Bringing the Ecology in Ecosystem Accounting

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WAVES

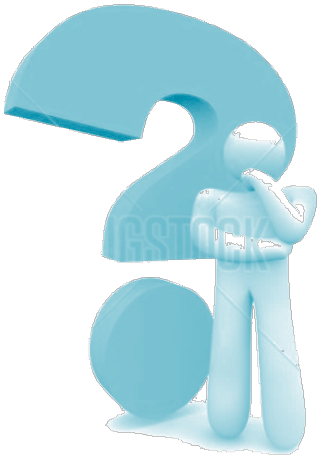
Wealth Accounting and the Valuation of Ecosystem Services
www.wavespartnership.org

WORLD BANK GROUP

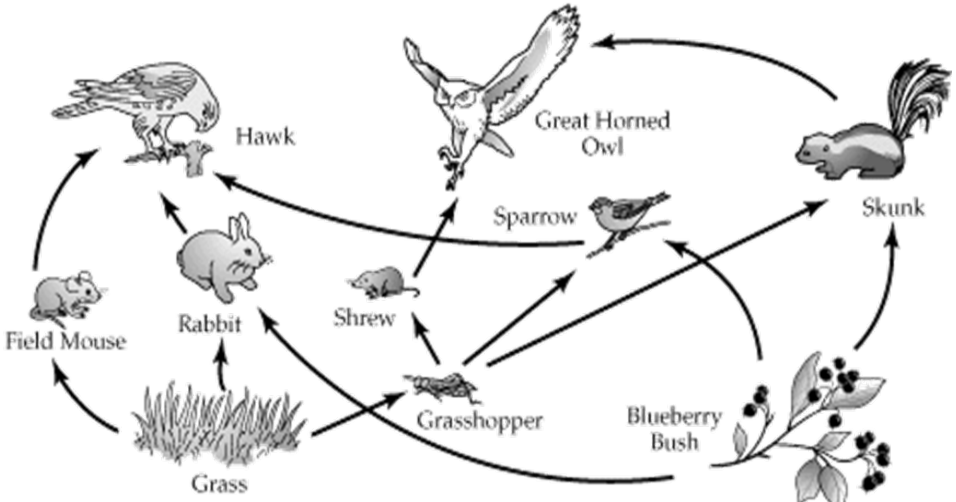
Contents

- Ecosystems and ecosystem services
- Ecology in Ecosystem accounting
- Biophysical model development: practical aspects
- Exercises (in groups of two)
- Plenary discussion on exercises
- Synthesis

Ecosystems



Ecosystems are defined as ‘communities of living organisms (plants, animals and microbes) interacting with one another as well as the non-living components of their environment (e.g. water and soil)’ (Wiki, Rio-conference)



An ‘ecosystem’

What is ‘wrong’ with this definition and picture ?

Ecosystems

Most ecosystems on the planet are strongly influenced, modified and managed by people

Types of ecosystems

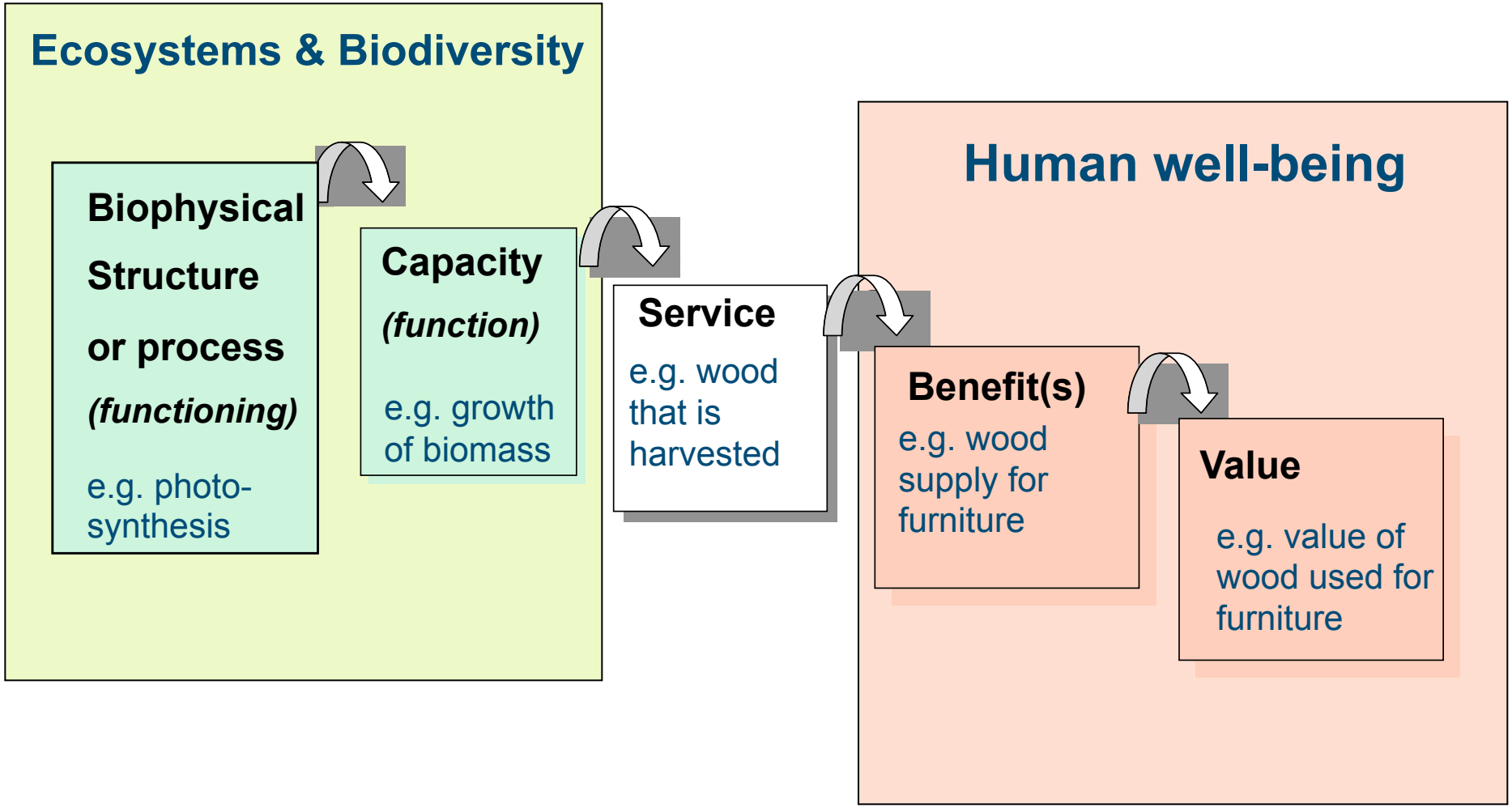
Cropland

Forests

Rangelands

Coastal zones

Ecosystem services and human well-being



Cascade Diagram, modified from Haines-Young and Potschin)

Types of ecosystem services

Provisioning services:

the products that can be extracted from or harvested in ecosystems

For example:
Timber
Fish


Regulating Services:

the regulation of ecological, hydrological and climate processes

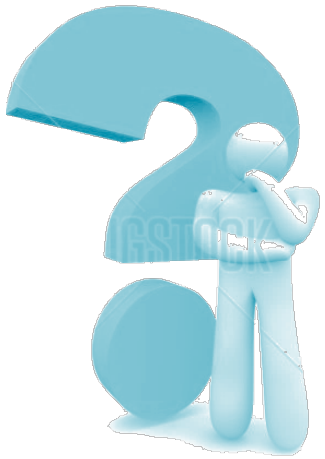
For example:
Water regulation
Carbon sequestration


Cultural services:

the non-material benefits from ecosystems (e.g. recreation)

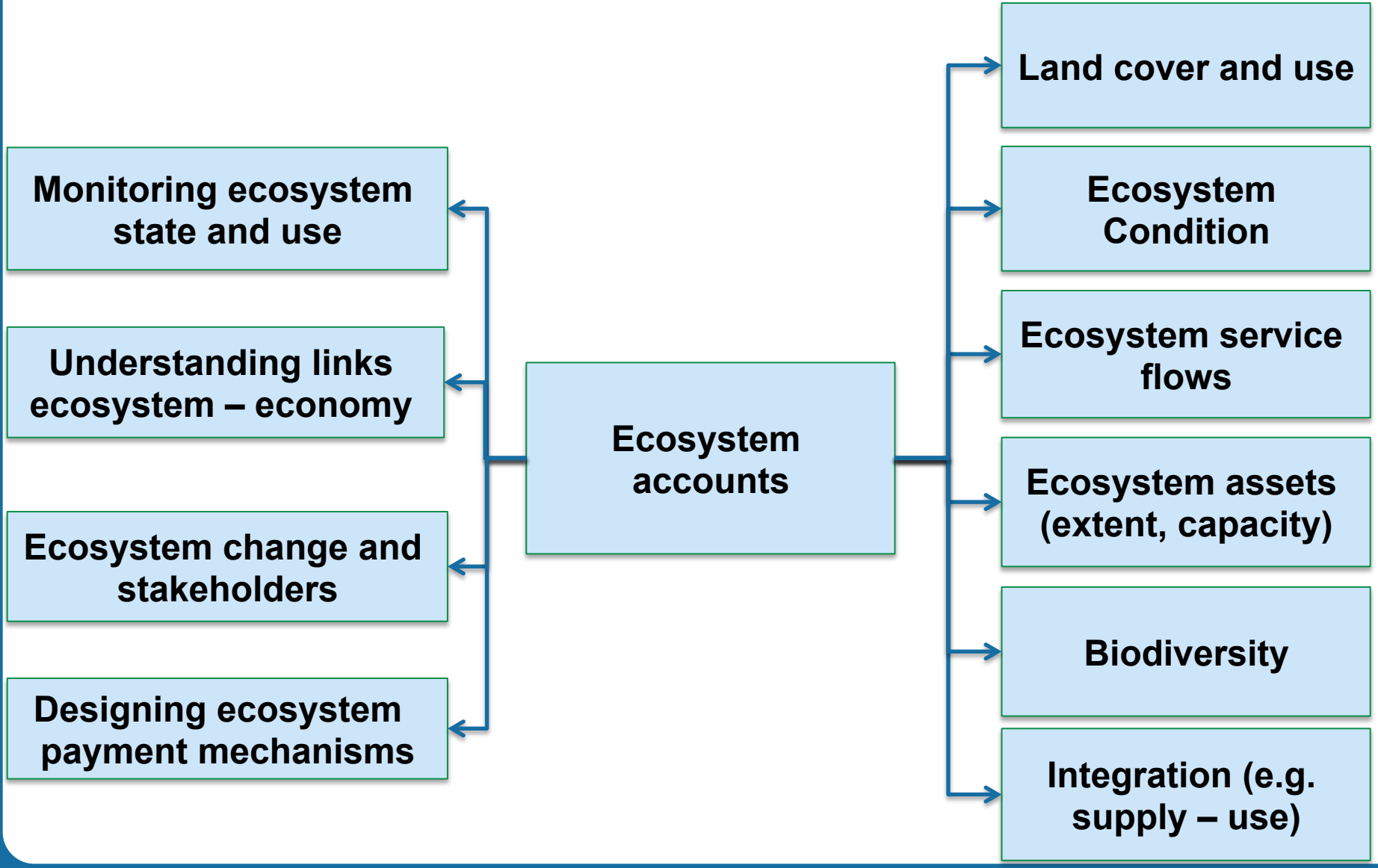
For example:
Recreation
Education


Ecosystem services



- **Can you give an example in your country of a service in each of the categories ‘provisioning’, ‘regulating’ and ‘cultural’ services ?**

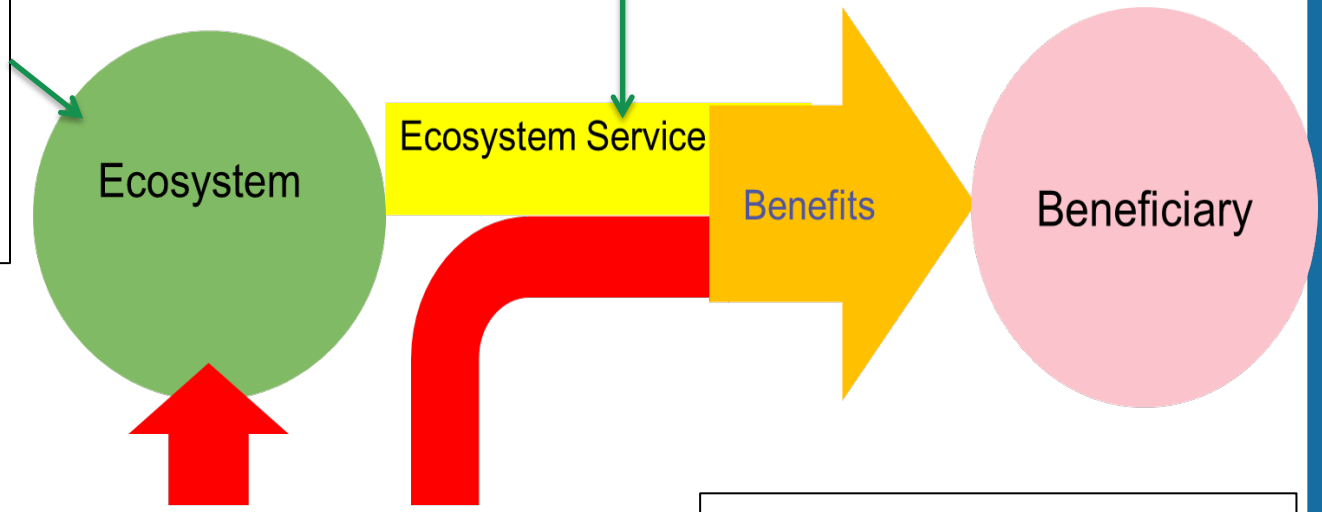
Key concepts and links to policy



The link between assets, services & benefits

Ecosystem asset
- Land cover: shows extent of ecosystems
- Ecosystem condition
- Specific components relevant for policy (carbon, water, biodiversity)
- Capacity to generate ecosystem services

Service flow accounts
- Provisioning
- Regulating
- Cultural



System of National Accounts

Integration of all accounts
- E.g. supply use tables

Ecosystem accounting is rapidly evolving

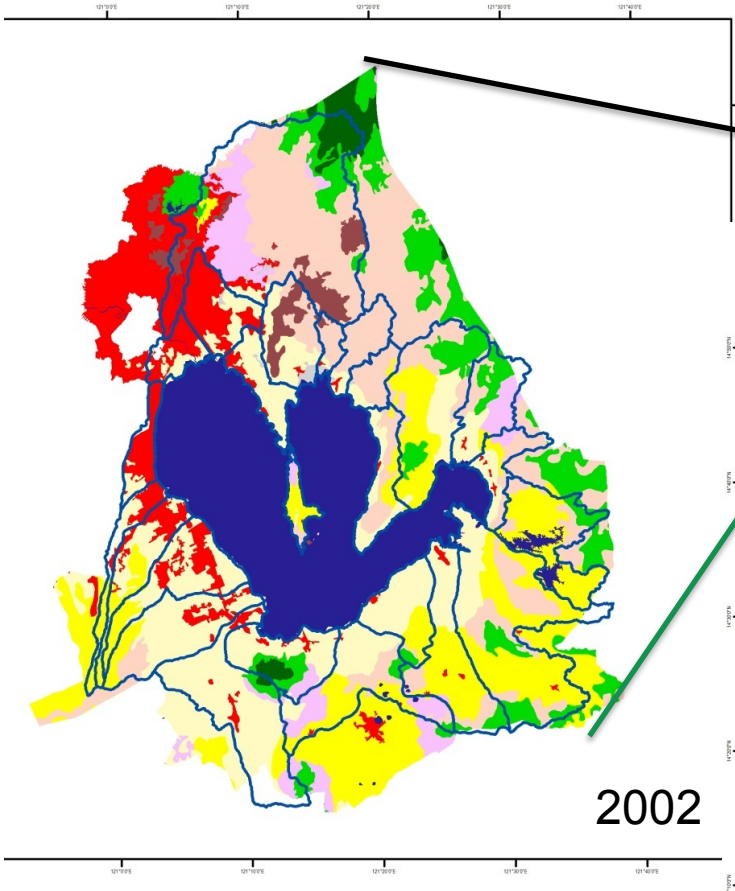
Basis: System for Environmental Economic Accounting (SEEA) Experimental Ecosystem Accounting Guidelines (2013)

- Process of standardisation with the UN Statistics Division

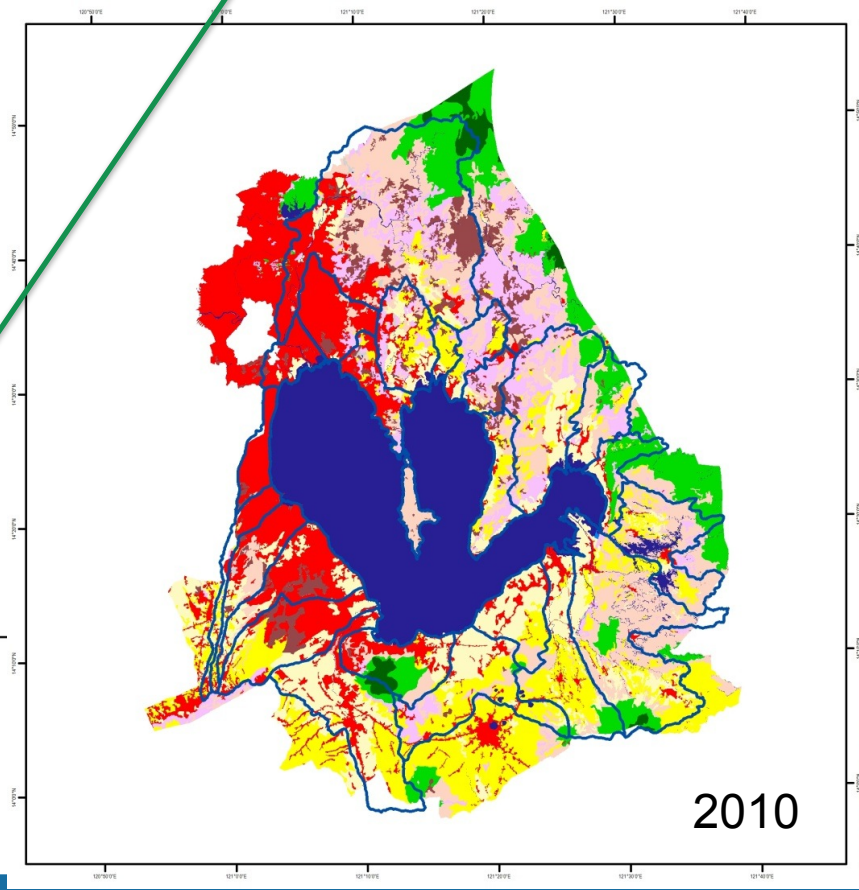
Our focus here builds on SEEA EEA, including:

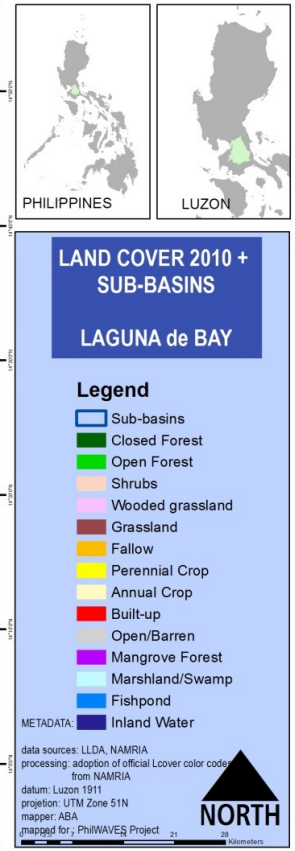
1. Land Account
2. Ecosystem Condition Account
3. Ecosystem Services Account
4. Ecosystem Asset Account
5. Biodiversity Account
6. Integration (e.g. supply-use)

Land Account Laguna Lake Basin



Includes land cover and land tenure





Change matrix provides quantitative overview of land cover change

Ecology in the Condition Account

The condition account is used:

1. To monitor changes in ecosystem state, and potentially pressures on ecosystems
2. As an information set required to model ecosystem's capacity to generate services

The indicators need to reflect:

1. Policy relevant ecosystem change processes
2. Indicators relevant for ecosystem services

The indicator set will always be context specific

Examples of condition indicators

Examples of indicators

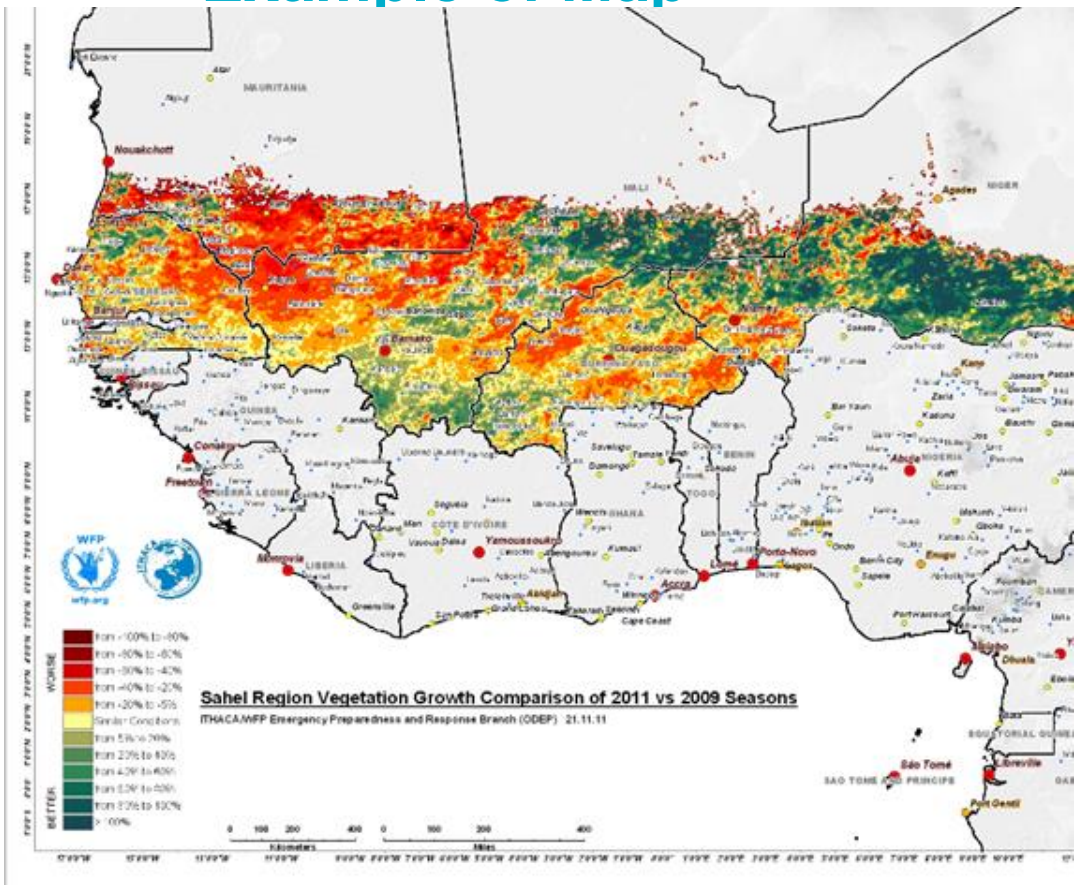
STATE Indicators

- Rainfall
- Soil type
- Groundwater depth
- Composition of vegetation
- Net primary production

PRESSURE Indicators

- Occurrence of fire
- Occurrence of droughts

Example of Map



Ecology in the Ecosystem Services Account

The services account is used:

1. To monitor annual flows of ecosystem services, in every Basic Spatial Unit (e.g. pixel) – in physical (& monetary) units

Ecology is needed:

1. To model flows of regulating services
2. To map ecosystem services flow across the landscape

The models for regulating services will always be context specific

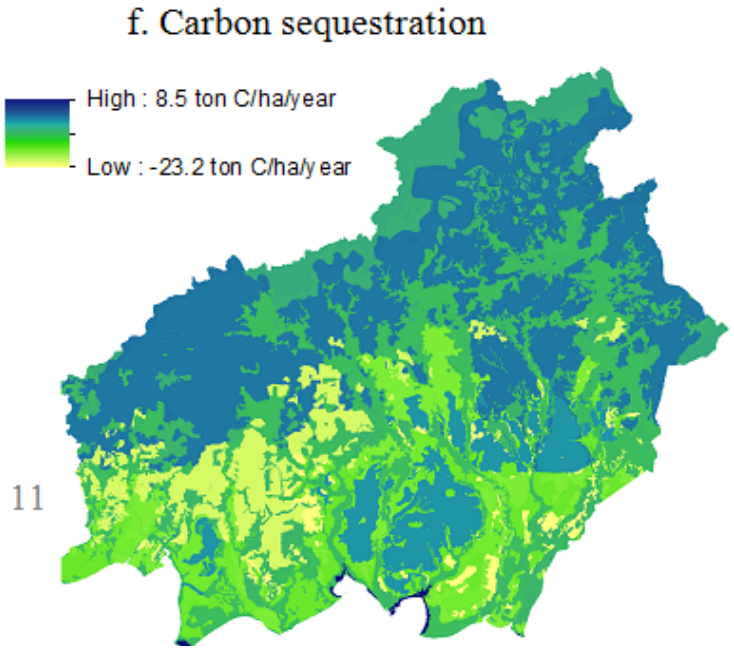
Example 1. Carbon sequestration

Modelled with a Lookup Table approach in Central Kalimantan, Indonesia

Aggregation per Land Cover Ecosystem Unit (LCEU)

Validation

Land cover	Carbon sequestration (ton C/ha/year)	Sources
Mangrove	8.5	Komiyama (2006)
Primary dipterocarp forest	0.8	Hirata et al. (2008)
Secondary dipterocarp forest	4.0	Luyssaert et al. (2007); Saigusa et al. (2008)



Source: Sumarga and Hein, 2014

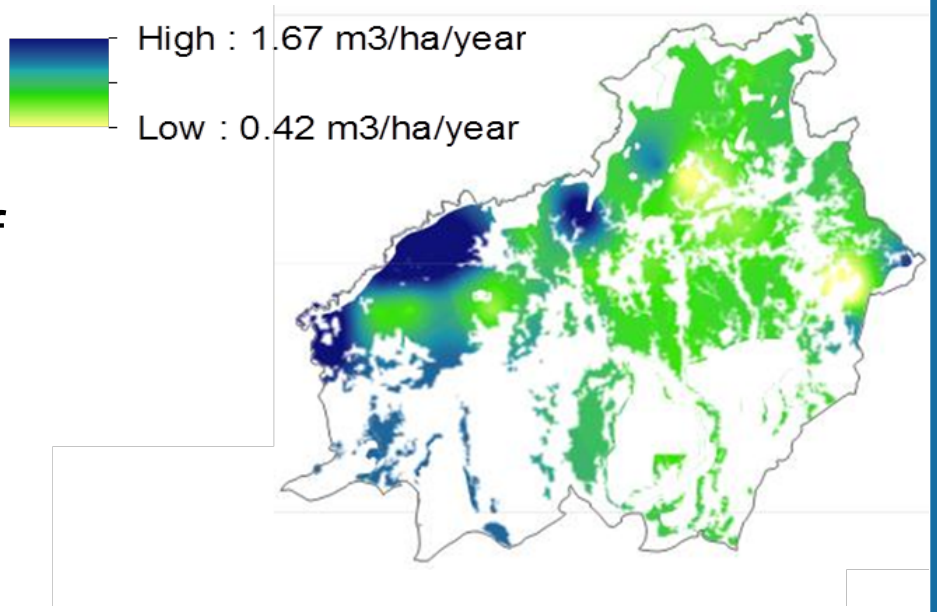
Example 2. Timber production

Timber production in Central Kalimantan modelled with interpolation (kriging) in ArcGIS.

Data were available for 35 out of 52 concessions

Timber production in other 17 concessions estimated based on production in nearby concessions

More sophisticated models possible, that also correct for soils, rainfall, slope, etc.



Source: Sumarga and Hein, 2014

Modelling flows of regulating services

Hydrological services (flood control, dry-season water, control of sedimentation)

1. Require use of spatial hydrological models (such as SWAT or SedNet)
2. Require data on river flows for prolonged period (say >5 years), preferably daily measurements (plus other data)

Carbon sequestration

1. Can be modelled using MODIS satellite data (Net Primary Production – Soil Respiration) *OR*
2. Using a Look Up Table that specifies carbon sequestration per vegetation type

Ecology in the Ecosystem Asset Account

The Asset account records the capacity of the ecosystem to generate ecosystem services as a function of condition and extent (area)

For provisioning services, capacity:

= The amount of ecosystem services that can be used without degrading the ecosystem

For regulating services, capacity:

= reflects the physical impacts of regulating services on the environment, irrespective of use

For cultural services, capacity equals flow

Example 3. Estimating capacity for hunting

Moose populations per municipality estimated with a basic population model (Austrheim et al. 2011)

$$N\downarrow t = Q\downarrow t \{(C\downarrow t - M/1 - C\downarrow t\ ) - (\lambda - 1)\}\uparrow -1$$

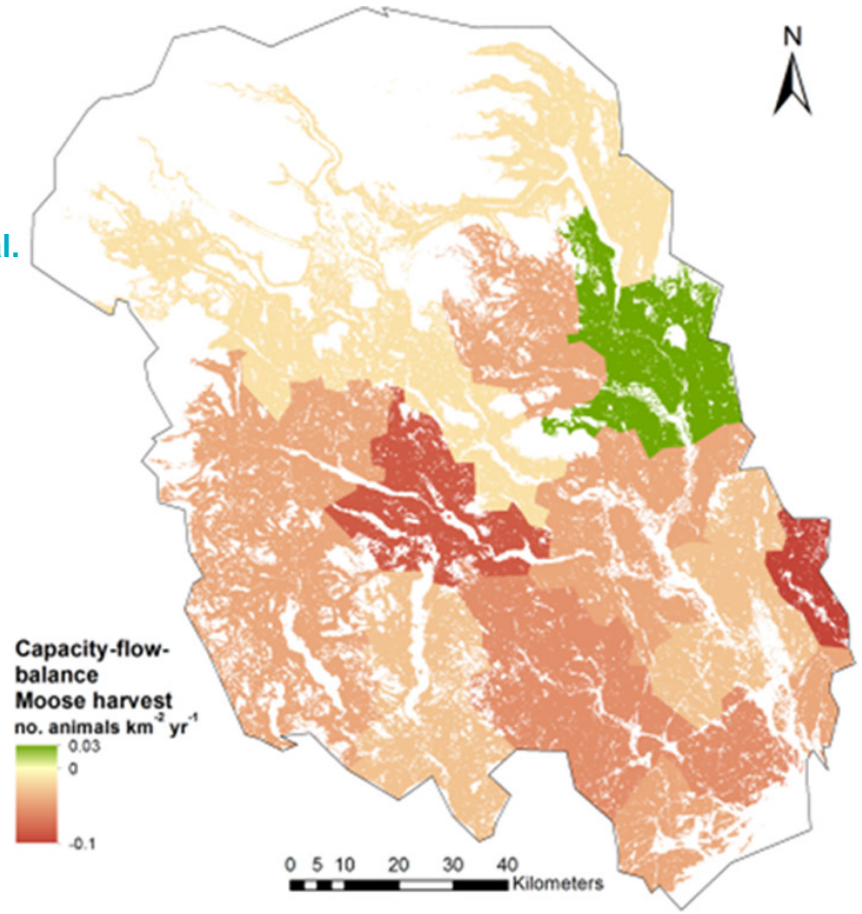
N_t = post-harvest population,

Q_t = annual harvest

C_t = pre-harvest proportion of calves in the population

M = natural mortality rate: 0.05

λ = population growth rate



Capacity–flow-balance for moose hunting in Telemark (Schröter et al., 2014)

Capacity & flood control

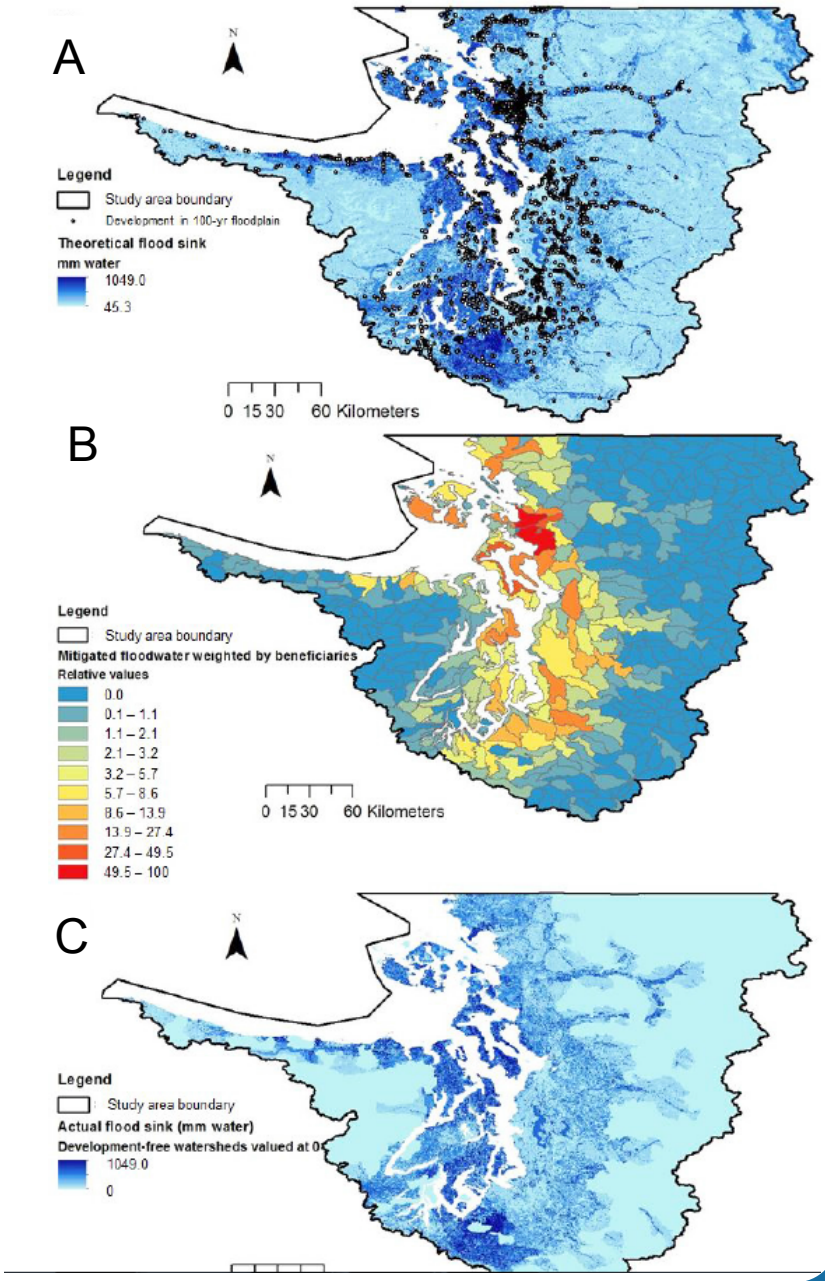
A. Capacity (*'theoretical service'*)

B. Beneficiary density

C. Actual service flow

Actual service flow only occurs where people are benefitting from the capacity

Puget Sound, West-coast US, source: Bagstad et al., 2014



Biodiversity in accounting

Biodiversity includes ecosystem, species and genetic diversity

The ecosystem accounting approach includes a specific 'Biodiversity Account' in support of land management

Relevant indicators include:
- species diversity,
- species numbers,
- red list species,
- occurrence of specific flagship species,
- habitat quality, etc.

Requires a spatial approach, i.e. maps, complemented with summary tables synthesising information for users

Biodiversity account

Ecology in the biodiversity accounts

1. Indicator selection

- Presence of species (species richness per BSU)
- Presence of Red List species (per BSU)
- Habitat condition (e.g. fragmentation, disturbance, naturalness of vegetation, etc.)

2. Modelling

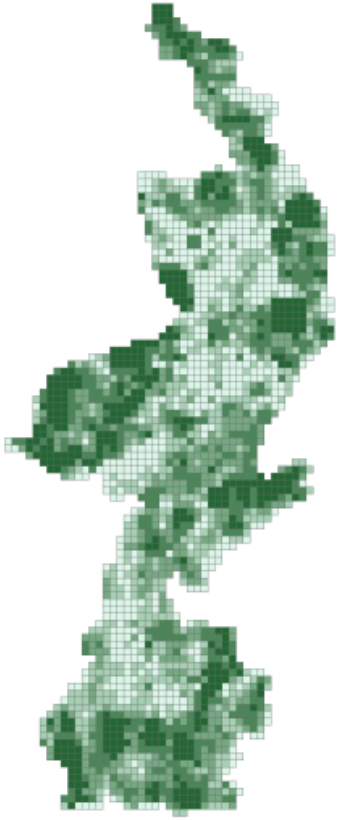
- Extrapolation of sample points

Example 4. Species richness in Limburg

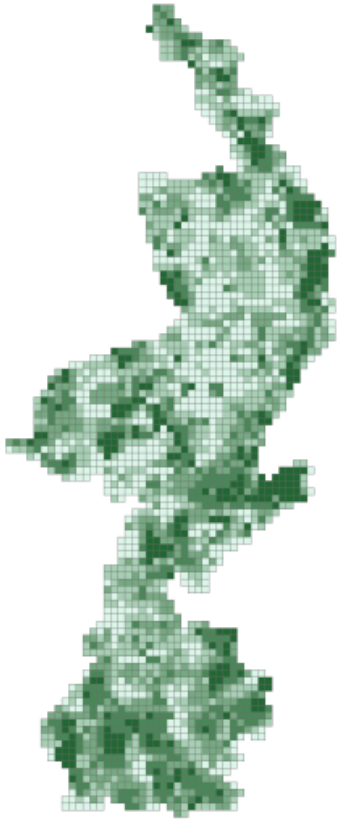
Source: Remme et al, in prep

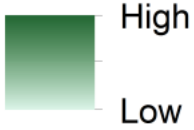
Biodiversity indicator: species richness

Butterflies



Amphibians





Work in progress shows little correlation between species richness of different species groups in Limburg, the Netherlands, and a range of different indicators are being tested

Source: Remme et al., in prep.

Biophysical model development (1)

Biophysical modelling requires:

- Geographical Information System (GIS)
- Specific models or modules for specific services
- Full time staff to collect data, model, prepare accounts
- Capacity building
- Time (>6 to 12 months to develop accounts)

Biophysical modelling requirements (2)

Data needs:

Maps

- soils, hydrology, elevation, river network, vegetation, land use, key pressures (fire, pollution), etc.

Field survey data, including (georeferenced) point measurements

- Ecosystem use, soils, etc.

Statistics

- Environmental, fisheries, agricultural and forest statistics

Crucial to develop linkages to data holders and users

Exercise 1

A forest contains four concessions. Every concession has a specific biomass of commercial timber species. The carrying capacity is 100. During the year the forest growths, and the end of the year it is harvested

Biomass

100	80
80	60

Regrowth

0	10
10	30

Harvest

50	30
0	0

- What is the flow of ecosystem services from the forest in this year ?
- What is the capacity of the forest to sustain timber harvest in this year ?
- What is the biomass in each concession in the following year ?
- Is the forest under sustainable management ?
- What will happen to the capacity over time if the extraction rate remains the same ?

Answers

Discuss answers

Exercise 2

Three upstream forests maintain downstream water supply. Downstream, the water is used for irrigating rice. Two of the forests were partly converted to maize fields ('M'), which have a lower water holding capacity.

Land cover	Irrigation water available for	Irrigation water used on
F F F F	100 ha	90 ha
F F F M	90 ha	90 ha
F M M M	20 ha	20 ha

- What is the flow of ecosystem services from each forest in this year ?
- What is the capacity of each forest to support paddy fields ?
- How and when is deforestation recorded in the asset account?

Answers

Discuss answers

Exercise 3

Imagine an ecosystem in your country

Select one provisioning service and one or two regulating services provided in this case study area

Develop a conceptual ecosystem model for these services:

- Which indicators can be used to model the flow of the services?
- Which models can be used to obtain a full spatial cover for the flows of both services (is extrapolation needed?)
- How can the capacity to generate the ecosystem services be modelled?
- What data would be needed to model flow and capacity ?
- Are these available? If not how can they be collected?

Answers

Discuss answers of individual participants

Synthesis / conclusions

Ecology is important for Ecosystem Accounting:

- to model and scale up ecosystem services flows
- to model regulation services in the landscape
- to model capacity
- to analyse biodiversity

Ecosystem accounting is data-intensive, requires in-depth analyses

It provides detailed information on ecosystem resources not covered in other national accounts

Long time perspective required (>3 years)