Natural capital accounting seminar

9 July 2019

Pretoria

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I. But what *is* natural capital?

UNITED NATIONS

EP

UNEP/EA.2/Res.13

Distr.: General
4 August 2016

Original: English

United Nations Environment Assembly of the United Nations Environment Programme

United Nations Environment Assembly of the United Nations Environment Programme
Second session
Nairobi, 23–27 May 2016

2/13. Sustainable management of natural capital for sustainable development and poverty eradication

The United Nations Environment Assembly,

Recalling General Assembly resolution 70/1 of 25 September 2015, "Transforming our world: the 2030 Agenda for Sustainable Development", and the Sustainable Development Goals and targets,

Recalling also paragraph 2 of Governing Council decision 27/8 and resolution 1/10 adopted by the United Nations Environment Assembly, which acknowledge that United Nations Member States have developed different approaches, visions, models and tools in order to achieve sustainable development and poverty eradication,

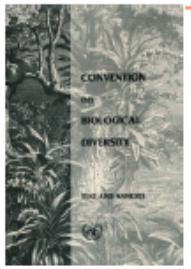
Acknowledging that natural capital is a concept whose meaning is still under discussion, and that, for the purposes of this resolution, natural capital assets have different intrinsic values and are subject to national jurisdiction and sovereignty,

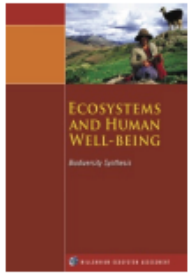
A working definition

- "Natural Capital" is understood as assets in their role of *providing inputs and services for economic consumption and production* which also requires maintenance.

II. The Origins of TEEB

TEEB initiative (2008-2012)





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**

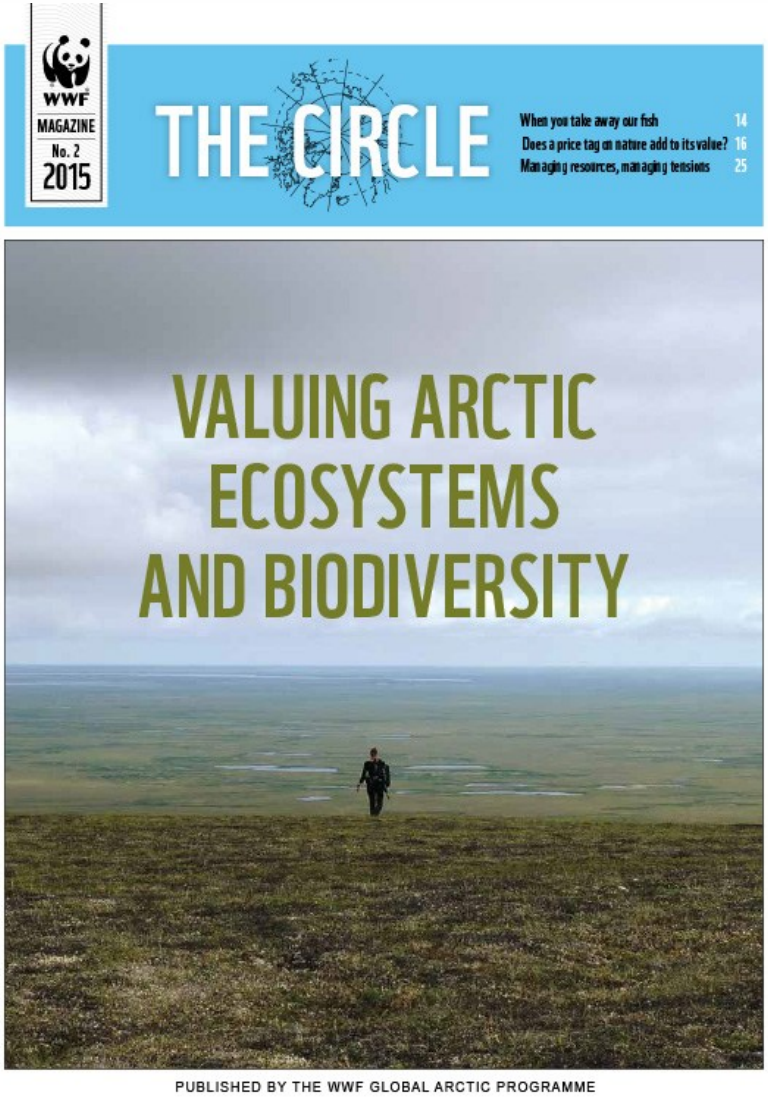
What did we learn from TEEB Phase I?

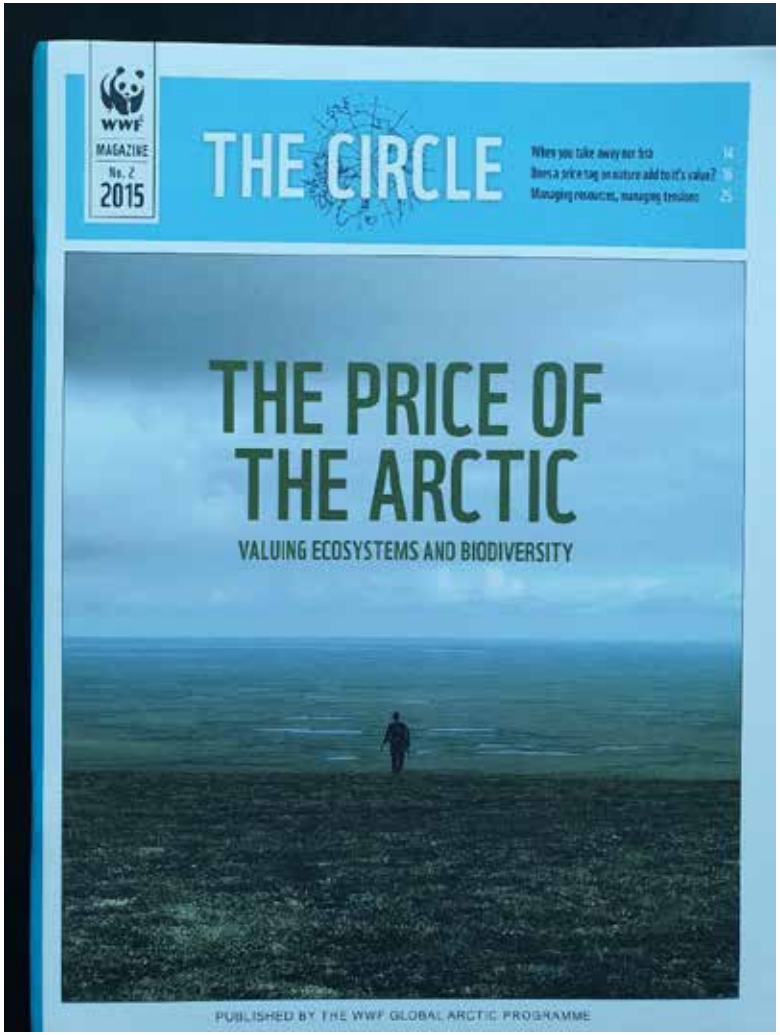
1. Metrics for biodiversity are much more complex and multi-dimensional than those for climate change
   - Ø *c.f.* CO2-equivalents, ppm
   - Ø Post-2020 agenda – apex indicators

What did we learn from TEEB Phase I?

1. Metrics for biodiversity are much more complex and multi-dimensional than those for climate change
2. Valuing biodiversity in and of itself is fraught with difficulties/controversy
   - Ø ‘commodification’ of nature
   - Ø Intrinsic versus instrumental values
   - Ø We will never be able to *nor should we* put a monetary value on all the instrumental values of nature, let alone intrinsic values
   - Ø Value does not equal price

What did we learn from TEEB Phase I?





What did we learn from TEEB Phase I?

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3. Most of what TEEB was/is doing was valuing ecosystem services/Nature's Contribution to People (NCP under IPBES)
4. For some decision-makers, values in monetary terms *do* matter
   - Ø will be the only evidence that will 'swing' a decision
   - Ø But recall value estimates will be incomplete

What did we learn from TEEB Phase I?

5. Marginal changes are meaningful, *total values* less so

Contents lists available at ScienceDirect

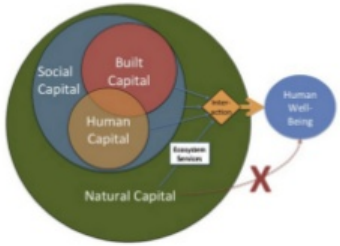
Global Environmental Change

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

Changes in the global value of ecosystem services

Robert Costanza [a,*], Rudolf de Groot [b], Paul Sutton [c,d], Sander van der Ploeg [b], Sharolyn J. Anderson [d], Ida Kubiszewski [a], Stephen Farber [e], R. Kerry Turner [f]

[a] Crawford School of Public Policy, Australian National University, Canberra, Australia
[b] Environmental Systems Analysis Group, Wageningen University, Wageningen, The Netherlands
[c] Department of Geography, University of Denver, United States
[d] Barbara Hardy Institute and School of the Natural and Built Environments, University of South Australia,
[e] University of Pittsburgh, United States
[f] University of East Anglia, Norwich, UK

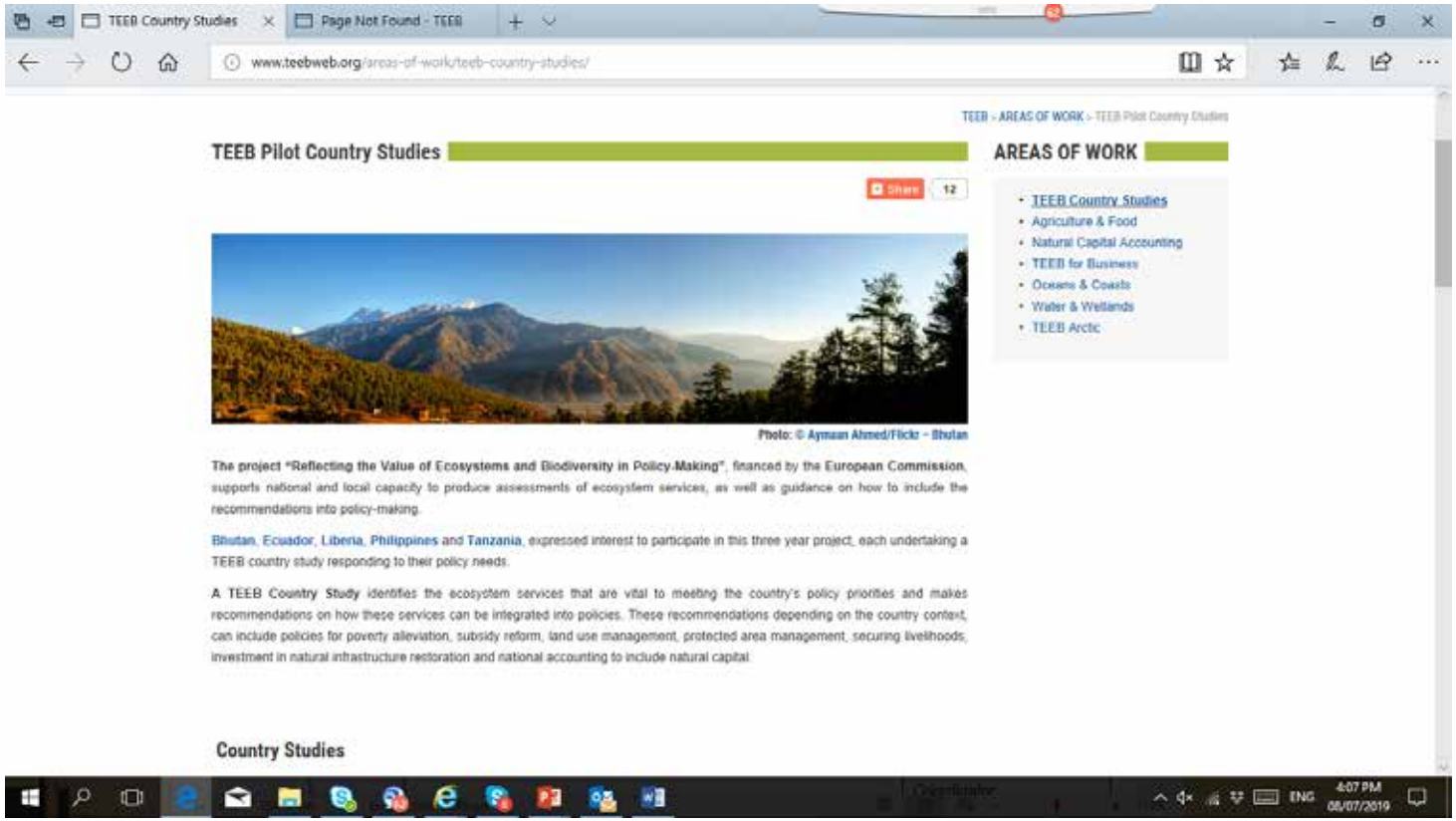


Using the same methods as in the 1997 paper but with updated data, the estimate for the total global ecosystem services in 2011 is $125 trillion/yr (assuming updated unit values and changes to biome areas) and $145 trillion/yr (assuming only unit values changed), both in 2007 $US. From this we estimated the loss of eco-services from 1997 to 2011 due to land use change at 4.3–20.2 trillion/yr, depending on which unit values are used

Costanza *et al.* (2014) *Global Environmental Change* **26**: 152
http://dx.doi.org/10.1016/j.gloenvcha.2014.04.002

What did we learn from TEEB Phase I?

6. There was and is an appetite to apply TEEB at Country level



What did we learn from TEEB Phase I?

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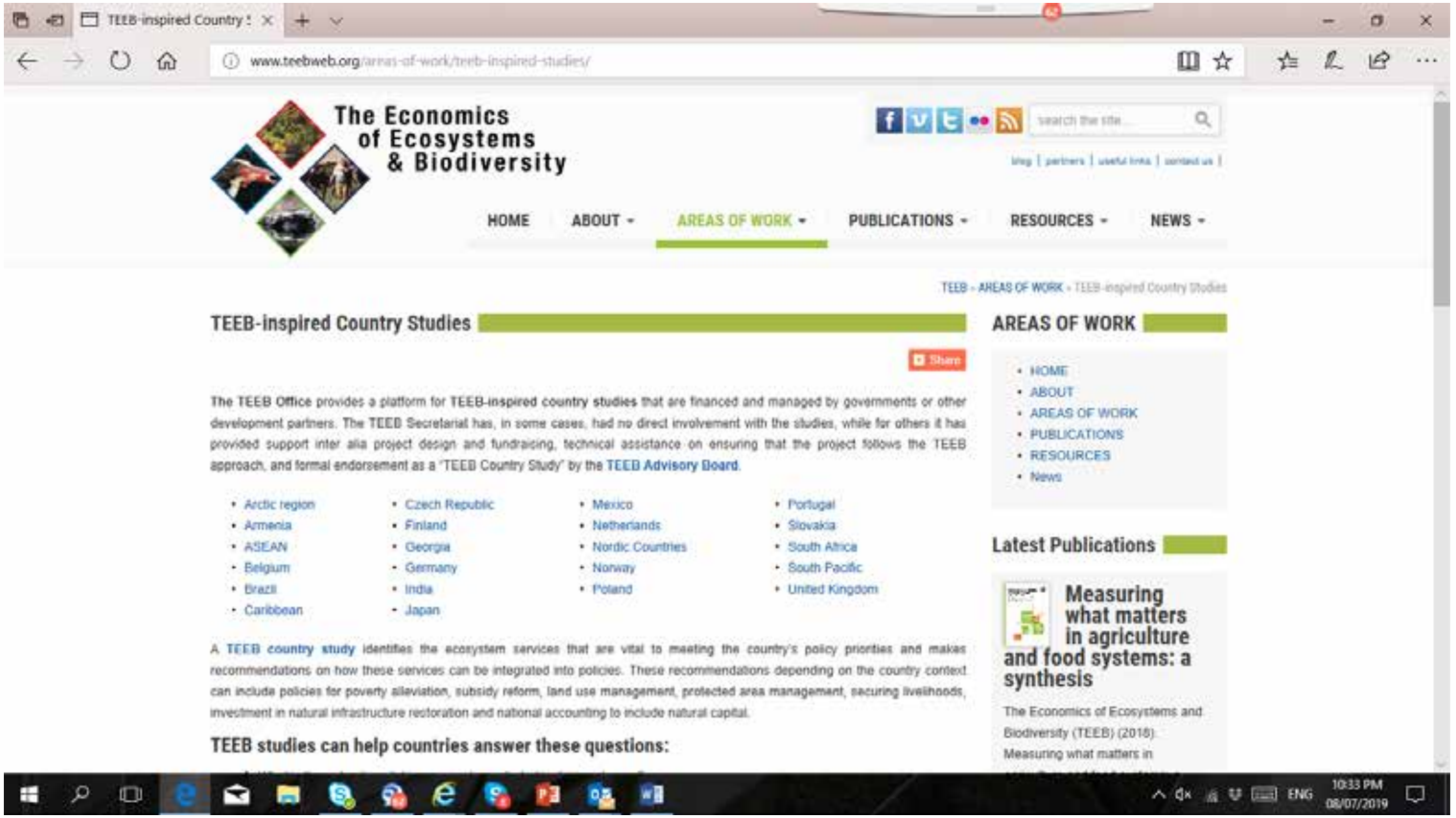


III. TEEB Country studies

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

TEEB Bhutan: implementation of integrated watershed management to benefit maximum from hydropower

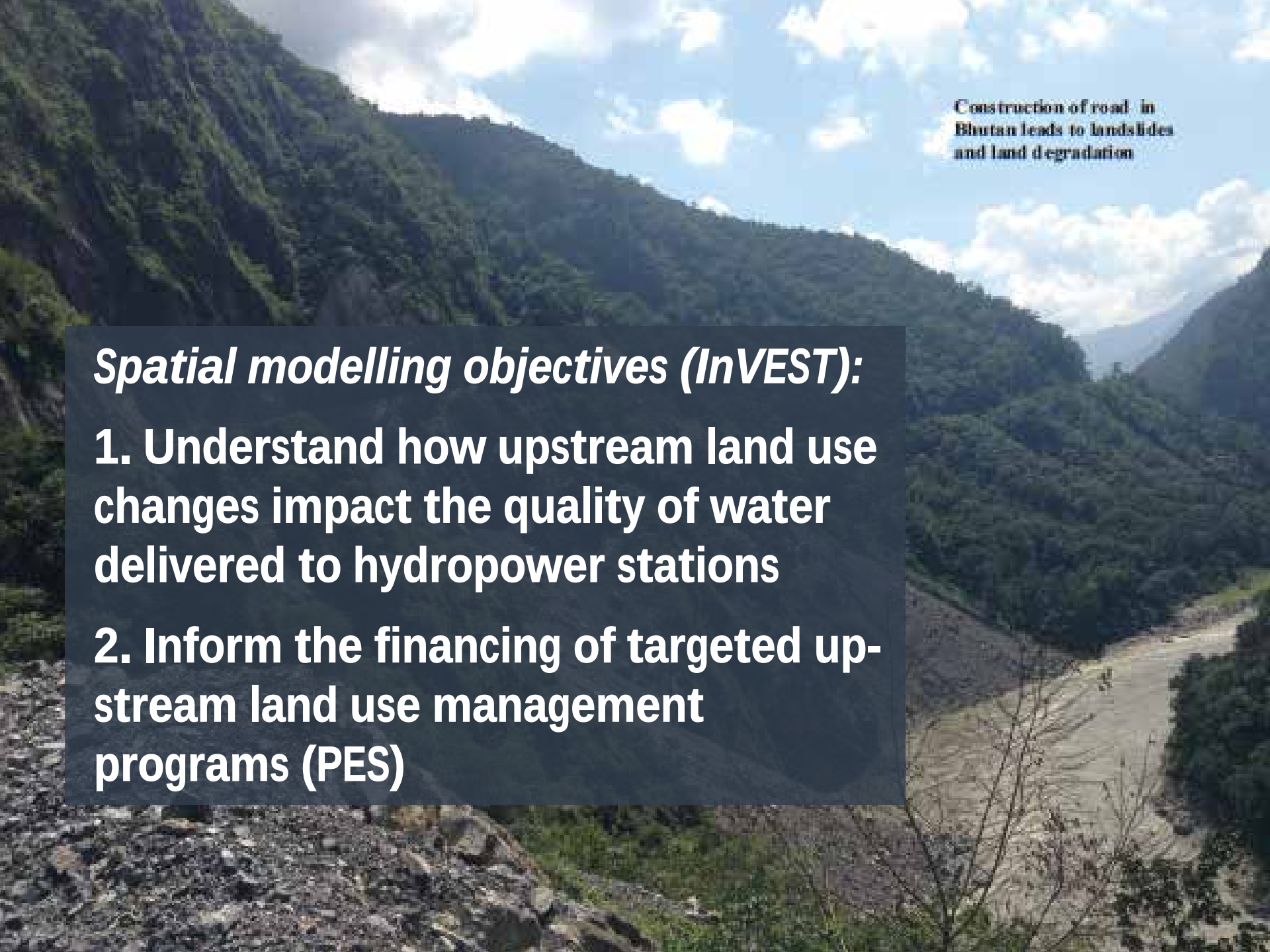
1. ***Policy objective**:* re-allocating part of the energy revenues to local environmental preservation
2. ***Policy relevance:*** Hydropower is Bhutan's largest export (India buys; min. 5000 MW by 2020)
3. ***Ecosystem services prioritized**:* sedimentation control, habitat for species, regulation of carbon sequestration and storage, biological control, timber production

Ugyen Wangchuck Institute for Conservation and Environmental Research (UWICER)

Department of Forests and Park Services

UN environment

This project is funded by the European Union

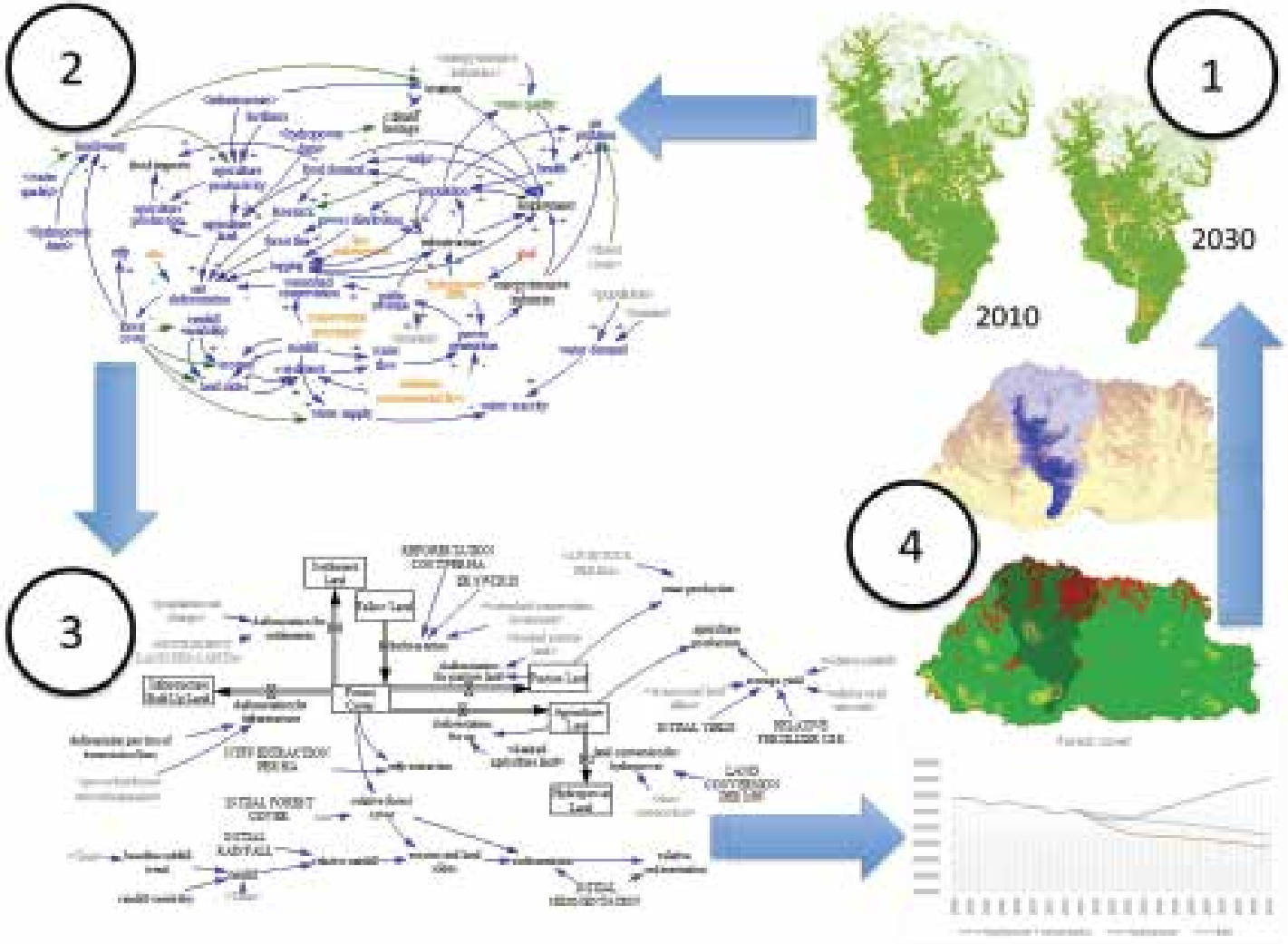


Spatial modelling objectives (InVEST):

1. Understand how upstream land use changes impact the quality of water delivered to hydropower stations

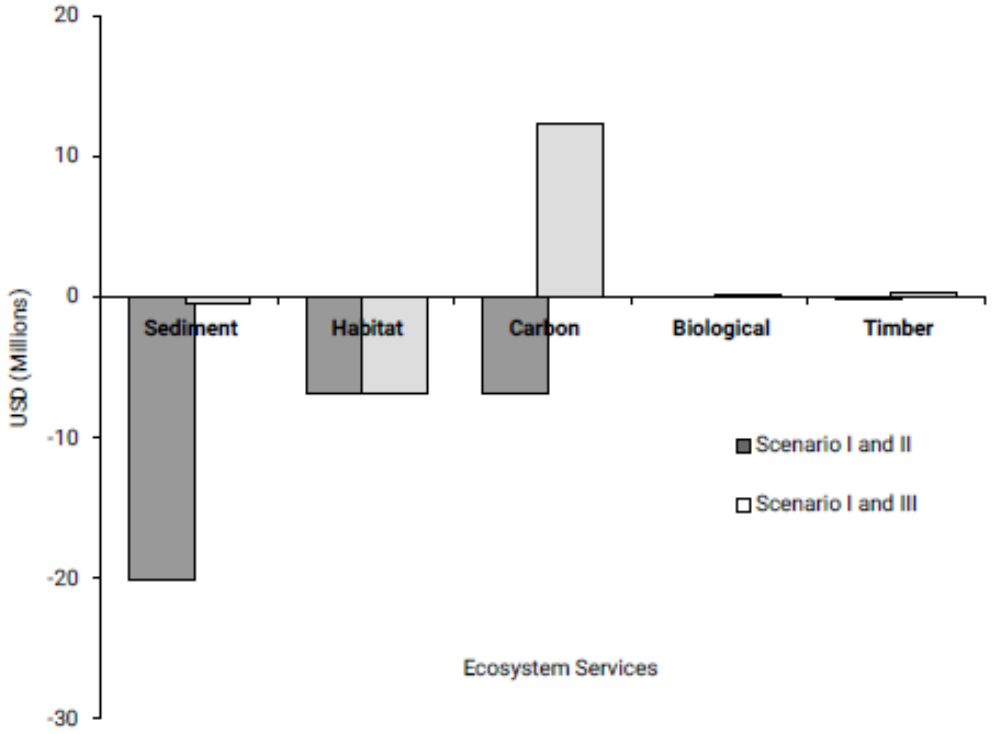
2. Inform the financing of targeted up-stream land use management programs (PES)

Combine (i) spatial planning tools and biophysical ecosystem service models, (ii) socioeconomic models based on System Dynamics, and (iii) nonmarket environmental valuation methods , leading to (iv) an integrated model



Source: Knowledge srl, UWICE

Hydropower construction *without* restoration measures leads to a loss of 34 million USD by 2030, but conversely, by putting restoration measures in place, Ecosystem Services worth 5 million USD are generated by 2030 (mostly sediment control and carbon).



Caveat: model did not look at aquatic fauna and the environmental costs of dismantling the dam.

Ecosystem services that will be affected in all drainage basins of study area

http://www.uwice.gov.bt/admin_uwice/publications/publication_files/Reports/2018/TEEB_Factsheet.pdf

teebweb.org

TEEB – Bhutan

Recommendations:

- Institute sustainable funding for targeted up-stream land-use management programs by institutionalizing within the framework of Royal Government of Bhutan's Five Year Plans;
- A follow up study to identify the source of sediments (mines, quarries, transmission lines, roads, agriculture etc.) and targets for its management should be undertaken; and
- Evaluate and strengthen water management plans that affect or are affected by hydropower installation and integrate with environmental management plans and programs. Implementation, monitoring and evaluation of these plans should be included in the mandate of the existing river basin management committees.

Prepared by: *Sangay Wangchuk – UWICER; Changa Tshering – UWICER; Kavita Sharma – UNEP*

Suggested citation: *UWICER (2018): Implementation of Integrated Watershed Management to Benefit Maximum from Hydro-Power in Bhutan. Ugyen Wangchuck Institute for Conservation and Environment, Royal Government of Bhutan.*

Limitation of the study: *The study is based on modeling exercise and the model does not take into account any changes that may occur within the predicted time frame. The study forecasts the data based on land-use and land cover change projections estimated from system dynamics model.*

Department of Forests and Park Services

Ugyen Wangchuck Institute for Conservation and Environmental Research (UWICER)

This policy brief is a result of The Economics of Ecosystem and Biodiversity (TEEB) study, which is a global initiative focused on "making nature's values visible". It is part of the project "Reflecting the value of Ecosystems and Biodiversity in Policy-Making", financed by the European Commission and Coordinated by TEEB Office, UN Environment – Geneva. Bhutan was one of the participating countries as TEEB pilot country studies together with Ecuador, Liberia, Philippines and Tanzania.

For more information: http://www.teebweb.org/areas-of-work/teeb-country-studies/Bhutan/

UN environment

This project is funded by the European Union

IMPLEMENTATION OF INTEGRATED WATERSHED MANAGEMENT TO BENEFIT MAXIMUM FROM HYDRO-POWER IN BHUTAN

Ugyen Wangchuck Institute for Conservation and Environmental Research

Removing sediments from Chhukha Hydropower Plant

Introduction

Royal Government of Bhutan confirmed Bhutan's participation as one of the pilot countries for the European Commission funded project for The Economics of Ecosystems and Biodiversity (TEEB) national implementation study. As part of TEEB country study, a scoping workshop was held in 2014 which recommended TEEB – Bhutan to assess changes in ecosystem services provisioning with hydropower development.

The study used spatial models to understand how upstream land use changes impact the quality of water delivered to hydropower stations in Bhutan. Spatial models were linked to a system model with social and economic variables to ensure relationships between hydropower and socio-economic development were captured to generate more realistic land use scenarios.

Three scenarios were looked at with the base year as 2010 and projected till 2030 to study ecosystem services that may be affected by hydropower development. Eight hydropower plants were considered for the study [3 commissioned; 2 under-construction and 3 planned for construction].

Hydropower plants considered:

- Kuri I Hydropower [Kurichhu drainage]
- Punatsangchhu Hydropower [Punatsangchhu drainage]
- Gamri II Hydropower [Gamri drainage]
- Bunakha Reservoir [Wangchhu drainage]
- Nikachhu II Hydropower [Nikachhu drainage]

Revenue generated and maintenance expenses incurred data from the commissioned plants [Chhukha Hydropower; Kurichhu Hydropower and Dagachhu Kydropower] were used as reference data to project ecosystem services likely to be affected for the 5 hydropower plants. The study projected whole drainage basin's ecosystem services unlike the specific areas as the Detail Project Report (DPR) considers. Three scenarios were considered for the study:
Scenario I – Business as usual scenario
Scenario II – Hydropower dam construction
Scenario III – Hydropower dam construction but with up-stream conservation programs: Assumes that 20 percent of the 1 percent electricity sale revenue is invested in up-stream land-use management activities.

The study compared ecosystem services between: Scenario I and II; and Scenario I and III for following ecosystem services:

- Sedimentation control
- Habitat for species
- Regulation of carbon sequestration and storage
- Biological Control
- Timber Production.

TEEB – Bhutan

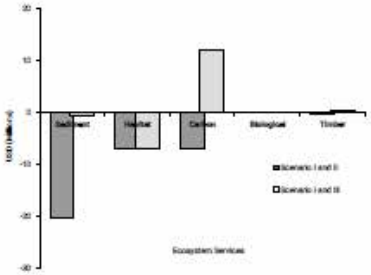
Key Results

- Five drainage basins may contribute ecosystem services worth [five services] of USD 5 million in 2030 if scenario III is followed;
- Just by constructing hydropower plants without undertaking watershed management practices [Scenario II] these five drainage basins may lose USD 34 million worth of ecosystem services by 2030; and
- Sedimentation control and carbon sequestration stands out to be the most significant ecosystem system services that will bring significant shifts by adopting scenario III.

Conclusion

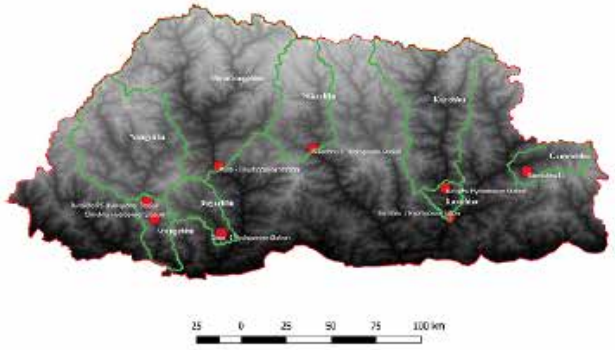
The analysis shows that re-allocating part of the revenues to local environmental preservation can avoid most of the negative impacts forecasted. Investments in reforestation, among other options, would avoid the reduction of forest cover, thereby reducing sediment export and increasing carbon sequestration, providing habitat for species and genetic resources, as well as supporting economic activities (e.g. timber production).The results from the study clearly showed marked effect on the sediment load; habitat quality and carbon sequestration by adopting hydropower development with up-stream land use management.

The study showed the importance of initiating targeted up-stream land use management programs through the introduction of Payment for Ecosystem Services (PES) and to undertake sustainable developmental activities with minimum destruction to forest cover. Article 12.4 of the Sustainable Hydro-power Development Policy 2008 of the Royal Government of Bhutan also necessitates 1% of the revenue generated from the energy sector to be paid to Ministry of Agriculture and Forests to pursue integrated sustainable water resources management. Since the Royal Government of Bhutan is using this plough back mechanism to subsidize electricity to the rural communities, the study looked at what if only 20% of the 1% plough back revenue could be spent on instituting PES. The model suggests that institutionalizing such mechanism would mean increase in economy and environmental benefits and this could help in the development of hydro-power plant for the country. Though, there could be marked ecosystem destruction at the construction sites during the initial phase of development, in the longer run following Scenario III would in-fact prove beneficial. However, this in no way is a state-



Ecosystem services that will be affected in all drainage basins of study area

Study Area: Bhutan map showing drainage basin of the selected hydropower plant



ment suggesting to dam more rivers as the model didn't look at the aquatic fauna and the aftermath of bringing down the dam after its shelf-life. Thus, studies should be pursued to look from both economy and ecosystem services aspects to obtain holistic understanding on hydro-power construction; de-commissioning of dams; and also the ecosystem services which are affected at earlier stage of development and at later stage of commissioning the hydropower.

The study demonstrated the importance of considering the study at watershed level during the DPR or Ecosystem and Social Impact Assessment (ESAI) study for any hydropower developmental works unlike the current trend of focusing within the project sites. The study showed the need to undertake broader level of study to clearly project the problems and to suggest mitigation measures for betterment of both the power plants and environment.

Road construction in Bhutan

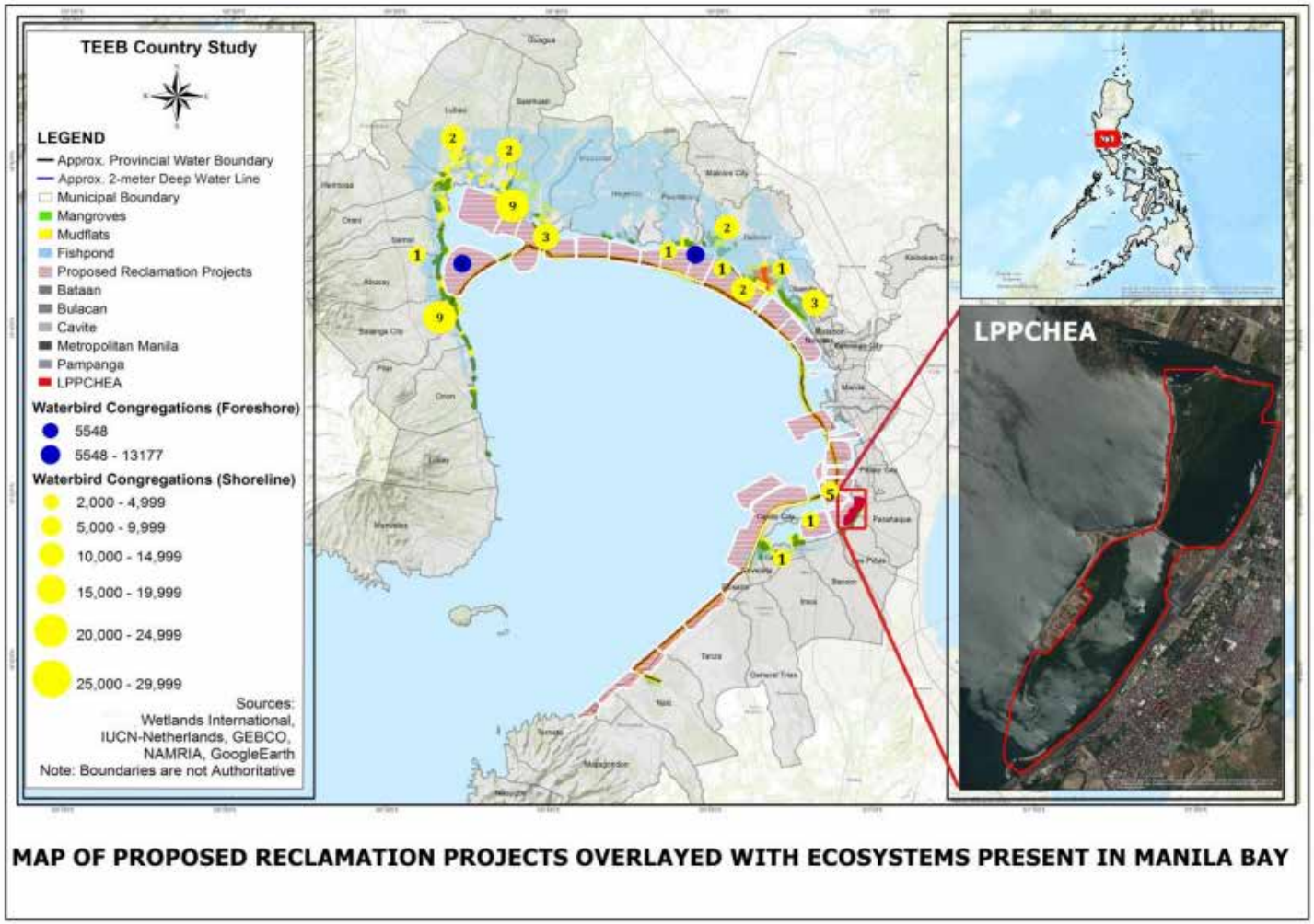

Confluence of Kuri – Gongri chhu. Note the difference in the color of water.

No Payment for Ecosystem Services scheme introduced, but government provides 100 unit of electricity free to rural communities

Institutionalization of valuation has increased at various levels

TEEB - The Philippines

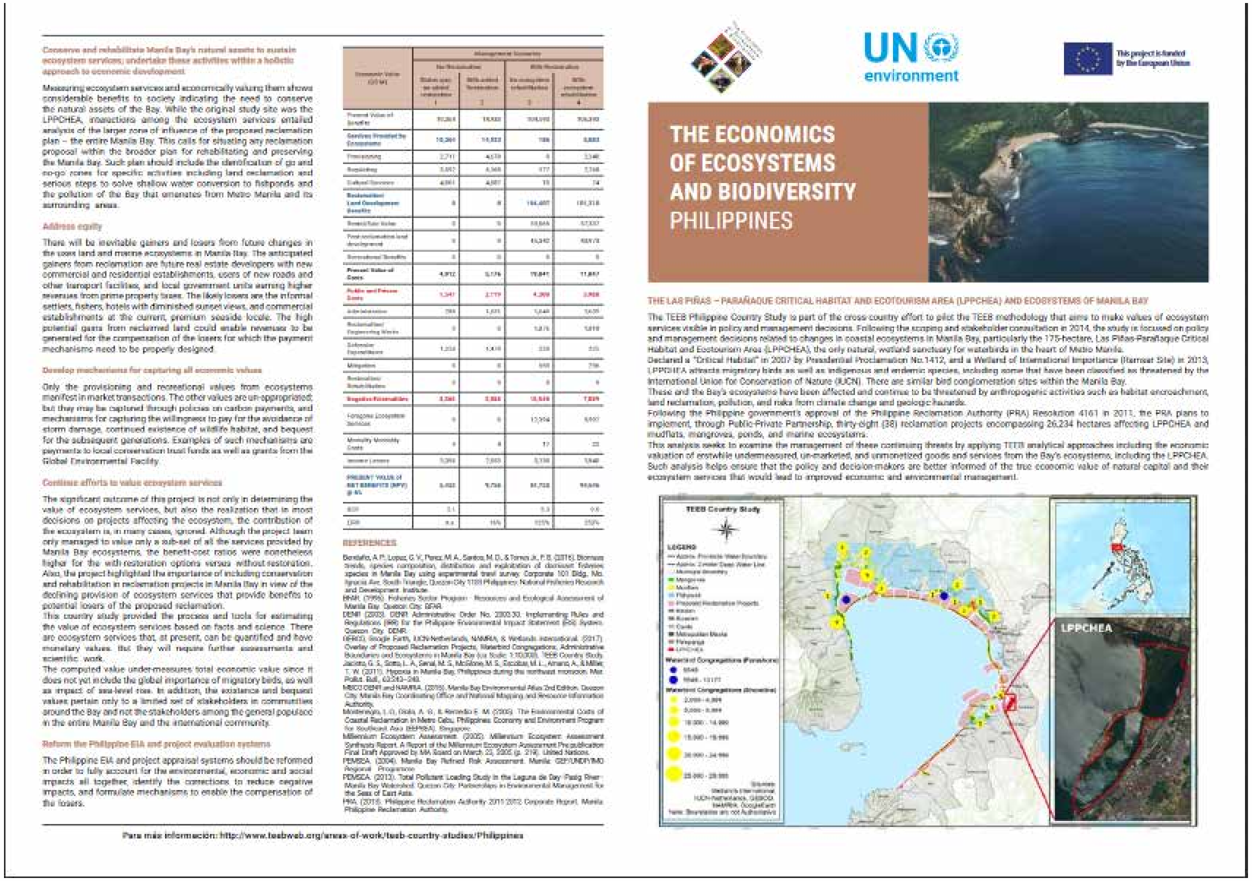
THE LAS PIÑAS – PARAÑAQUE CRITICAL HABITAT AND ECOTOURISM AREA (LPPCHEA) AND ECOSYSTEMS OF MANILA BAY



MAP OF PROPOSED RECLAMATION PROJECTS OVERLAYED WITH ECOSYSTEMS PRESENT IN MANILA BAY

TEEB - The Philippines

THE LAS PIÑAS – PARAÑAQUE CRITICAL HABITAT AND ECOTOURISM AREA (LPPCHEA) AND ECOSYSTEMS OF MANILA BAY


Conserve and rehabilitate Manila Bay's natural assets to sustain ecosystem services; undertake these activities within a holistic approach to economic development

Measuring ecosystem services and economically valuing them shows considerable benefits to society indicating the need to conserve the natural assets of the Bay. While the original study site was the LPPCHEA, interactions among the ecosystem services entailed analysis of the larger zone of influence of the proposed reclamation plan – the entire Manila Bay. This calls for situating any reclamation proposal within the broader plan for rehabilitating and preserving the Manila Bay. Such plan should include the identification of go and no-go zones for specific activities including land reclamation and serious steps to solve shallow water conversion to fishponds and the pollution of the Bay that emanates from Metro Manila and its surrounding areas.

Address equity

There will be inevitable gainers and losers from future changes in the uses land and marine ecosystems in Manila Bay. The anticipated gainers from reclamation are future real estate developers with new commercial and residential establishments, users of new roads and other transport facilities, and local government units earning higher revenues from prime property taxes. The likely losers are the informal settlers, fishers, hotels with diminished sunset views, and commercial establishments at the current, premium seaside locale. The high potential gains from reclaimed land could enable revenues to be generated for the compensation of the losers for which the payment mechanisms need to be properly designed.

Develop mechanisms for capturing all economic values

Only the provisioning and recreational values from ecosystems manifest in market transactions. The other values are un-appropriated, but they may be captured through policies on carbon payments, and mechanisms for capturing the willingness to pay for the avoidance of storm damage, continued existence of wildlife habitat, and bequest for the subsequent generations. Examples of such mechanisms are payments to local conservation trust funds as well as grants from the Global Environmental Facility.

Continue efforts to value ecosystem services

The significant outcome of this project is not only in determining the value of ecosystem services, but also the realization that in most decisions on projects affecting the ecosystem, the contribution of the ecosystem is, in many cases, ignored. Although the project team only managed to value only a sub-set of all the services provided by Manila Bay ecosystems, the benefit-cost ratios were nonetheless higher for the with-restoration options versus without restoration. Also, the project highlighted the importance of including conservation and rehabilitation in reclamation projects in Manila Bay in view of the declining provision of ecosystem services that provide benefits to potential losers of the proposed reclamation.

This country study provided the process and tools for estimating the value of ecosystem services based on facts and science. There are ecosystem services that, at present, can be quantified and have monetary values. But they will require further assessments and scientific work.

The computed value under-measures total economic value since it does not yet include the global importance of migratory birds, as well as impact of sea-level rise. In addition, the existence and bequest values pertain only to a limited set of stakeholders in communities around the Bay and not the stakeholders among the general populace in the entire Manila Bay and the international community.

Reform the Philippine EIA and project evaluation systems

The Philippine EIA and project appraisal systems should be reformed in order to fully account for the environmental, economic and social impacts all together, identify the corrections to reduce negative impacts, and formulate mechanisms to enable the compensation of the losers.

REFERENCES

UN environment

This project is funded by the European Union

THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY PHILIPPINES

THE LAS PIÑAS – PARAÑAQUE CRITICAL HABITAT AND ECOTOURISM AREA (LPPCHEA) AND ECOSYSTEMS OF MANILA BAY

The TEEB Philippine Country Study is part of the cross-country effort to pilot the TEEB methodology that aims to make values of ecosystem services visible in policy and management decisions. Following the scoping and stakeholder consultation in 2014, the study is focused on policy and management decisions related to changes in coastal ecosystems in Manila Bay, particularly the 175-hectare, Las Piñas-Parañaque Critical Habitat and Ecotourism Area (LPPCHEA), the only natural, wetland sanctuary for waterbirds in the heart of Metro Manila.

Declared a "Critical Habitat" in 2007 by Presidential Proclamation No.1412, and a Wetland of International Importance (Ramsar Site) in 2013, LPPCHEA attracts migratory birds as well as indigenous and endemic species, including some that have been classified as threatened by the International Union for Conservation of Nature (IUCN). There are similar bird conglomeration sites within the Manila Bay.

These and the Bay's ecosystems have been affected and continue to be threatened by anthropogenic activities such as habitat encroachment, land reclamation, pollution, and risks from climate change and geologic hazards.

Following the Philippine government's approval of the Philippine Reclamation Authority (PRA) Resolution 4161 in 2011, the PRA plans to implement, through Public-Private Partnership, thirty-eight (38) reclamation projects encompassing 26,234 hectares affecting LPPCHEA and mudflats, mangroves, ponds, and marine ecosystems.

This analysis seeks to examine the management of these continuing threats by applying TEEB analytical approaches including the economic valuation of erstwhile undermeasured, un-marketed, and unmonetized goods and services from the Bay's ecosystems, including the LPPCHEA. Such analysis helps ensure that the policy and decision-makers are better informed of the true economic value of natural capital and their ecosystem services that would lead to improved economic and environmental management.

Para más información: http://www.teebweb.org/areas-of-work/teeb-country-studies/Philippines

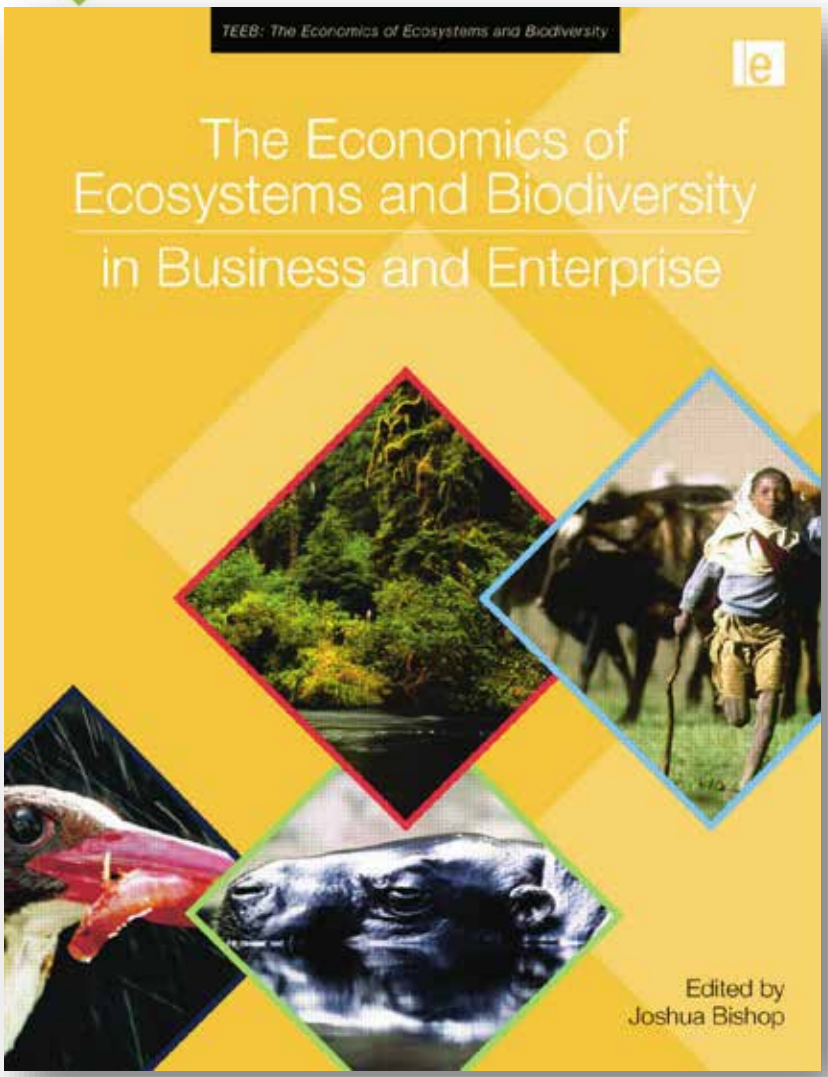
TEEB - The Philippines

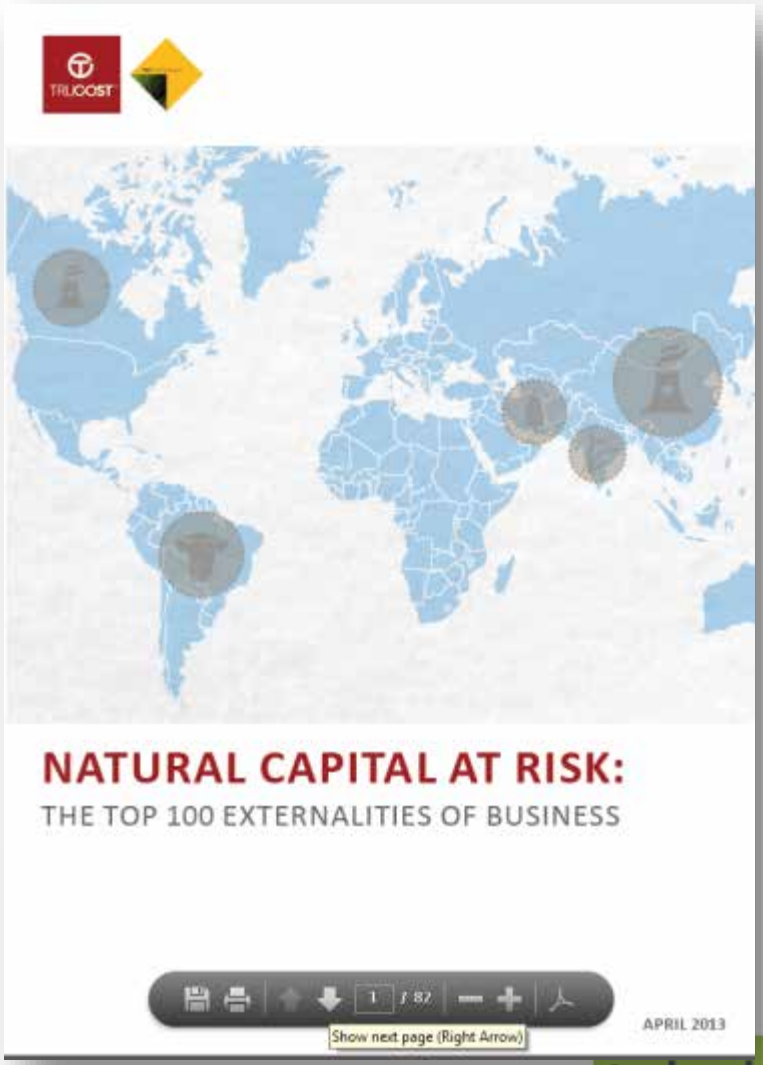
THE LAS PIÑAS – PARAÑAQUE CRITICAL HABITAT AND ECOTOURISM AREA (LPPCHEA) AND ECOSYSTEMS OF MANILA BAY

1. The sustainable management of Manila Bay has became a political priority
2. May 2019 - TEEB analysis feeds into the development of a Master Plan for Manilla Bay that is being drafted.
3. The incoming mayor of Manila has already expressed that he will not approve any application for reclamation, *with evidence from the TEEB report*

IV. TEEB for Agriculture and Food (TEEBAgriFood)

TEEB for Business





Why select the Agriculture sector?

7.1.2 THE GLOBAL 20 REGION-SECTORS

Ranking of the 20 region-sectors with the greatest total impact across the 6 EKPIs when measured in monetary terms.

RANK	SECTOR	REGION	NATURAL CAPITAL COST. US$ BN	REVENUE. US$ BN	IMPACT RATIO
1	COAL POWER GENERATION	EASTERN ASIA	452.8	443.1	1.0
2	CATTLE RANCHING AND FARMING	SOUTH AMERICA	353.8	16.6	18.8
3	COAL POWER GENERATION	NORTHERN AMERICA	316.8	246.7	1.3
4	WHEAT FARMING	SOUTHERN ASIA	266.6	31.8	8.4
5	RICE FARMING	SOUTHERN ASIA	235.6	65.8	3.6
6	IRON AND STEEL MILLS	EASTERN ASIA	225.6	604.7	0.4
7	CATTLE RANCHING AND FARMING	SOUTHERN ASIA	163.0	174.0	0.8
8	CEMENT MANUFACTURING	EASTERN ASIA	147.0	5.8	23.0
9	WATER SUPPLY	SOUTHERN ASIA	111.7	14.1	7.9
10	WHEAT FARMING	NORTHERN AFRICA	100.1	7.4	13.6
11	RICE FARMING	EASTERN ASIA	99.3	91.2	1.1
12	WATER SUPPLY	WESTERN ASIA	86.7	18.4	4.7
13	FISHING	GLOBAL	86.1	136.0	0.6
14	RICE FARMING	NORTHERN AFRICA	84.2	1.2	69.6
15	CORN FARMING	NORTHERN AFRICA	80.4	1.7	47.8
16	RICE FARMING	SOUTH-EASTERN ASIA	79.7	41.0	1.9
17	WATER SUPPLY	NORTHERN AFRICA	76.4	3.4	22.2
18	SUGARCANE	SOUTHERN ASIA	75.6	6.0	12.5
19	PETROLEUM AND NATURAL GAS EXTRACTION *(excludes water and land use)*	EASTERN EUROPE	72.6	371.6	0.2
20	NATURAL GAS POWER GENERATION	NORTHERN AMERICA	69.4	122.7	1.0

‘The Good’

+ Agriculture employs 1 in 3 of the world’s economically active labour force, or about 1.3 billion people. For the 70 per cent of the world's poor living in rural areas, agriculture is the main source of income and employment.

+ Smallholder farms (i.e. less than 2 hectares) represent over 475 million of the world’s 570 million farms and, in much of the developing world, they produce over 80 per cent of the food consumed.

+ Food production systems produce approximately 2,800 calories per person per day which is enough to feed the world population.

‘The Bad’

- Eighty per cent of new agricultural land has replaced tropical forests since the 1980s, a trend resulting in significant biodiversity loss and ecosystem degradation.

- Crop and livestock farming produce between five and six billion tons of CO_2-equivalent in greenhouse gas (GHG) emissions each year, mostly in developing countries where the agricultural sector has expanded in recent years.

- The agricultural sector utilizes 70 per cent of the water resources we withdraw from rivers, lakes and aquifers, raising serious concerns in terms of sustainability and security.

Summary statement

The **TEEBAgriFood** study is designed to:

1. provide a comprehensive economic evaluation of the ***'eco-agri-food systems' complex***
2. demonstrate that the economic environment in which farmers operate is distorted by ***significant externalities***, both negative and positive, and a lack of *awareness of* ***dependency on natural and social capital***

The visible and invisible flows of agricultural production

COMMENT

ZAKIR HOSSAIN CHOWDHURY/ANADOLU AGENCY/GETTY

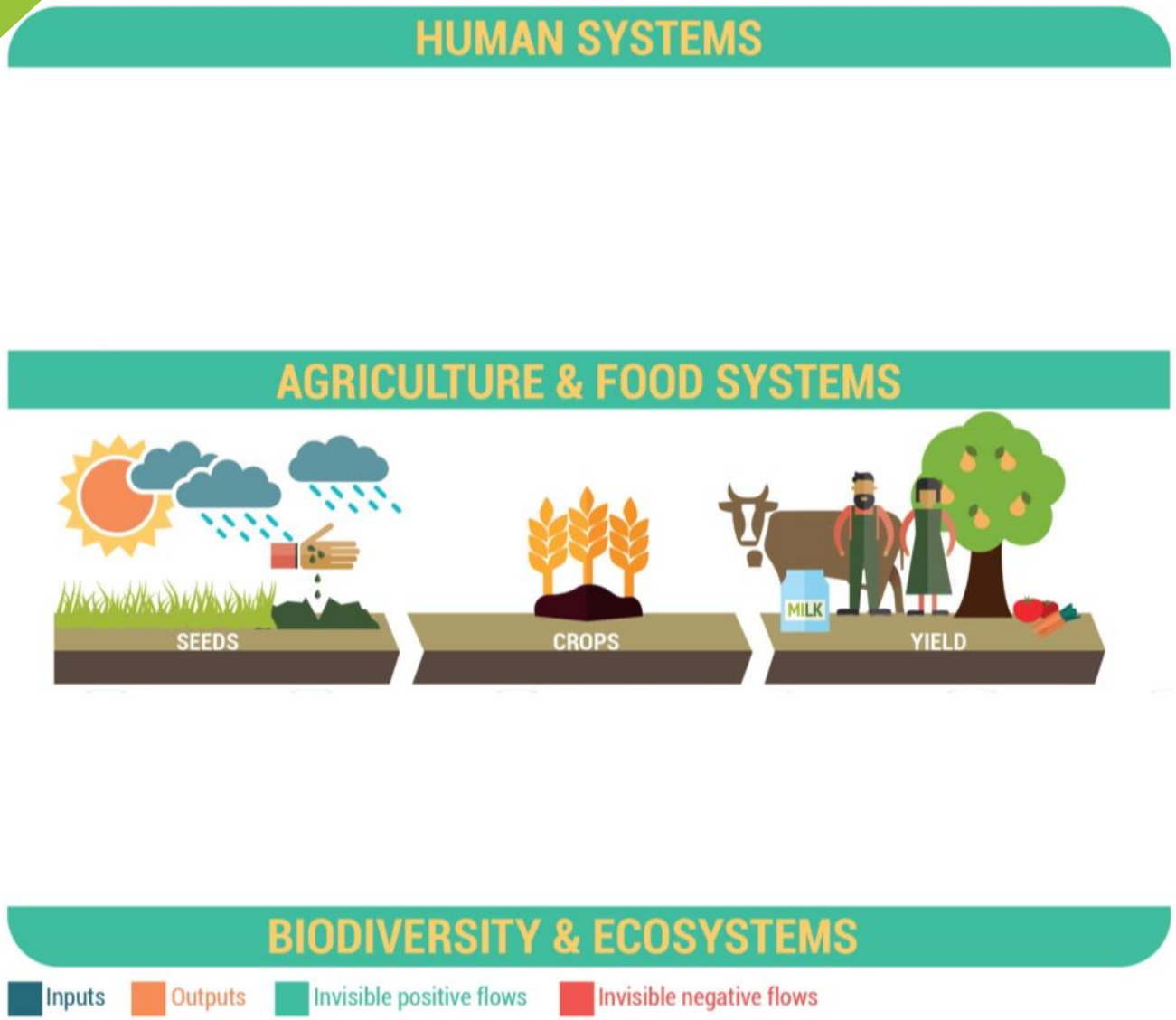
Drying red chillis under the sun provides one of the few sources of employment for women in an area of Bangladesh.

Fix food metrics

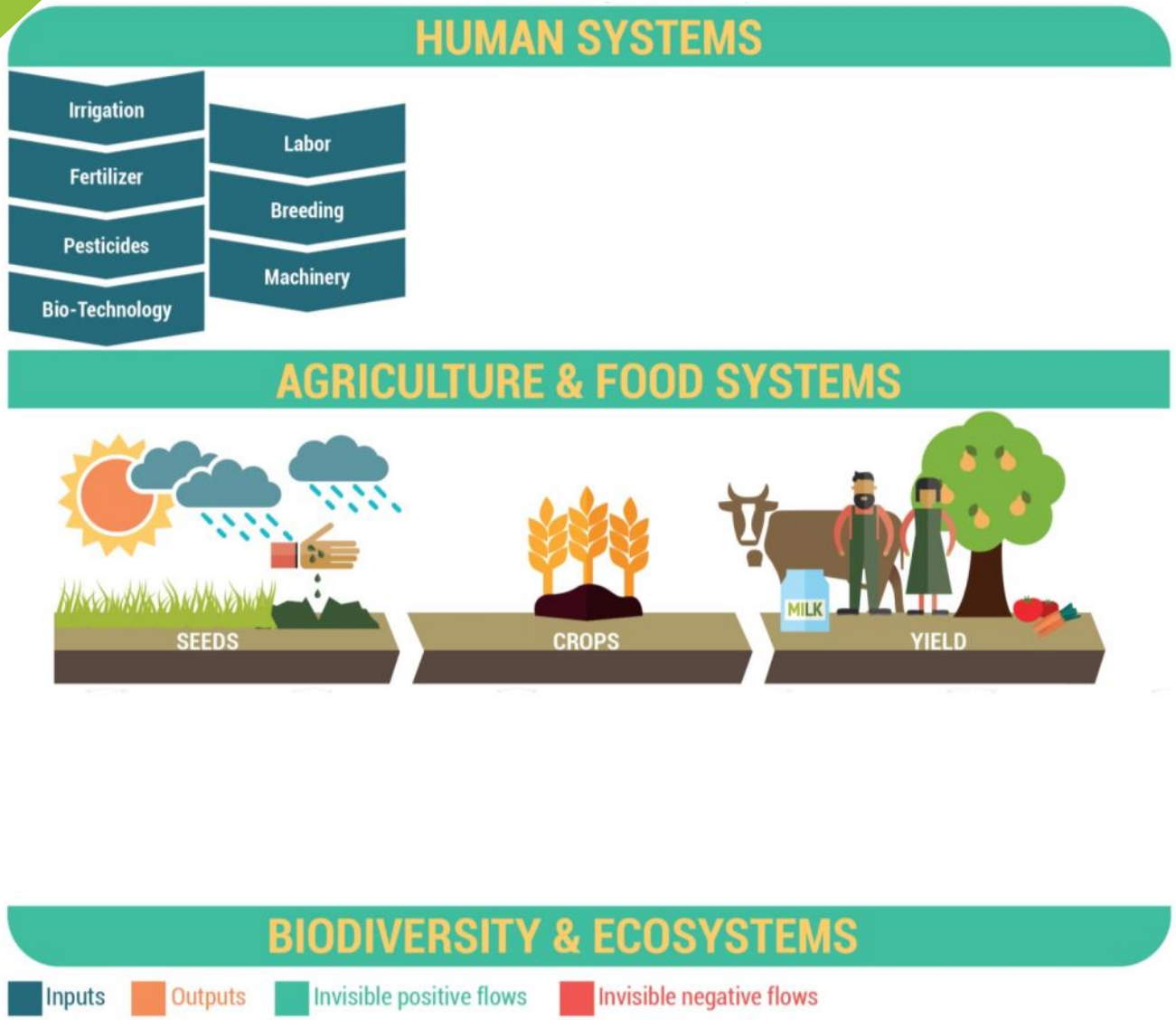
For sustainable, equitable nutrition we must count the true global costs and benefits of food production, urge **Pavan Sukhdev**, **Peter May** and **Alexander Müller**.

The visible and invisible flows of agricultural production

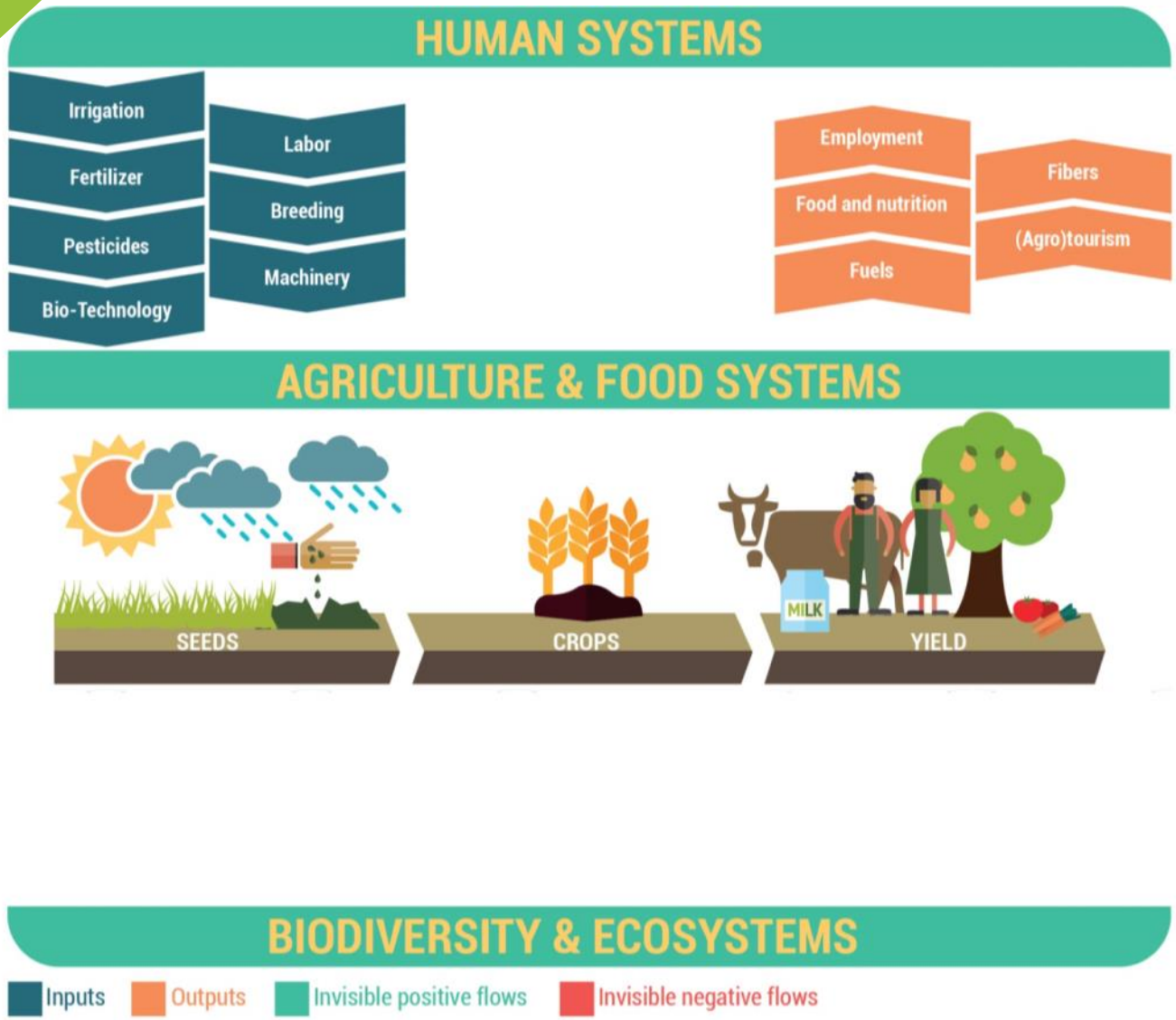
The visible and invisible flows of agricultural production



The visible and invisible flows of agricultural production



The visible and invisible flows of agricultural production



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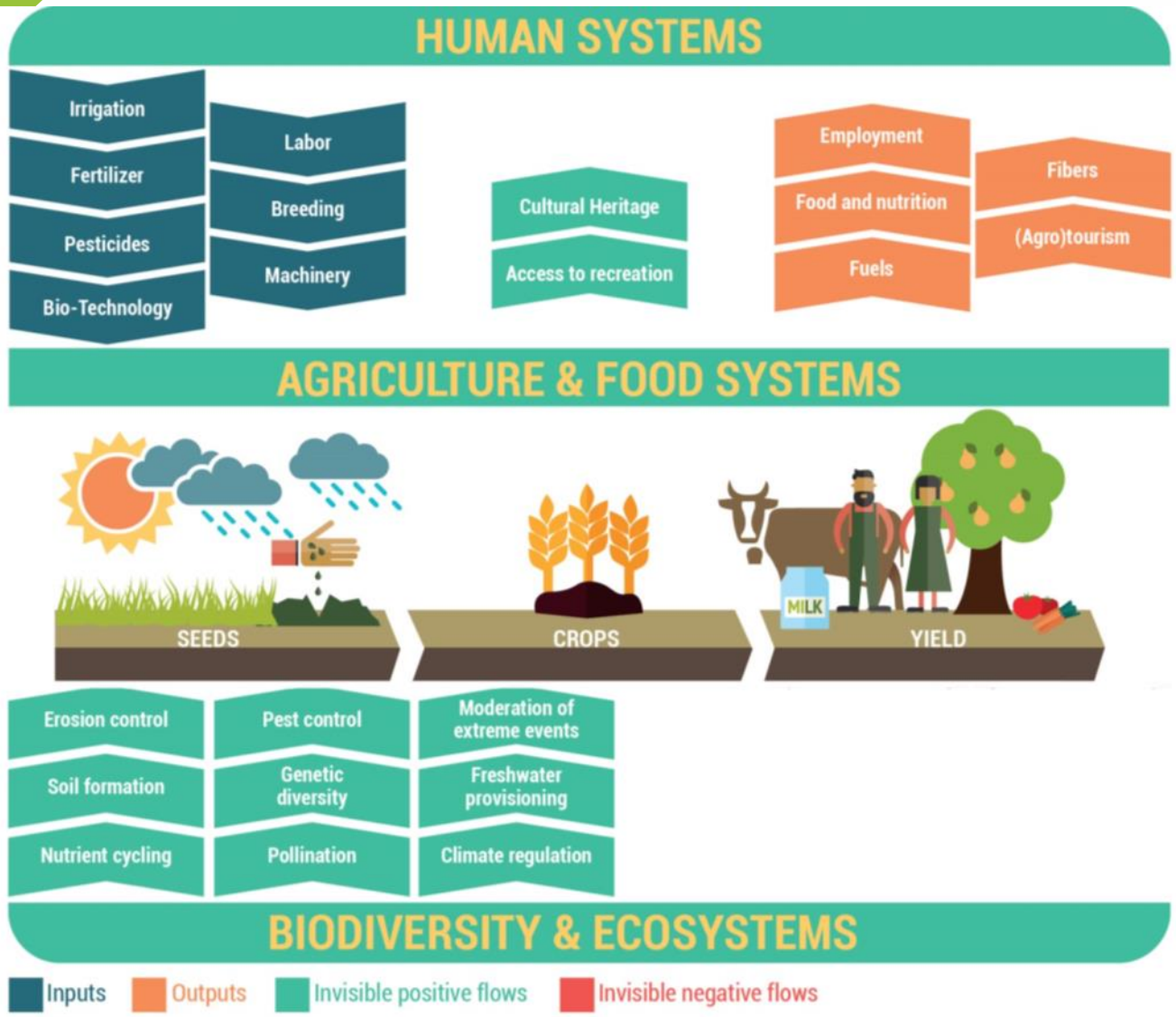
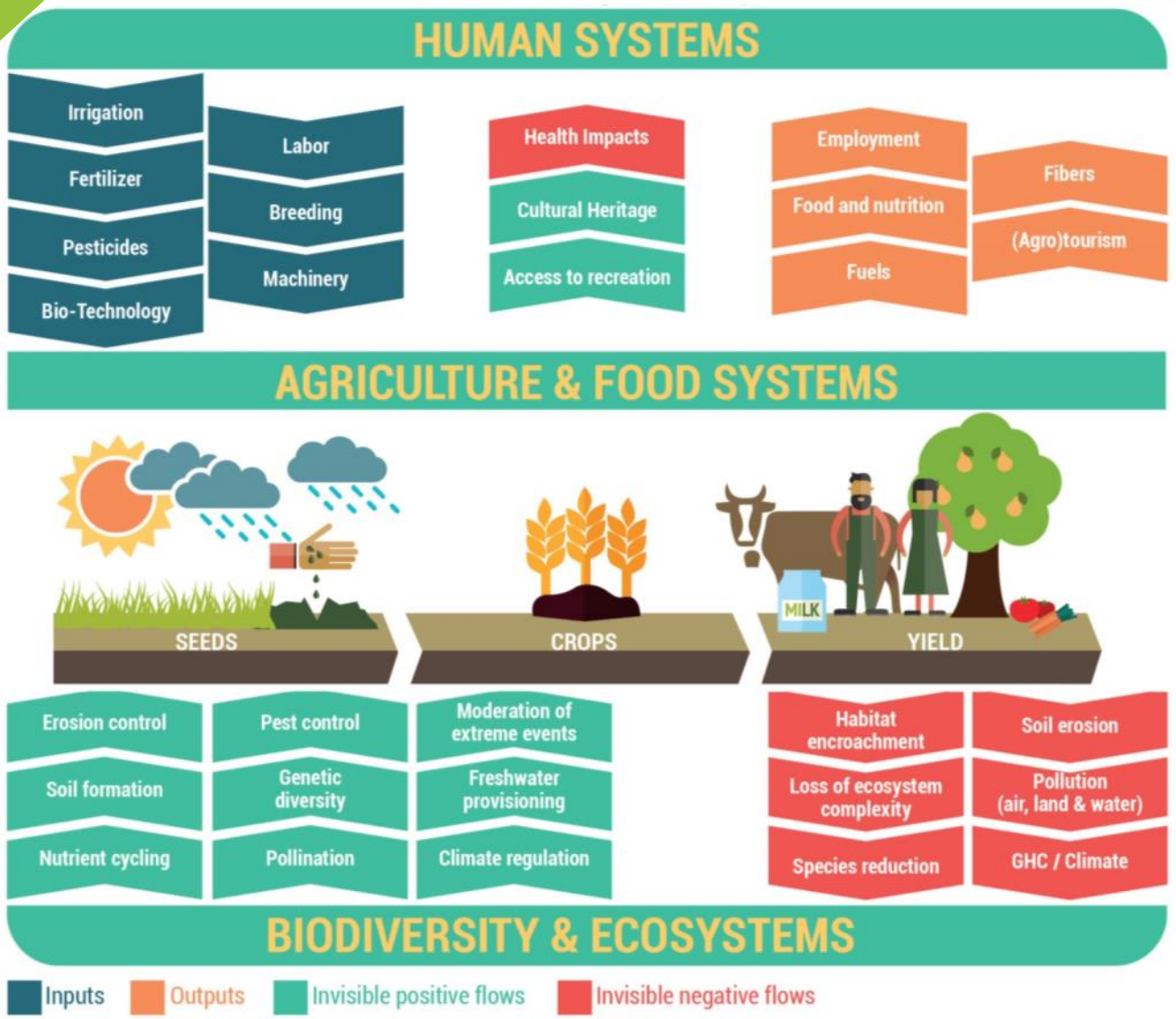
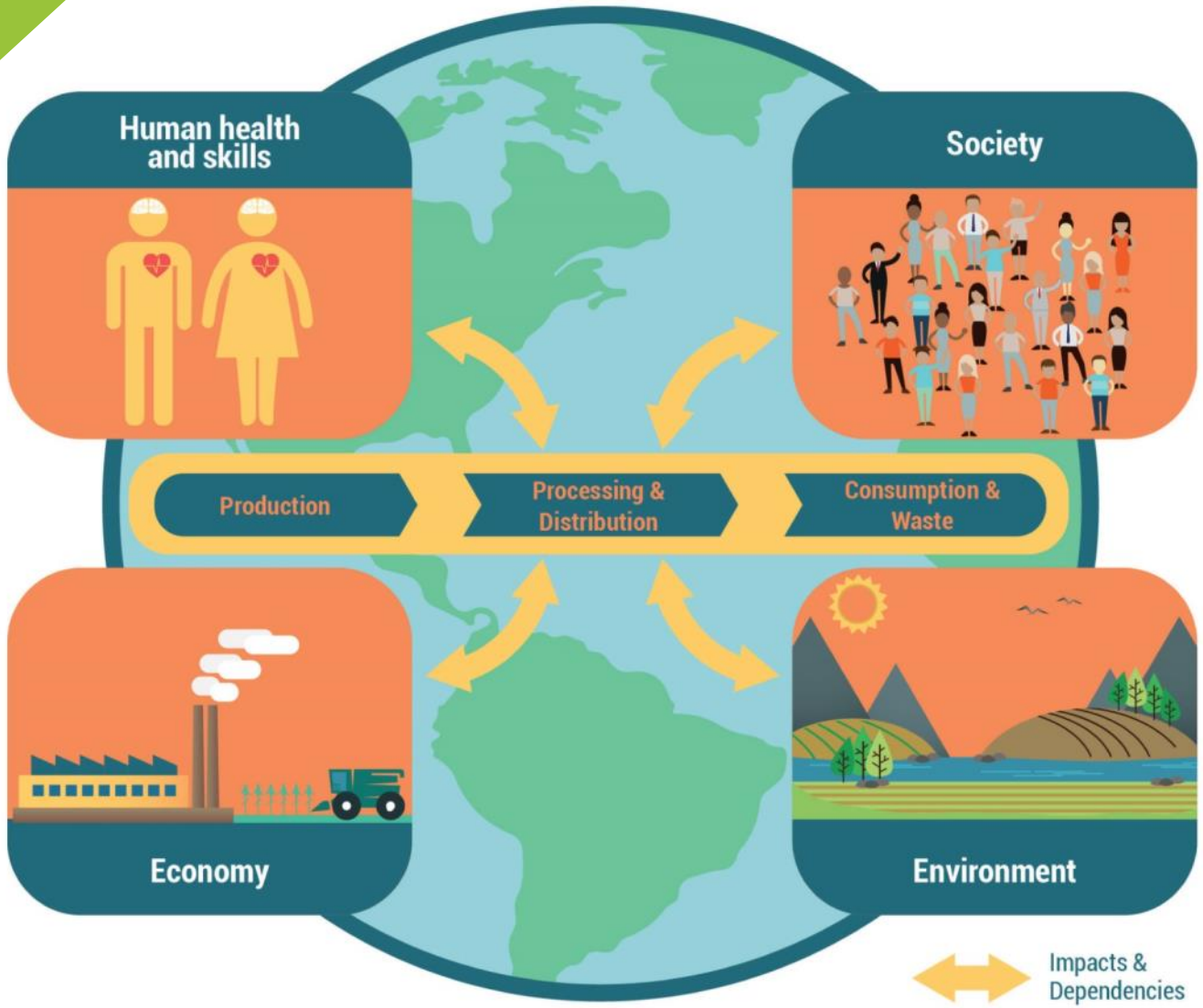


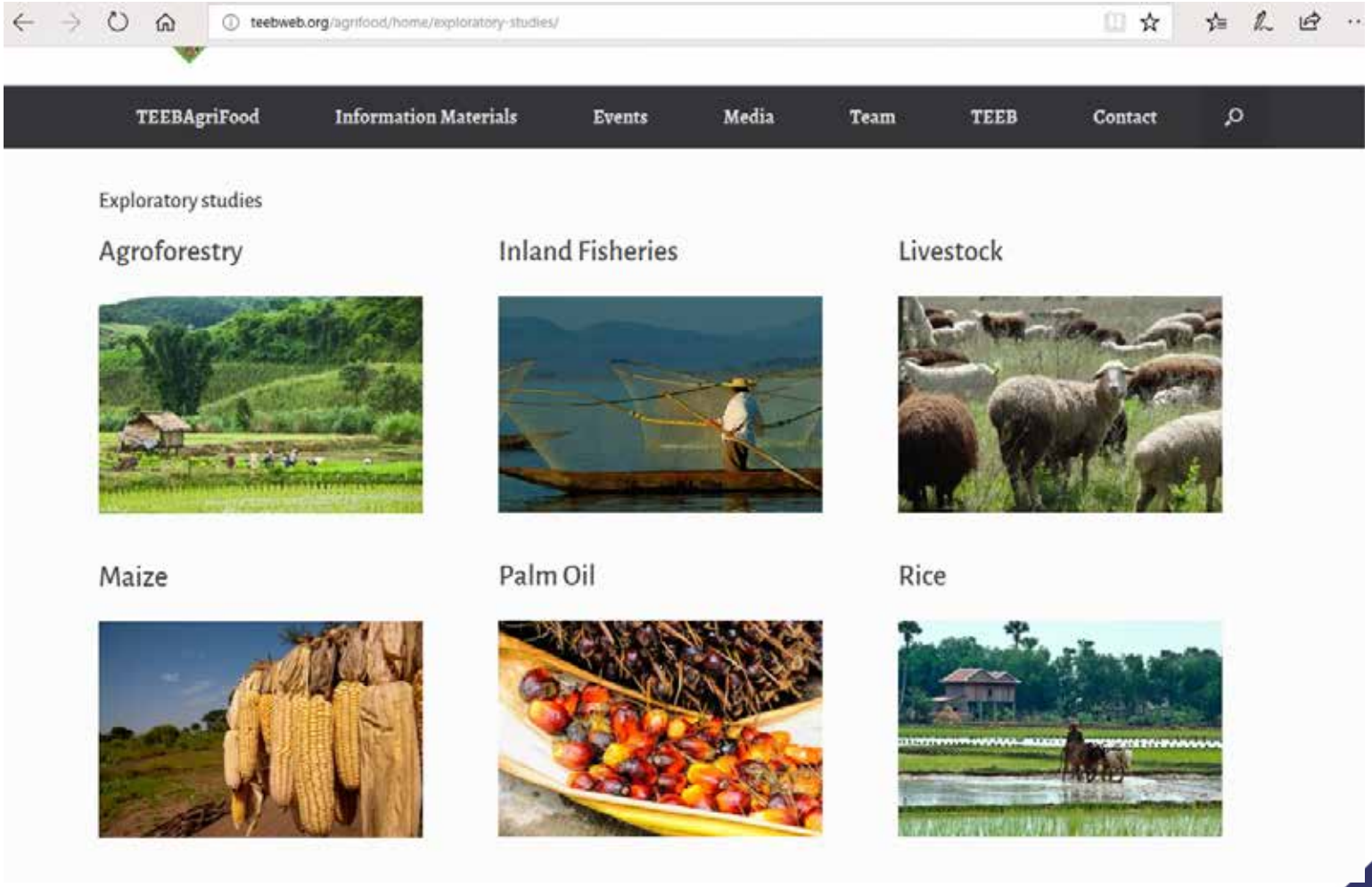
The visible and invisible flows of agricultural production



Eco-agri-food systems complex – impacts and dependencies



2014-2016 ‘Exploratory studies’



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

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

Developing scenarios

- 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)
- Coffee profitability is very low in smallholder agroforestry systems in Ethiopia, mostly due to **volatility in global market prices**
- Climatic predictions show that areas bioclimatically suitable for coffee production may **reduce by 65%** (Davis et al. 2012)

Developing scenarios

Scenarios plausible?

I: Conversion to maize monocrop - drivers include 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: Scenarios and 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

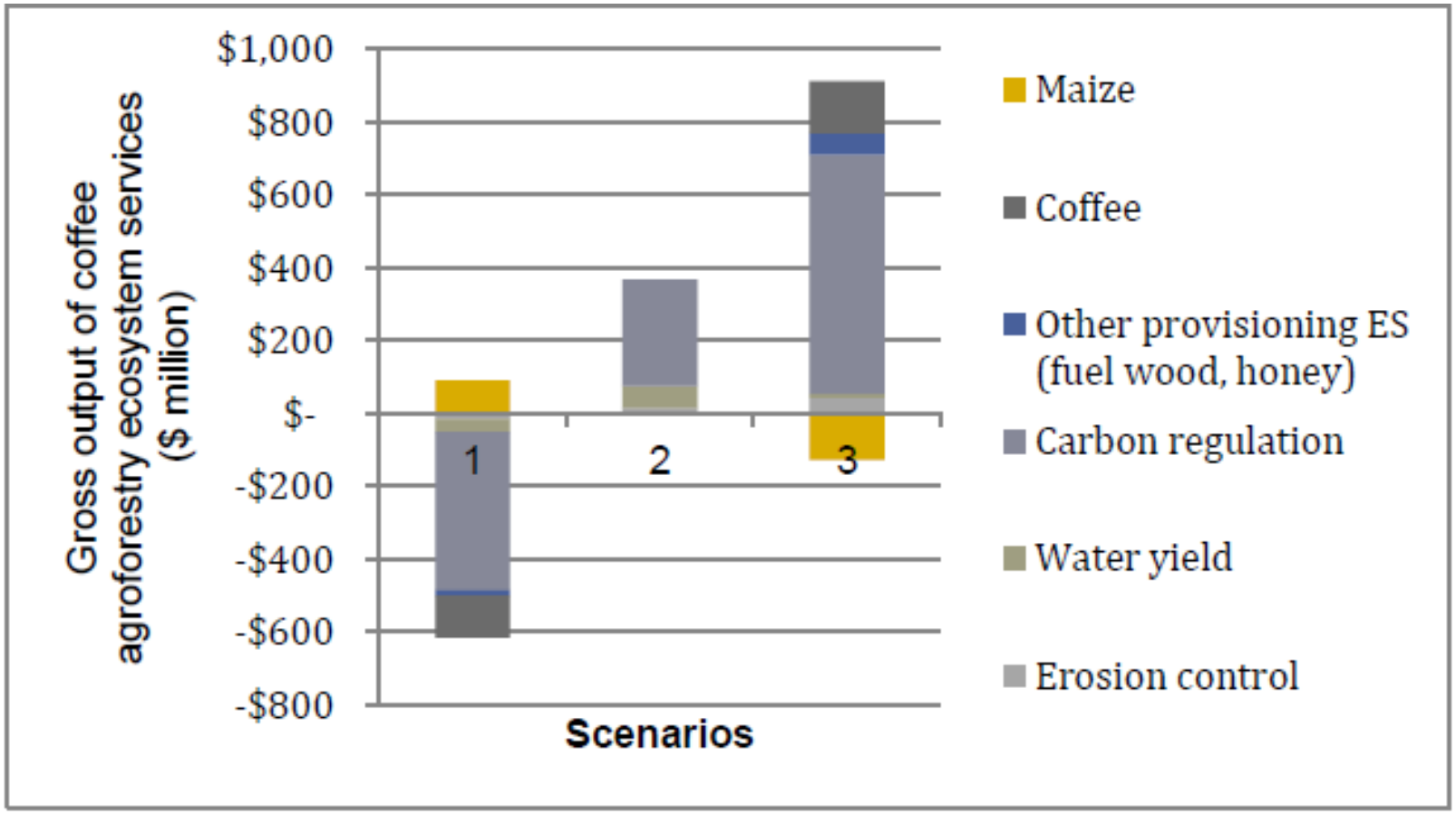
Ecosystem Service	Agroforestry System			Valuation Method
	Cocoa	Coffee	Ngitili	
Provisioning				
Cash Crops	***	***	N/A	Market price[16]
Food Crops	***	***	***	Market price
Tree Crop Products	***	***	N/A	Market price
Medicines	*	*	***	Shadow price[17], replacement cost
Wild Food and all other NTFP	*	***	***	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

Agro-forestry Scenario analysis

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

Agro-forestry Scenario analysis



teebweb.org/agrifood/home/scientific-and-economic-foundations-report/

TEEB for Agriculture & Food

An initiative of 'The Economics of Ecosystems and Biodiversity' (TEEB)

Scientific and Economic Foundations

Scientific and Economic Foundations Report

Measuring what matters in agriculture and food systems

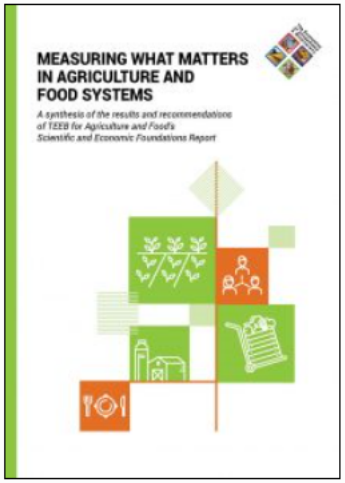
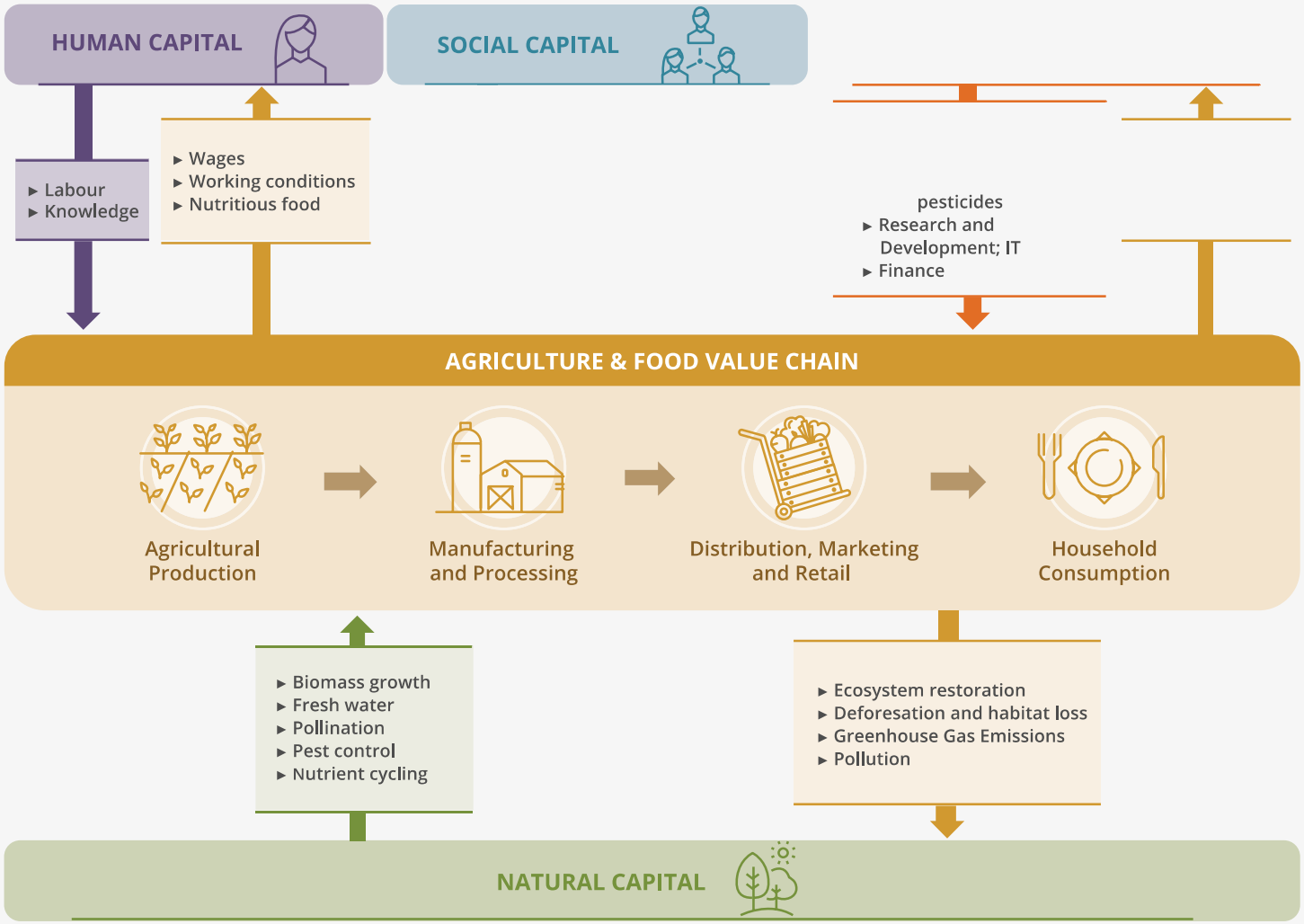


Figure 2.1 Capital stocks and value flows in eco-agri-food systems (Source: Hussain and Vause 2018)



Applying the TEEBAgriFood Framework

I. Evaluate the full value chain:
- Production
- Manufacturing / Processing
- Distribution / Marketing
- Household consumption

II. Measure stocks of all four capitals:
- Natural capital
- Produced capital
- Human capital
- Social capital

III. Measure all classes of flows or “impacts”
- Ag, forest, livestock output
- Purchased inputs
- Ecosystem services
- “Residuals” (Pollution and waste)

Agro-forestry: Phase I 'landing page'

Value chain stages / Visible and invisible flows	Production (and associated waste)			Processing and Distribution (and associated waste)			Consumption (and associated waste)
Flows generated at the level of	**Landscape**	**Infrastructure and Manufacturing**	**Farm**	**Wholesale**	**Food and Beverage**	**Retail**	**Industry/ Household/ Hospitality**
Value Captured by System of National Accounts (SNA)			Income from yield				
Provisioning Services (Materials, Energy, etc.)			Yield				
			Fresh water				
			Timber, fuelwood, honey				
			Medicinal plants				
Regulation and Maintenance Services (Soil, Water, Habitat for biodiversity, etc.)			Freshwater quality				
			Carbon storage and sequestration				
			Soil erosion				
			Soil fertility				
			Biodiversity				
			Pollination				
			Pest control				
Cultural Services (Heritage, Recreation, etc.)							
Health Impacts (Nutrition, Lifestyle diseases, Antibiotic resistance, etc.)							
Pollution Impacts (Nitrates, Pesticides, Heavy metals, etc.)							
GHG Emissions (CO_2, CH_4, etc.)							
Social values (Food security, Gender equality, etc.)			Food security/access				
Risks and uncertainties (Resilience, Health, etc.)							

Monetary estimates
Quantitative estimates
Qualitative discussion

Agro-forestry Phase II

COVERAGE OF IMPACTS AND DEPENDENCIES BEING ASSESSED IN COCOA VALUE CHAINS IN GHANA AND COFFEE VALUE CHAINS IN ETHIOPIA		Value chain			
		Agricultural production	Manufacturing & processing	Distribution & marketing	Household consumption
Stocks / Outcomes (change in capital					
Natural capital	Water (incl. quality, quantity)	X	X		
	Soil (incl. quality, quantity)	X			
	Air	X	X	X	X
	Vegetation cover and habitat quality	X			
	Biodiversity	X	X		
	Other				
Produced capital	Buildings				
	Machinery and equipment		X	X	
	Infrastructure				
	Research and development				
	Finance	X	X	X	
	Other				
Human capital	Education / skills				
	Health	X	X		X
	Working conditions (decent work)	X	X	X	X
	Other				
Social capital	Land access/tenure (private, public and communal)				
	Food security (access, distribution)				X
	Opportunities for empowerment (gender and minority)				
	Social cooperation (incl networks/unions)	X		X	X
	Institutions				
	Laws and regulations (e.g. child labor)	X			
	Other				
Flows					
Agricultural and food outputs	Agricultural and food products	X			
	Income: value added, operating surplus	X	X	X	X
	Subsidies, taxes and interest				
Purchased inputs	Labour inputs (incl skills)	X	X	X	
	Intermediate consumption (produced inputs such as water, energy, fertilizers, pesticides, animal health and veterinary inputs)	X	X	X	
Ecosystem services	Provisioning (e.g. biomass growth, freshwater)	X			
	Regulating (e.g. pollination, pest control, nutrient cycling)	X	X		
	Cultural (e.g. landscape amenity)				
Residuals	Agricultural and food waste	X	X	X	X
	GHG emissions	X	X	X	
	Other emissions to air, soil and water	X			
	Wastewater		X		
	Solid waste and other residuals				

V. Policy mainstreaming and SEEA-EEA

What is do we mean by policy mainstreaming?

A change in *outcomes*:

Ø Reduced impacts of anthropogenic activities on ecosystems and biodiversity

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Achieving these changes in outcomes:

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Mainstreaming SEEA-EEA:

- *Establishing an environment* such that change agents use the evidence and information provided by SEEA-EEA as an input to determining their behaviors, and in turn reducing impacts

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Achieving these changes in outcomes:

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Mainstreaming SEEA-EEA:

Ø *Establishing an environment* such that change agents use the evidence and information provided by ~~SEEA-EEA~~ [other competing frameworks or tools] as an input to determining their behaviors, and in turn reducing impacts

What does SEEA-EEA bring to the table?

1. **The *only* statistical framework that is endorsed by the UN Statistical Commission**
   - Ø Same agencies (National Statistical Offices) that are charged with providing System of National Accounts (SNA) and GDP measures, i.e. *credibility*
   - Ø Like the SNA, *continuity* of data collection
   - Ø Transactions costs of establishing the mechanisms to collect the data for the first time versus *lower on-going costs* of continuing to do so year-on-year

What does SEEA-EEA bring to the table?

1. The *only* statistical framework that is endorsed by the UN Statistical Commission
2. **Links to achieving global commitments**
   - Ø Sustainable Development Goals
   - Ø Aichi Biodiversity Targets

What does SEEA-EEA bring to the table?

1. The *only* statistical framework that is endorsed by the UN Statistical Commission
2. Links to achieving global commitments
3. **A framework that can support *spatially-specific* decision-making**
   - Ø The vast majority of economic/political choices have a spatial dimension

Agro-forestry: How could SEEA-EEA 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-EEA) 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-EEA space...

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

Thank You!

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