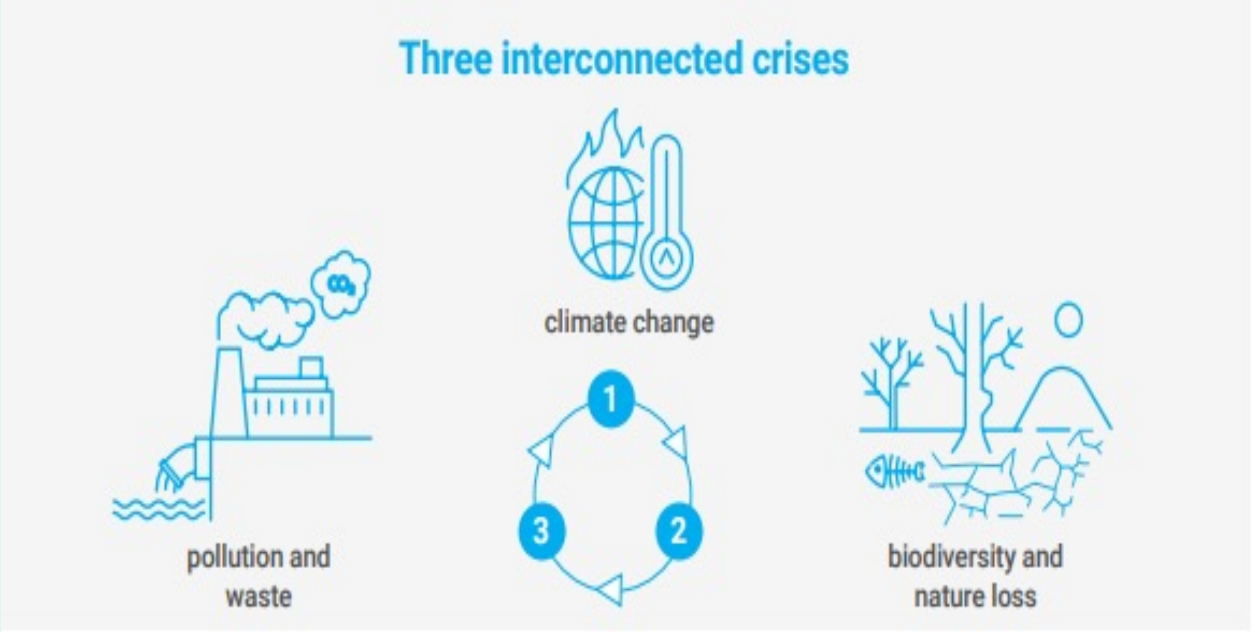
Policy Demand for Ecosystem Accounting

Development of Ecosystem Accounts Using ARIES for SEEA: Training for Country Practitioners
Kigali, 18 July 2022

Dr. Salman Hussain
Head a.i. Economics of Nature Unit,
Biodiversity and Land Branch, Ecosystems Division

Current Policy Context for the SEEA EA



"With science as our guiding light, UNEP seeks to ensure the link between science, policy and decision-making remains stronger than ever, sustained by strong environmental governance and supported by economic policies that can be the foundation of a catalytic response to the challenges of climate change, biodiversity loss and pollution."

– Inger Andersen, Executive Director, UNEP

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Current Policy Context for the SEEA EA: Action Areas

Climate Action

Desired outcomes

- **Decarbonization, dematerialization and resilience**
- Increased capacity, finance and access to **adaptation and mitigation technologies**
- Enhanced **transparency framework** under the Paris Agreement

Example SEEA EA contribution

- Carbon accounts
- Carbon sequestration / retention services
- Climate change impact on ecosystems
- Soil organic carbon

NCAVES policy example

- Mitigation and adaptation impacts of ecosystem restoration in South Africa

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Current Policy Context for the SEEA EA: Action Areas

	Desired outcomes	Example SEEA EA contribution	NCAVES policy example
 **Nature Action**	• **Halt and reverse loss of biodiversity** and enhance ecosystem integrity • **Sustainable land management** • Enhanced **nature conservation and restoration**	• Changes in ecosystem extent, condition, services • Economic assessment of conservation / restoration interventions • Species accounts	• Ecological compensation schemes in southern China • Spatial land use planning in Karnataka, India

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Current Policy Context for the SEEA EA: Action Areas

	Desired outcomes	Example SEEA EA contribution	NCAVES policy example
 **Pollution and Waste Action**	• Optimized human health and environmental outcomes through **sound management of chemical and waste** • Improved waste **management and circularity** • Reduced release of **pollutants to air, water, soil and ocean**	• Condition indicators • Air filtration, soil and water quality regulation ecosystem services	• Effect of agricultural land use change on water and soil in Rio Grande, Brazil

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Current Policy Context for the SEEA EA: Action Areas

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 **Climate Action**	• **Decarbonization, dematerialization and resilience** • Increased capacity, finance and access to **adaptation and mitigation technologies** • Enhanced **transparency framework** under the Paris Agreement	• Carbon accounts • Carbon sequestration / retention services • Climate change impact on ecosystems • Soil organic carbon	• Mitigation and adaptation impacts of ecosystem restoration in South Africa
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Current Policy Context for the SEEA EA: Foundations and Enablers

Science-policy: a foundation

Delivery of **scientifically credible** and unbiased data, information and knowledge to provide **policy-relevant** analysis and recommendations

e.g. Guidance document on Policy Scenario Analysis Using Ecosystem Accounts (UNEP and UNSD, 2021)

Finance and economic transformations: an enabler

Shift **finance and business practices and socio-economic systems** to sustainable production and consumption patterns

e.g. new measures and models of progress, such as Gross Ecosystem Product in China and application of Integrated Economic-Environmental Modelling (IEEM) in Mexico

Environmental governance: a foundation

More effective **legal and institutional** arrangements

e.g. South Africa NCA Strategy Advisory Group and 10-year NCA Strategy; Brazil, India and Mexico Roadmaps to Institutionalizing NCA; Africa NCA Community of Practice

Digital transformations: an enabler

Systematize, integrate and democratize environmental data, knowledge and insight

e.g. ARIES for SEEA and our training programme for this week!

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Links to international policy agendas

- **Sustainable Development Goals** – calculation of indicators including water-related ecosystems (6.6.1), open space in urban areas (11.7.1), forest ecosystems (15.1.1) and land degradation (15.3.1)
- **Post-2020 global biodiversity framework (GBF)** and UN Convention of Biological Diversity (CBD) – measures of ecosystems diversity, their extent, condition and services generated can underpin monitoring of targets and indicators
- **UN Convention to Combat Desertification (UNCCD)** – data and indicators for monitoring progress towards land degradation neutrality
- **UN Decade on Ecosystem Restoration** – costs and benefits of alternative approaches and sites for restoration (e.g. ReLISA: Restoring Landscapes in South Africa)
- **UN Food Systems Summit** – True Cost Accounting for Food Systems

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Policy Scenario Analysis Using SEEA EA

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I What do we mean by ‘policy interventions’, ‘mainstreaming’ and ‘scenarios’?

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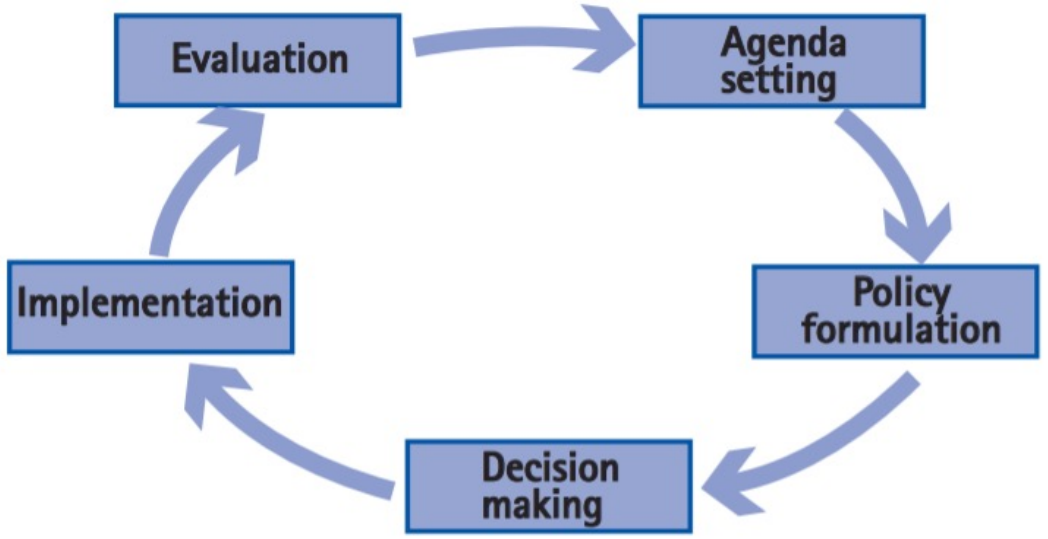
A Stylized Policy Formulation Process

1. The goal is climate mitigation: reduction of GHG emissions



2. The policy options considered are incentives for renewable energy and reforestation

3. The decision is to proceed with reforestation: 500,000 hectares per year

4. Reforestation will be implemented in coordination with local civil society organizations, in areas of strategic relevance

5. The following indicators are monitored: hectares of land reforested, jobs created, increase in carbon storage, income from non timber forest products

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Policy Scenario Analysis and SEEA-EA

- Ecosystem accounts are by nature **backward-looking**: they describe the state of affairs at some point in the past, which may be relevant for a whole range of policies.
- Policymaking is, by contrast, **forward-looking**: it seeks to influence future states of affairs based on decisions taken today.
- **Linking SEEA-EA and policy making:** the use of backward-looking data in forward-looking policy scenario analysis that allows policymakers to assess the possible impacts of their choices.
- Policy Scenario analysis serves the **ultimate goal to improve decision making** in policy areas with many variables involved, by facilitating the comparison of alternative policy interventions.

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The SEEA EA and Policy Scenario Analysis

The use of SEEA EEA can inform the policy making cycle by:

- Contribution to the determination of **where (geo-spatially) new policy interventions are needed**
- Providing consistent and coherent **input data** for simulation models
- Improving the **interpretation and contextualization of scenario** and forecasting exercises
- Providing data for the **calculation of new indicators** to track progress against policy objectives (Monitoring, Reporting and Verification – MRV)

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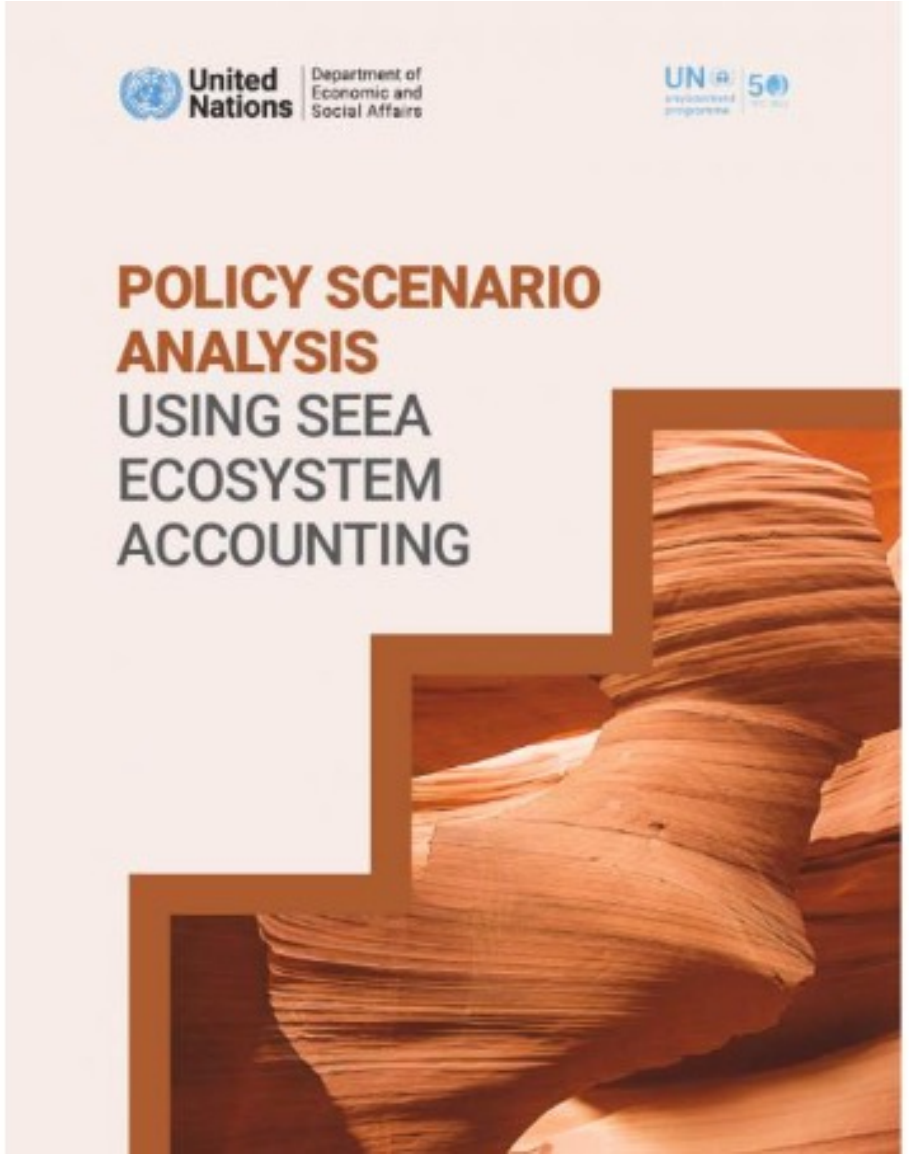
Quantitative models

Thematic models

- Land
- Ecosystem service
- Macroeconomic
- Energy
- Water
- Infrastructure

Cross-sectoral models

- Nested models
- Integrated models



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II The Economics of Ecosystems and Biodiversity (TEEB)

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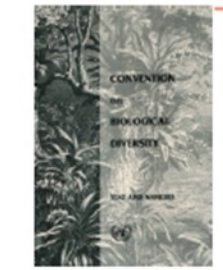

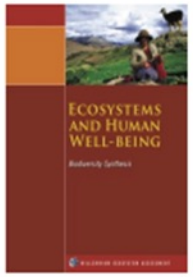

Ecol./Env. Economics literature

G8+5
Potsdam
2007

"Potsdam Initiative – Biological Diversity 2010"

The economic significance of the global loss of biological diversity….

Importance of recognising, demonstrating & responding to values of nature…

Interim Report

CBD COP 9
Bonn 2008

Climate Issues Update

Input to UNFCCC 2009

TEEB End User Reports Brussels 2009, London 2010

India, Brazil, Belgium, Japan & South Africa Sept. 2010

TEEB Synthesis

TEEB Books

BD COP 10 Nagoya, Oct 2010

CBD COP11 India

National TEEB Work

Sectoral TEEB Work

Business Externalities Work

Rio+20 Brazil

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The TEEB Six Step Approach

STEP 1: Refine the objectives of a TEEB Country Study by specifying and agreeing on the key policy issues with stakeholders

STEP 2: Identify the most relevant ecosystem services

STEP 3: Define information needs and select appropriate methods

STEP 4: Assess and value ecosystem services

STEP 5: Identify and outline the pros and cons of policy options, including distributional impacts

STEP 6: Review, refine and report: Produce an answer to each of the questions

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Agro-forestry study

- Agroforestry is a practice involving the **deliberate integration of trees or shrubs in farming landscapes** involving crops or livestock in order to obtain benefits from the interactions between trees and/or shrubs the tree and crop or livestock component

- Global extent of agroforestry over **1 billion hectares of land**, supporting more than **900 million people**, mostly in the tropical and sub-tropical (Zomer et al. (2014)

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Agro-forestry case studies

Selection criteria	Cocoa agroforestry Ghana	Coffee agroforestry Ethiopia	Ngitili system Tanzania
Trend of agroforestry system	Increased by about twice the area in the 1990s to about 1.6 million ha (FAOSTAT 2013)	Increased by 100% since the 1990s to about 520,000 ha (FAOSTAT 2013)	Increased from **600 ha in 1986 to >350000 ha in 2003** (Mlenge 2004)
Number of people benefiting from the system	Between 1.9 million (Coulombe & Wondon 2007) to 6 million people (Anthonio and Aikins, 2009) - 700,000 smallholder farmers (Kolavalli & Vigneri 2011)	**7 million to 15 million people** (Petit 2007); 95% of the coffee produced by smallholder farmers About 4.5 million smallholder farmers (Central Statistical Agency 2013)	No data available, but estimated about 1500 households employed in Shinyanga's formal and informal forestry sector, in which ngitili products play a major role
Contribution to national economy	18.9% of the agricultural GDP; 8.2% of the Ghana's GDP and 30% of total export earnings (GAIN, 2012)	**36% of national export income in 2006/07** (Ejigie 2005) *Approximately* 10% of national GDP (Economic Report on Africa 2013)	No data available but estimated to contribute approximately 0.43% of Shinyanga region's GDP

www.teebweb.org/agriculture-and-food/agroforestry

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Agro-forestry: Credible Scenarios I

1. In Ethiopia, the rate of deforestation is estimated at **1-1.5% per year** (Teferi et al. 2013), mostly driven by smallholder coffee expansion (Davis et al. 2012)
2. Coffee profitability is very low in smallholder agroforestry systems in Ethiopia, mostly due to **volatility in global market prices**
3. Climatic predictions show that areas bio-climatically suitable for coffee production may **reduce by 65%** (Davis et al. 2012)

Agro-forestry: Credible Scenarios II

I: Conversion to maize monocrop - drivers:

- price volatility
- climate change
- allocation of land to investors for biofuel

II: Conversion existing agroforestry coffee to heavy shade grown coffee – drivers:

- ongoing Climate Resilience Green Growth Strategy
- the national REDD+ program
- certification programs and improvements in land tenure conditions

III: Conversion and further expansion of heavy shade grown coffee – drivers:

- contingent on success of scenario II

Agro-forestry: Modelling

The **WaterWorld model** was also used to model ecosystem services change

- freshwater provision and runoff
- increased water quality
- above ground carbon stock
- reduction of soil erosion

Agro-forestry valuation methods

Ecosystem Service	Agroforestry System			Valuation Method
	Cocoa	Coffee	Ngitili	
Provisioning				
Cash Crops	***	***	N/A	Market price[16]
Food Crops	***	***	***	Market price
Tree Crop Products	***	***	N/A	Market price
Medicines	*	*	***	Shadow price[17], replacement cost
Wild Food and all other NTFP	*	***	***	Shadow price
Timber and Poles	***	***	***	Market price
Energy (Wood fuel and Charcoal)	*	***	***	Market price, shadow price, replacement cost
Regulating and Supporting				
Soil and biomass C stocks	***	***	***	Market price, avoided cost
Erosion control	ND	***	ND	Contingent valuation, replacement cost
Soil fertility (Soil N also P and K where available)	**[18]	**	***	Replacement cost
Biological Pest Control	**	**	ND	Insufficient data for benefit transfer
Pollination	**	**	N/A	Insufficient data for benefit transfer
Biodiversity	**	**	**	Insufficient data for monetary valuation
Avian Diversity	**	**	**	Insufficient data for monetary valuation
Vegetative Diversity	**	**	**	Insufficient data for monetary valuation
Other mammalian diversity	**	ND	ND	Insufficient data for monetary valuation

*** Sufficient data for biophysical quantification and monetary valuation;
** Quantitative biophysical data available, but insufficient data for monetary valuation;
* Qualitative information available; ND No relevant data available; N/A No applicable

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Agro-forestry valuation outcomes

Ecosystem service	Scenario 1: Converting to Maize monoculture (million $/y)	Scenario 2: Canopy cover ≥ 30% [due to REDD+ or certification incentive] (million $/y)	Scenario 3: Canopy cover ≥ 30% & expansion of agroforestry to all areas bar: (I) urban; (II) priority land use such as forests; and (III) wildlife reserves (million $/y)
Increase in system extent (ha)	-202,342	0	+286,852
Provisioning	**-38.4**	**No change**	**73.4**
Coffee	-115.9	No change	+143.9
Maize	+90.5	No change	-128.3
Other ES (fuel wood, honey)	**-13.0**	**No change**	**+57.9**
Carbon regulation	**-435**	**+292**	**+655**
Other regulating	**-19**	**+74.5**	**+54.3**
Water yield	-34.9	+58.6	+10.7
Soil erosion	+15.9	+15.9	+43.6

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Agro-forestry: How could SEEA-EA have helped?

1. Researchers from ICRAF/WCMC used *whatever data were available to them*. A centralized repository of data in a standardized form (i.e. via SEEA-EA) might have thus improved the modelling

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2. This is ultimately a policy decision on *ecosystem extent* (agro-forestry versus maize) and one that affects/is affected by *ecosystem condition* (canopy cover). The unit of account was changes in Ecosystem Services provisioning. This is the SEEA-EA space

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3. If NSOs were to be involved then that might change the *potential for policy uptake*, if they linked with other Line Ministries

1. In Indonesia, the TEEBAgriFood assessment was sent to the President's Office and was used **to support the inclusion (for the first time) of agroforestry goals** in the Medium-Term Development Plan (Executive Order 18/2020)
2. In the Philippines, a TEEB process was held to look at the impact on ecosystem service provisioning of converting a proposed land reclamation area in Manila Bay. As a result, there was a **moratorium on land reclamation in Manila Bay** in 2019, with arguments from the TEEB analysis being used by the Biodiversity Management Bureau in their submissions.
3. In Bhutan, a TEEB process brought the hydropower energy and the conservation sector together for the first time, conducting a joint analysis. Planned hydropower projects in Bhutan have been down-sized and **targeted up-stream sustainable land use management programs ensure regular and reliable water flow** and deliver benefits to local communities.

Three-minute snapshot on policy impact TEEB Philippines:
https://www.youtube.com/watch?v=jD2ufFKW4hk&t=140s

Two-minute snapshot on policy impact TEEB Bhutan:
https://www.youtube.com/watch?v=ypuFYnLb4J4

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III Examples from the EU-funded SEEA-EA project (UNSD-UNEP):

NCAVES - Natural Capital Accounting and the Valuation of Ecosystem Services

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Policy application: Eco-compensation schemes in China

Inter-provincial compensation Xijiang River Basin – Guangxi, Guizhou, Yunnan, Guangdong

"We will improve systems for regeneration of croplands, grasslands, forests, rivers, and lakes, and set up diversified market-based mechanisms for ecological compensation." President Xi's speech to 19th National Congress of the Communist Party of China

- Various pilot schemes for eco-compensation trailed (grain-for-green, sloping land conversion, grassland restoration etc.). A central question remains: how much should 'users' of ecosystem services compensate 'providers'?

→ Role for SEEA EA to map and value ecosystem services to calibrate compensation

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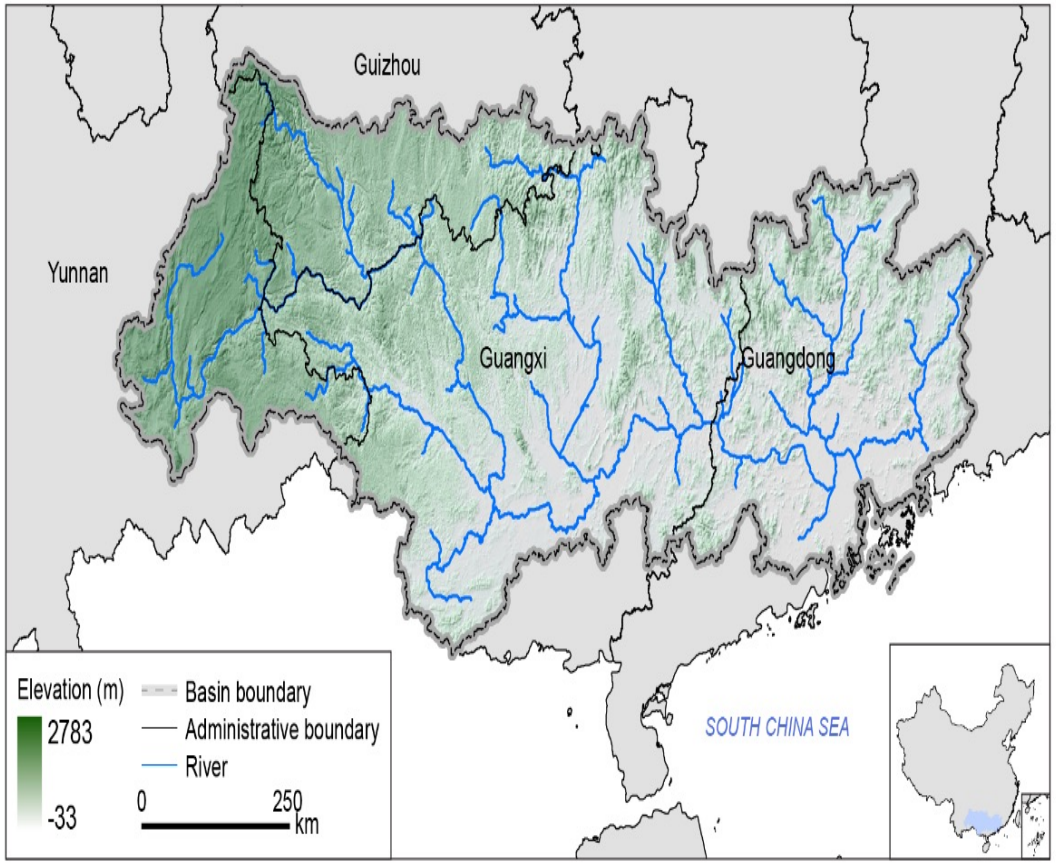
Policy application: Eco-compensation schemes in China

Inter-provincial compensation Xijiang River Basin – Guangxi, Guizhou, Yunnan, Guangdong provinces



RCP8.5

A high pathway in which radiative forcing reaches greater than 8.5 W m^{-2} by 2100.

RCP4.5

A stabilization pathway in which radiative forcing is stabilized at ~ 4.5 W m^{-2} after 2100.

Greenhouse gas emission \ Strength of human disturbances	Ecological Protection Priority	Business As Usual	Economic Development Priority
RCP8.5	RCP8.5 – ECOL: Enhanced protection and restoration of ecological lands with a high emission goal.	RCP8.5 – BAU: Baseline: continued historical trend of land use changes over next years with a high emission goal.	RCP8.5 – ECON: Increased expansion of urban land with a high emission goal.
RCP4.5	RCP4.5 – ECOL: Enhanced protection and restoration of ecological lands with a low emission goal.	RCP4.5 – BAU: Baseline: continued historical trend of land use changes over next years with a low emission goal.	RCP4.5 – ECON: Increased expansion of urban land with a low emission goal.

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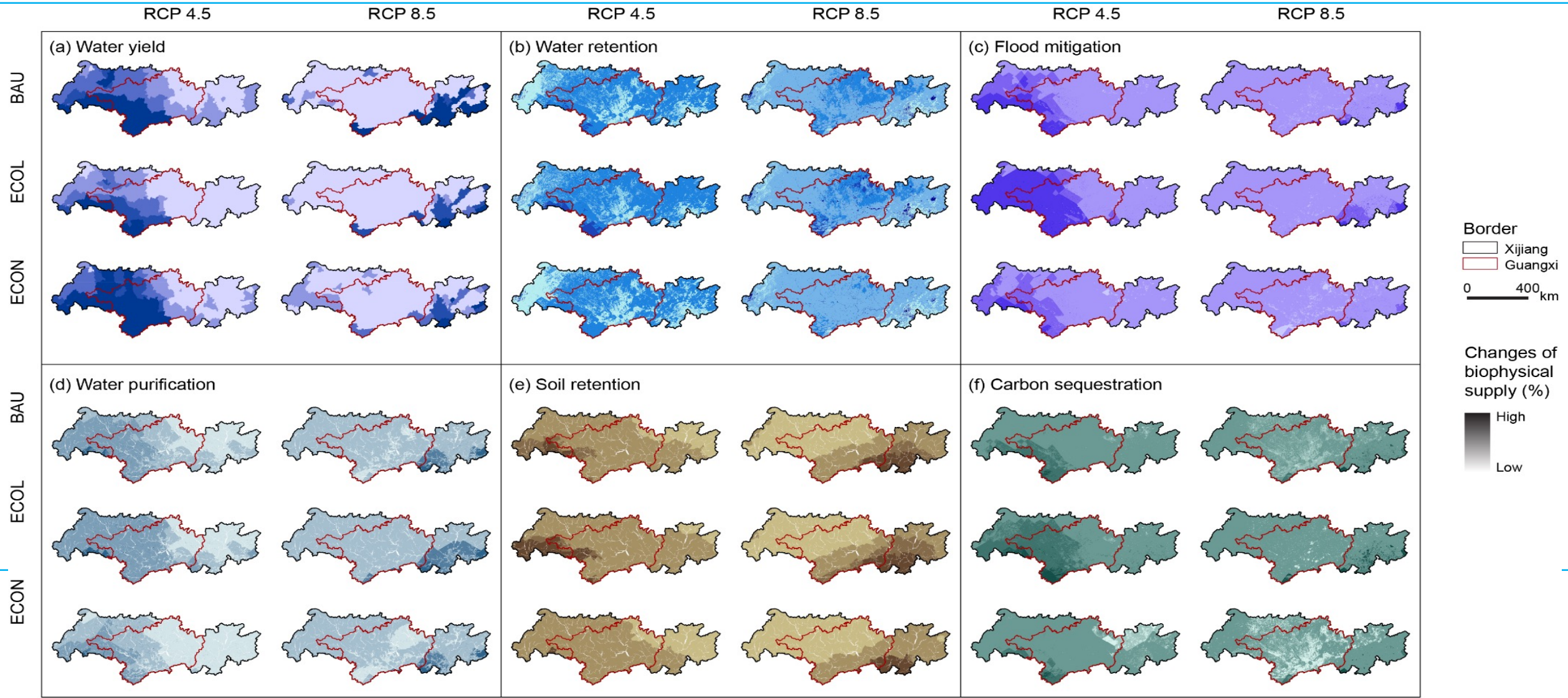
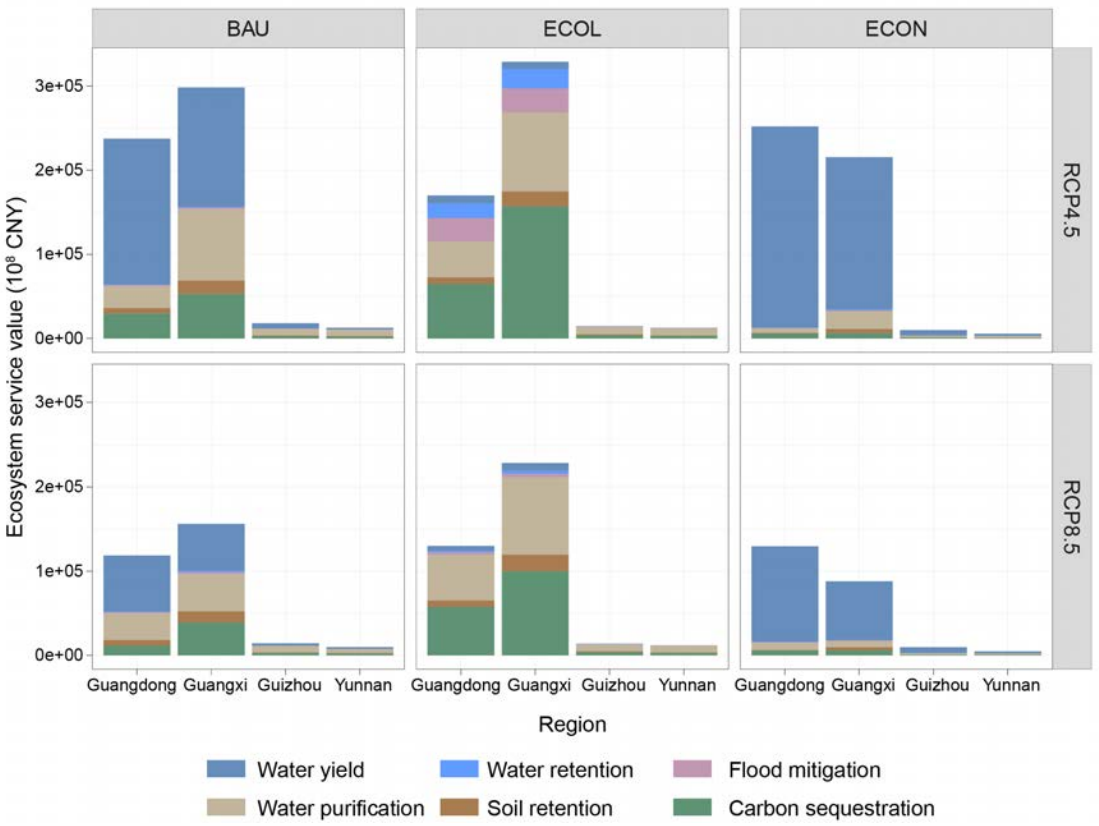
Policy application: Eco-compensation schemes in China

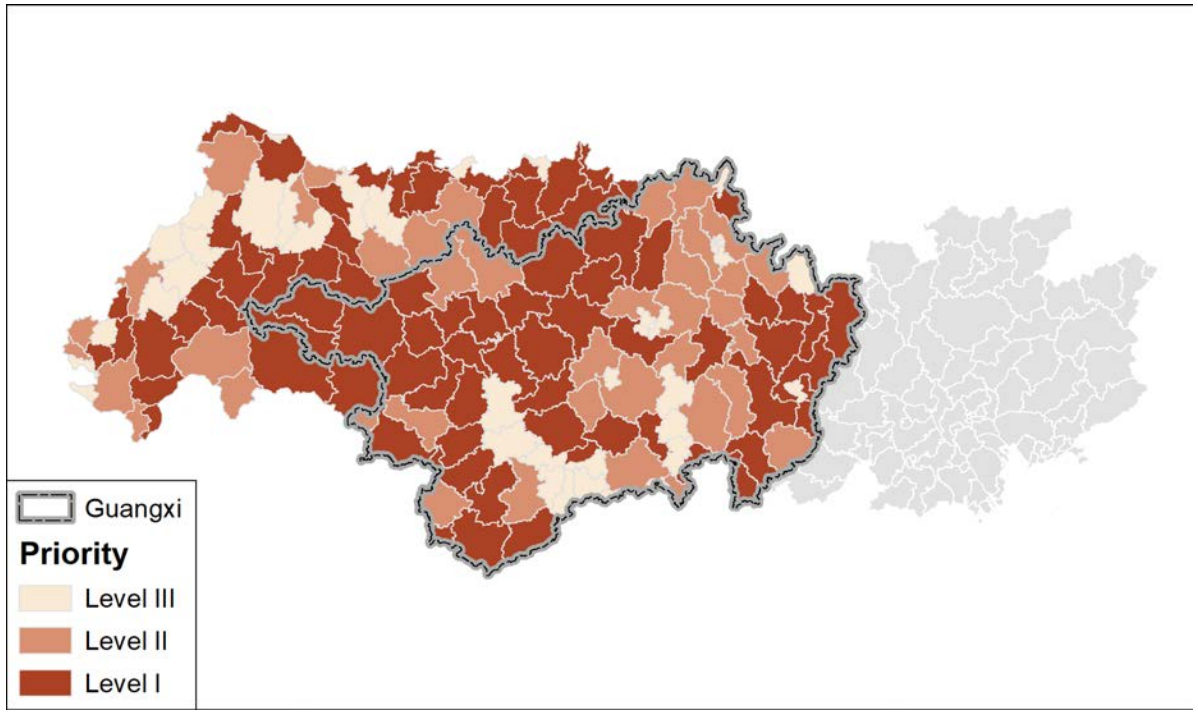
Changes in the spatial distribution of the biophysical supply of ecosystem services for 2035 under different climate and land cover scenarios



Policy application: Eco-compensation schemes in China

Ecosystem service values for different regions of Xijiang basin under different climate and land cover scenarios in 2035 is used to map priority areas for ecological compensation, to more accurately calibrate the scheme.





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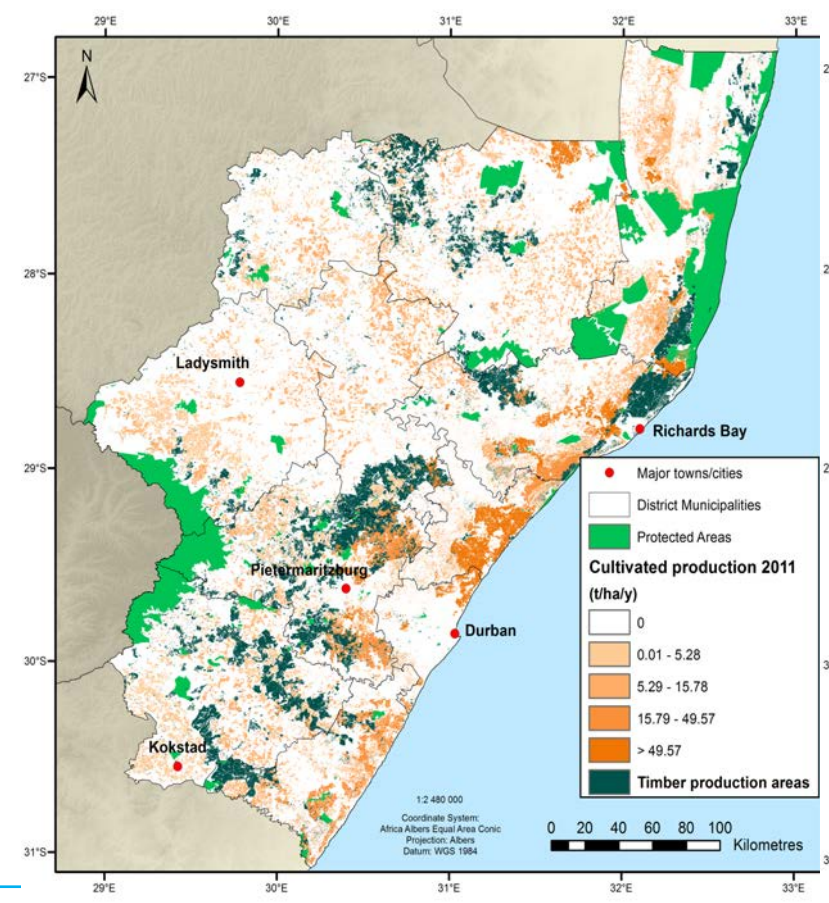
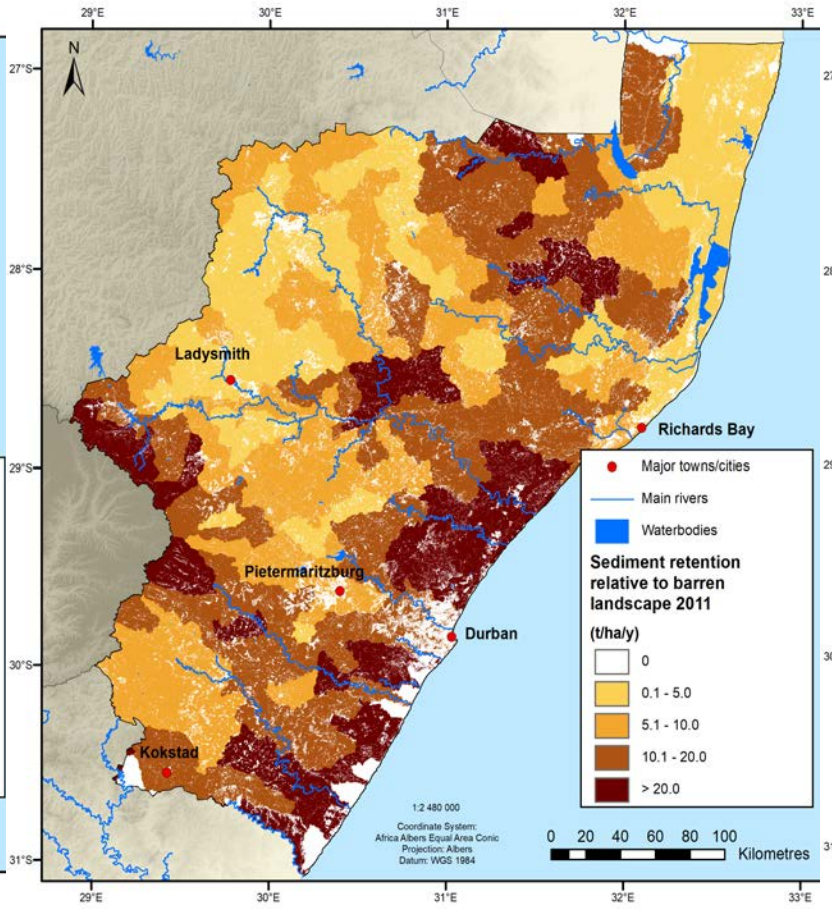
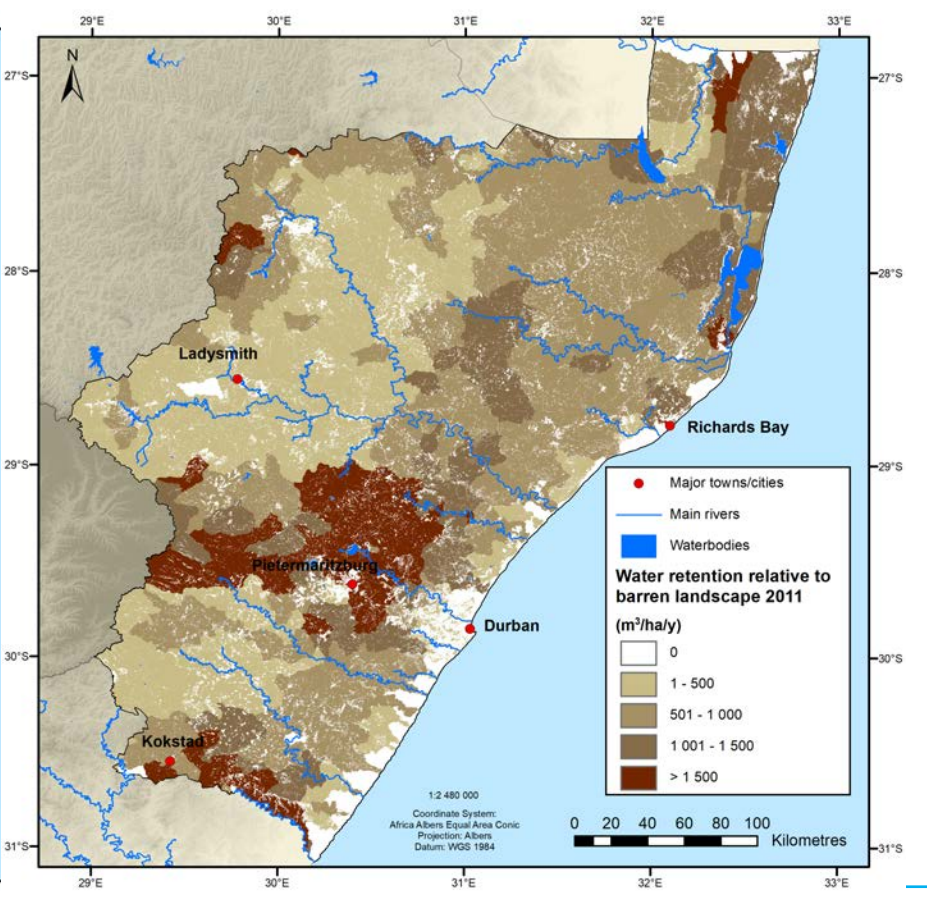
Ecosystem services accounts (biophysical) – KwaZulu Natal South Africa

Spatially-explicit data on provision of ecosystem services – water retention, crop provisioning, and sediment retention shown here, but results for a suite of eleven ecosystem services







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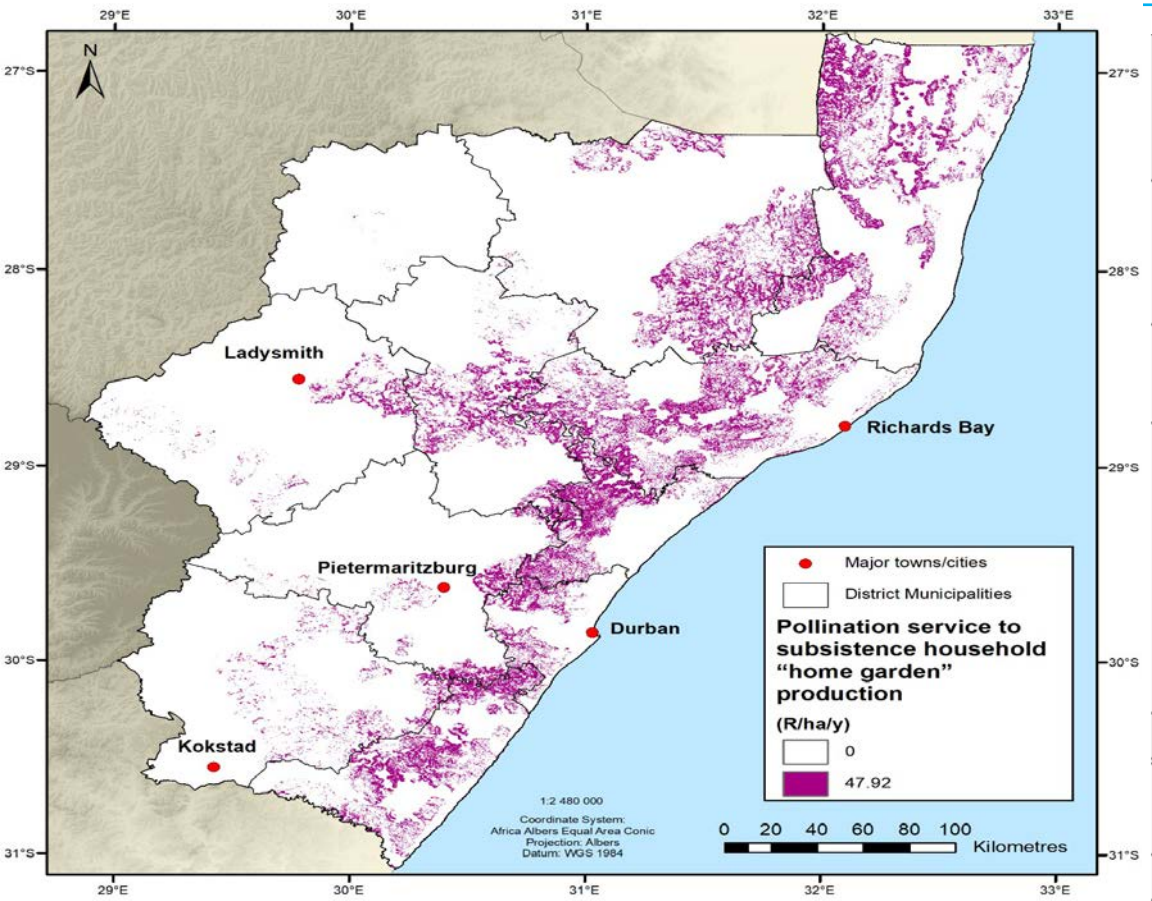
Ecosystem services accounts (monetary) – KwaZulu Natal South Africa

Spatially-explicit data on value of ecosystem services, and trends over time



Class	Ecosystem service	2005		2011	
		Annual flow R millions	Asset value R millions	Annual flow R millions	Asset value R millions
Provisioning	Wild resources	3 722.16	32 032.23	3 180.25	28 440.48
	Animal production	1 672.99	27 100.67	1 472.87	23 859.03
	Cultivation	6 456.70	104 591.91	7 535.43	122 066.22
Cultural	Nature-based tourism	532.83	8 631.31	798.83	12 940.22
	Property	1 164.97	18 871.27	1 327.78	21 508.60
Regulating	Carbon storage (global value)	29 922.56	484 745.42	34 579.34	560 185.33
	Pollination	51.26	830.33	47.69	772.50
	Flow regulation	3 247.87	52 612.12	3 166.78	51 298.55
	Flood attenuation	31.02	502.49	23.50	380.68
	Sediment retention	435.79	7 059.28	330.40	5 352.18
	Water quality amelioration	20.40	330.46	16.03	259.67
Total		**47 258.53**	**737 307.48**	**52 478.90**	**827 063.46**
Value of flows and asset values in 2005 and 2011 when using national carbon values					
Regulating	Carbon storage (national)	236.39	3 829.49	273.18	4 425.46
Total		**17 572.38**	**256 391.56**	**18 172.74**	**271 303.59**

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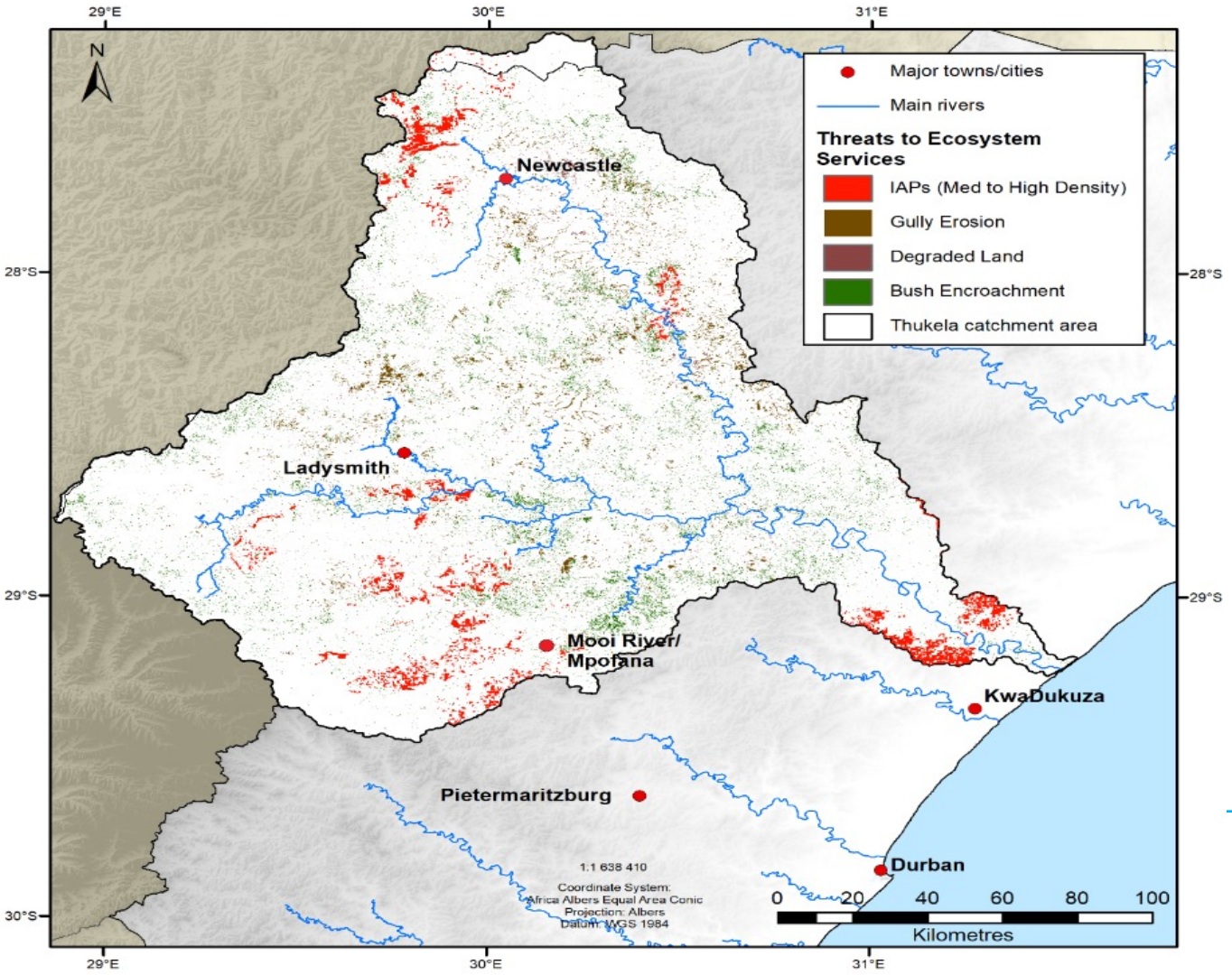
Policy application: Ecosystem restoration in South Africa

Cost-benefit analysis of ecosystem restoration programmes in Thukela river basin, KwaZulu Natal



Policies:

Extension services

Betterment schemes

Natural Resource Management Programmes

e.g. ‘Working for Water’

2030 Land Degradation Neutrality target, UNCCD and SDGs

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Policy application 2: Ecosystem restoration in South Africa

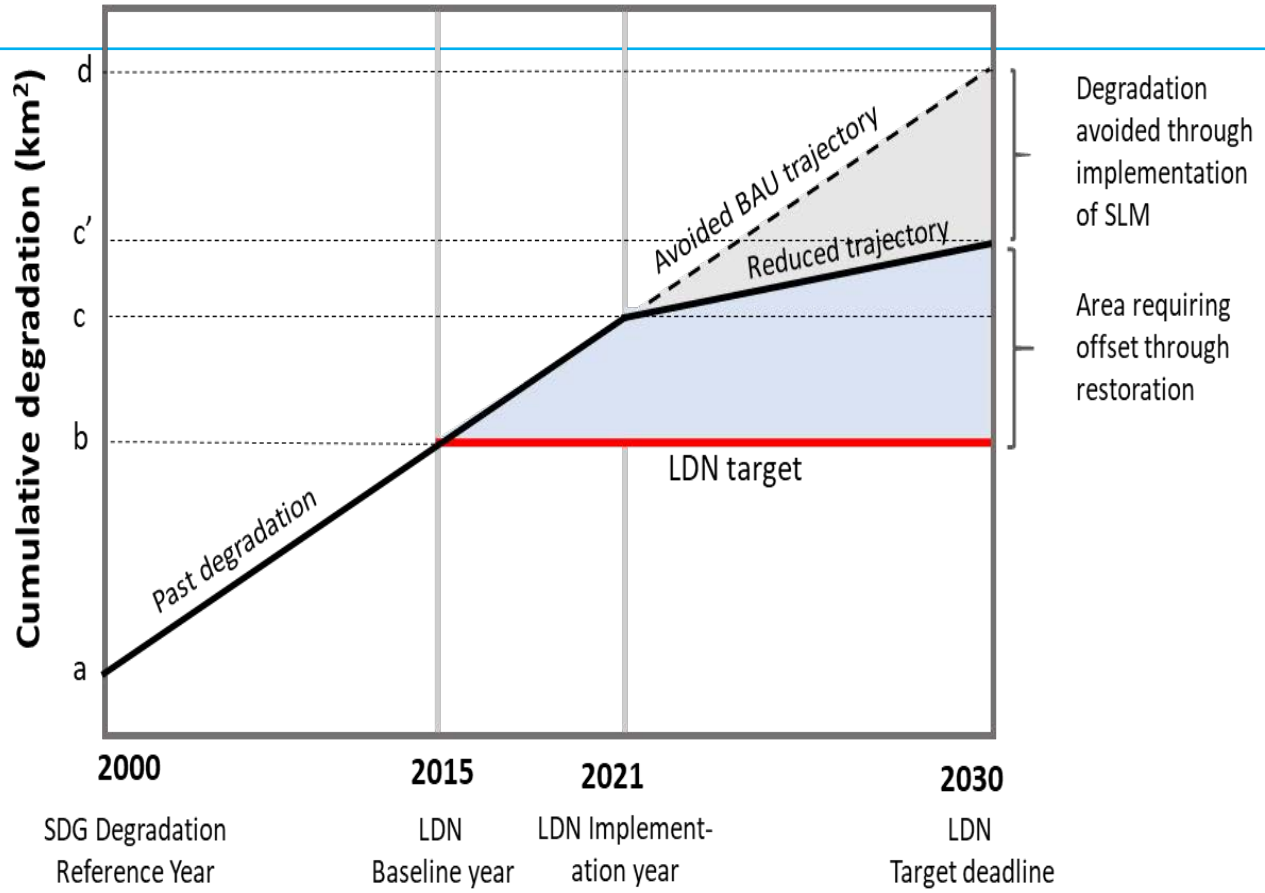
Cost-benefit analysis of ecosystem restoration programmes in Thukela river basin, KwaZulu Natal

Business-as-usual (BAU) – continued degradation, projected based on past rates

Optimistic LDN - degradation at 2021 relative to 2015 is reversed and sustainable land management SLM measures stop any further degradation.

Pessimistic LDN - assumes SLM ineffective, thus requiring restoration of an area equivalent to all projected degradation from 2015-2030.

Full restoration - restores all degraded areas as at 2021 to healthy condition. Assumes SLM would stem further degradation.



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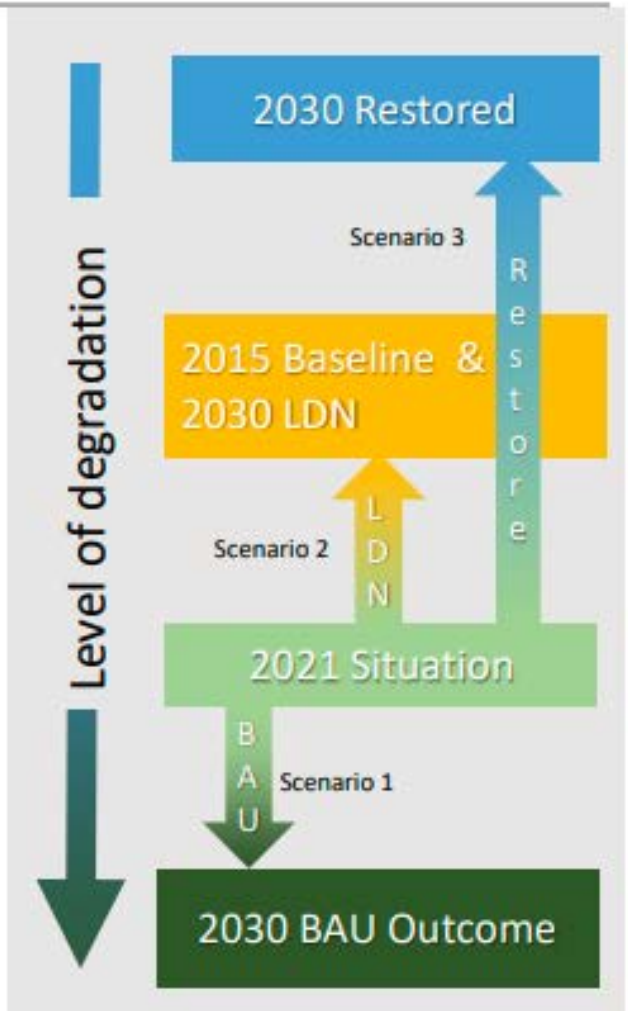
Study approach

- Estimation of the baseline land cover, trajectory to 2030 under BAU and resulting land cover, and the restored land cover
- Modelling of ecosystem services under BAU, LDN and restored outcomes
  - Same methods as Pilot, including SWAT model
- Costs and benefits of interventions compared with BAU Scenario
  - Costs of interventions based on literature, previous studies
  - Benefits estimated as difference in value of ecosystem services compared to BAU outcome



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Policy application: Ecosystem restoration in South Africa

Cost-benefit analysis of ecosystem restoration programmes in Thukela river basin, KwaZulu Natal

	Present value (R millions)		
	LDN Scenario		Full Restoration Scenario
Costs relative to BAU	Upper bound costs	Lower bound costs	
Clearing IAPs	514.4	514.4	2 355.2
Addressing Bush Encroachment	507.2	237.6	691.1
Active restoration of grasslands, erosion	2 623.6	–	–
Sustainable land management	–	1 981.02	6 093.62
Total present value of costs	**3 645.18**	**2 733.09**	**9 139.98**
Benefits relative to BAU			
Water supply	2 591.4	2 591.4	10 757.2
Sediment retention	38.9	38.9	63.1
Tourism	121.8	121.8	243.6
Carbon storage (avoided national cost)	–274.91	–274.91	597.5
Harvested resources	70.6	70.6	2 391.3
Livestock production	620.7	620.7	1 476.9
Total present value of benefits	**3 168.6**	**3 168.6**	**15 529.6**
Net Present Value	–476.6	435.5	6 389.6
BCR	0.9	1.2	1.7

Likely a vast underestimate because many intangible benefits cannot be valued. Other studies estimate a ROI of 9 – 30 for restoration projects.

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Restoring Landscapes in South-Africa (ReLISA): Nature-based solutions for climate, biodiversity and people

A proposal for the South Africa country call of the German International Climate Initiative (IKI)

July 2022


degraded thicket
restored thicket

ReLISA – the core value proposition: What are we trying to address?

1. There is a **lack of awareness** of commercial impacts and dependencies on ecosystems;
2. The **opportunities for bankable restoration activities are 'off the radar'** (such as value chain development for sustainably produced goat meat, NTFP and other commodities, and projects for voluntary carbon market projects, which could fund the upscaling of thicket, grassland or savanna restoration); and
3. There are **coordination failures** leading to 'locked-into' pathways as the main actors (government, civil society, communities, private sector) need to coordinate effectively towards large-scale restoration

ReLISA – How are we going to address these issues?

1. Develop and apply **biophysical and economic valuation modelling ex ante** to determine where there is the highest returns on investment (ROI) and opportunities to reduce income inequalities;
2. **Consult** with stakeholders (including the business and finance community) on final site selection to gain buy-in and create ‘readiness’ for restoration interventions;
3. **Develop bankable business investments** for the private sector;
4. **Implement** on-the-ground via restoration activities; and
5. Provide capacity building and knowledge products, to **ensure project sustainability**.

ReLISA Components and Work Packages

I. Biophysical/economic assessments & planning for restoration (30%)

Work Package 1 (lead UNEP): ex ante assessment of landscape restoration opportunities – 20%

Work Package 2 (lead CSIR): MRV & impact monitoring – 10%

II. Leveraging private sector investments (15%)

Work Package 3 (subcontractors): Business models & investment incubation – 15%

III. Direct Landscape-level interventions & on-the ground implementation (45%)

Work Package 4 (lead EWT): Restoration of proposed and established Biosphere Reserves – 20%

Work Package 5 (lead UNESCO): Water Funds, Payments for Ecosystem Services, GCF concept– 15%

Work Package 6 (lead UNDP): COVID-19 / Green Recovery – 10%

IV. Dissemination and communication (10%)

Work Package 7 (lead UNEP): Restoration knowledge hub, education and dissemination – 10%

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CSIR Touching lives through innovation
unesco
ENDANGERED WILDLIFE TRUST Protecting forever, together.
UNDP

IV An interactive exercise

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The TEEB Six Step Approach

STEP 1: Refine the objectives of a TEEB Country Study by specifying and agreeing on the key policy issues with stakeholders

STEP 2: Identify the most relevant ecosystem services

STEP 3: Define information needs and select appropriate methods

STEP 4: Assess and value ecosystem services

STEP 5: Identify and outline the pros and cons of policy options, including distributional impacts

STEP 6: Review, refine and report: Produce an answer to each of the questions

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Provisioning services

Food: Ecosystems provide the conditions for growing food. Food comes principally from managed agro-ecosystems but marine and freshwater systems or forests also provide food for human consumption. Wild foods from forests are often underestimated.

Raw Materials: Ecosystems provide a great diversity of materials for construction and fuel including wood, biofuels and plant oils that are directly derived from wild and cultivated plant species.

Fresh water: Ecosystems play a vital role in the global hydrological cycle, as they regulate the flow and purification of water. Vegetation and forests influence the quantity of water available locally.

Medicinal resources: Ecosystems and biodiversity provide many plants used as traditional medicines as well as providing the raw materials for the pharmaceutical industry. All ecosystems are a potential source of medicinal resources.

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Regulating services

Local climate and air quality: Trees provide shade whilst forests influence rainfall and water availability both locally and regionally. Trees or other plants also play an important role in regulating air quality by removing pollutants from the atmosphere.

Carbon sequestration and storage: Ecosystems regulate the global climate by storing and sequestering greenhouse gases. As trees and plants grow, they remove carbon dioxide from the atmosphere and effectively lock it away in their tissues. In this way forest ecosystems are carbon stores. Biodiversity also plays an important role by improving the capacity of ecosystems to adapt to the effects of climate change.

Moderation of extreme events: Extreme weather events or natural hazards include floods, storms, tsunamis, avalanches and landslides. Ecosystems and living organisms create buffers against natural disasters, thereby preventing possible damage. For example, wetlands can soak up flood water.

Waste-water treatment: Ecosystems such as wetlands filter both human and animal waste and act as a natural buffer to the surrounding environment. Through the biological activity of microorganisms in the soil, most waste is broken down. Thereby pathogens (disease causing microbes) are eliminated, and the level of nutrients and pollution is reduced.

Erosion prevention and maintenance of soil fertility: Soil erosion is a key factor in the process of land degradation and desertification. Vegetation cover provides a vital regulating service by preventing soil erosion. Soil fertility is essential for plant growth and agriculture. etc

Pollination: Insects and wind pollinate plants and trees which is essential for the development of fruits, vegetables and seeds. Animal pollination is an ecosystem service mainly provided by insects but also by some birds and bats. Some 87 out of the 115 leading global food crops depend upon animal pollination including important cash crops such as cocoa and coffee (Klein et al. 2007).

Biological control: Ecosystems are important for regulating pests and vector borne diseases that attack plants, animals and people. Ecosystems regulate pests and diseases through the activities of predators and parasites. Birds, bats, flies, wasps, frogs and fungi all act as natural controls.

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Habitat or supporting services

Habitats for species: Habitats provide everything that an individual plant or animal needs to survive: food; water; and shelter. Each ecosystem provides different habitats that can be essential for a species' lifecycle. Migratory species including birds, fish, mammals and insects all depend upon different ecosystems during their movements.

Maintenance of genetic diversity: Genetic diversity is the variety of genes between and within species populations. Genetic diversity distinguishes different breeds or races from each other thus providing the basis for locally well-adapted cultivars and a gene pool for further developing commercial crops and livestock.

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Cultural Services

Recreation and mental and physical health: Walking and playing sports in green space is not only a good form of physical exercise but also lets people relax. The role that green space plays in maintaining mental and physical health is increasingly being recognized, despite difficulties of measurement.

Tourism: Ecosystems and biodiversity play an important role for many kinds of tourism which in turn provides considerable economic benefits and is a vital source of income for many countries. In 2008 global earnings from tourism summed up to US$ 944 billion.

Aesthetic appreciation and inspiration for culture, art and design: Language, knowledge and the natural environment have been intimately related throughout human history. Biodiversity, ecosystems and natural landscapes have been the source of inspiration for much of our art, culture and increasingly for science..

Spiritual experience and sense of place: In many parts of the world natural features such as specific forests, caves or mountains are considered sacred or have a religious meaning. Nature is a common element of all major religions and traditional knowledge, and associated customs are important for creating a sense of belonging.

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