		**23.4**	**440.3**		**89.6**	**467.6**		**48.3**

Economic value change:
Investment in Agricultural Productivity



An economic appraisal of the Increased Agricultural Productivity Option

- Aggregate benefits (excluding Carbon) 2000 to 2050 = **$2964 bn** at 1% discount rate
- Aggregate cost (IIST, 2009) 2000 to 2050 = **$568 bn**
- B/C ratio without Carbon benefits= **5.2**
- Carbon benefits = **$6343 bn**
- B/C ratio including carbon = **16.4**



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