Biophysical Modelling (Levels 1 and 2)

Project: Advancing the SEEA
Experimental Ecosystem Accounting

United Nations UNEP Convention on Biological Diversity NORWEGIAN MINISTRY OF FOREIGN AFFAIRS

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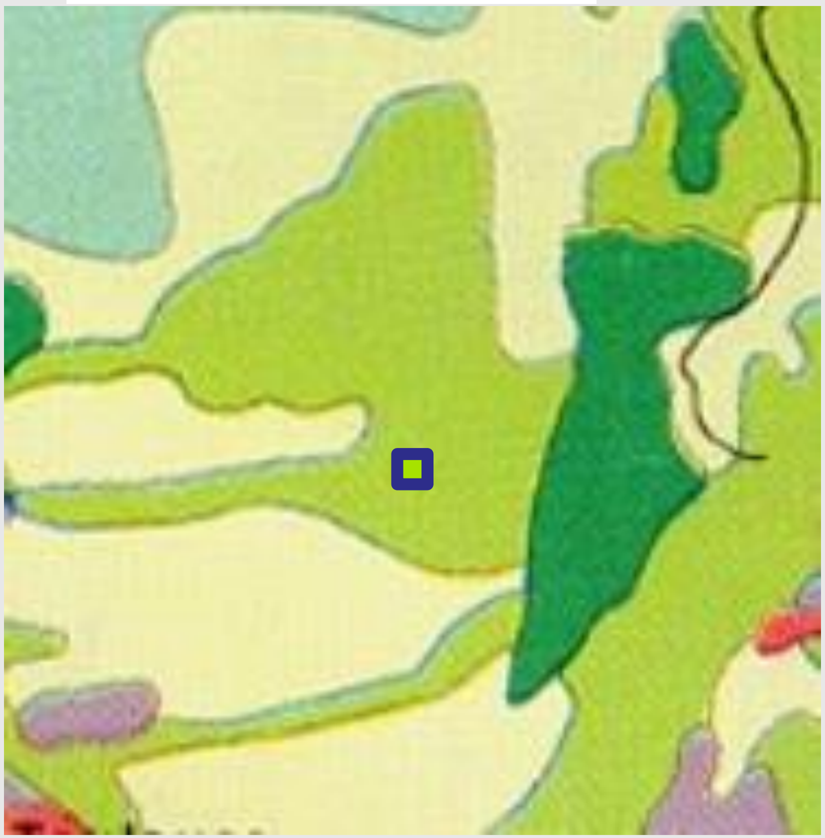
Level 1: Learning Objectives

- Understand the spatial units used in Ecosystem Accounting and the role of biophysical modelling in support of Ecosystem Accounting
  - Spatial Units
  - The role of spatial and of temporal modelling

- Required prior knowledge: the concept of ecosystem services

The three spatial Units in Ecosystem Accounts

Land cover map of Area X



Scale: 1:50,000

Pine forest

Deciduous forest

- **Ecosystem Accounting Unit** (EAU) = a country, province or watershed
- **Land cover/ecosystem functional unit** (LCEU) = e.g. Deciduous forest
- **Basic Spatial Unit** = a grid cell / pixel
- Ecosystem services flow, ecosystem condition and ecosystem asset needs to be defined for every pixel individually (i.e. mapped)

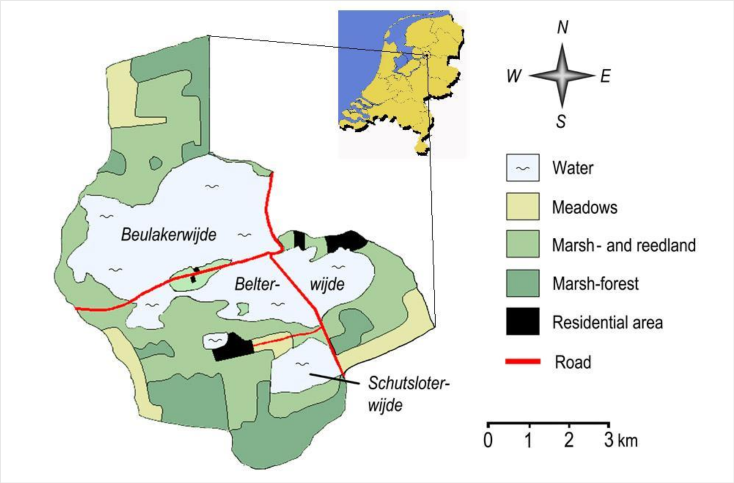
Biophysical modelling

- Biophysical modelling for the purpose of ecosystem accounting is required to:
  - Capture the spatial variability of ecosystems
  - Capture the temporal variability of ecosystems

Modelling: make it as simple as possible, but not simpler (after Einstein)

Spatial variability in Ecosystems

- Ecosystems vary across space because of differences in altitude, soils, vegetation, climate, etc. and because of spatial differences in the management of ecosystems (e.g. as a function of distance to road or settlement)



The Wetland ecosystem ‘De Wieden’, the Netherlands consists of different zones with different vegetation, humidity, soils, etc. (Source: Hein et al., 2006)

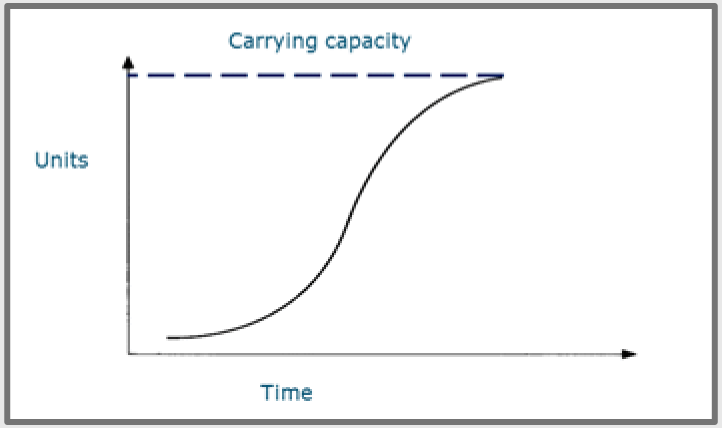
Modelling spatial variability

- Modelling spatial variability is required because
  - ecosystem accounting aims to record flows of ecosystems and stocks of ecosystem capital; and
  - both flows and stocks can be spatially very heterogeneous.
- Flows and stock modelling usually requires the combination of spatial datasets (maps) and point-data(e.g. from surveys).
- To combine these datasets, and to understand ecosystem flows and assets in areas with no data, a spatial model can be deployed.

Modelling temporal variability

- Temporal models are required to analyse ecosystem assets
- The Net Present Value of an ecosystem asset is the sum of the net, current and discounted future values generated by the ecosystem
- These values depend upon the capacity of the ecosystem to regenerate, for instance the regrowth of the forest after harvesting.
- Temporal models reveal the regeneration/regrowth of the ecosystem

The increase in a biological resource often follows an S-curve, where growth levels approach zero of at the carrying capacity.



Exercise 1

- What are the three spatial units in Ecosystem Accounting, and what is their meaning ?

Exercise 2

- Which processes or factors determine changes in the stock of a (renewable) ecosystem asset, for instance a timber resource in a natural forest?
- Which of these factors requires temporal modelling in order to analyse it?

Level 2. Biophysical modelling

- Learning objective:
  - To understand which types of modelling approaches can be used for the spatial and temporal modelling of ecosystem services in an accounting context
- Prior knowledge
  - Biophysical modelling level 1

Spatial modelling

- Useful to estimate ecosystem services flows and ecosystem assets across spatial units in the landscape
- In spatial models: ecosystem condition indicators, ecosystem services flow and ecosystem assets are defined and analysed for each spatial unit
- This requires Geographical Information Systems, where the spatial unit is usually a pixel (i.e. a grid cell in a grid, with specific x and y coordinates)

Four types of spatial models

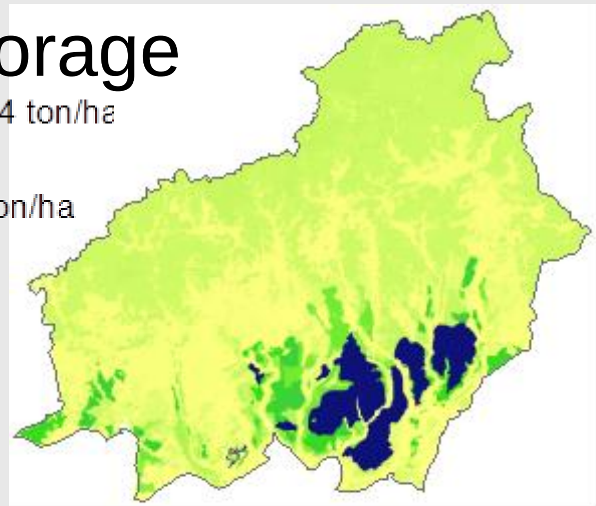
- **Look-up tables**: specific values for an ecosystem service or other variable are attributed to every pixel in a certain class, usually a land cover class.
- **Statistical approaches**: relate ecosystem services flow, asset or condition to explanatory variables such as soils, land cover, climate, distance from a road, etc., using a statistical relation derived from survey data.
- **Geostatistical interpolation**: techniques such as kriging rely on statistical algorithms to predict the value of un-sampled pixels on the basis of nearby pixels in combination with other characteristics of the pixel.
- **Process based modeling**: involves predicting ecosystem services flows based on a set of environmental properties, management variables and/or other spatial data sources, based on modelling of the ecological and/or ecosystem management processes involved.

Ecosystem services Central Kalimantan

Carbon storage

High : 7882.64 ton/ha

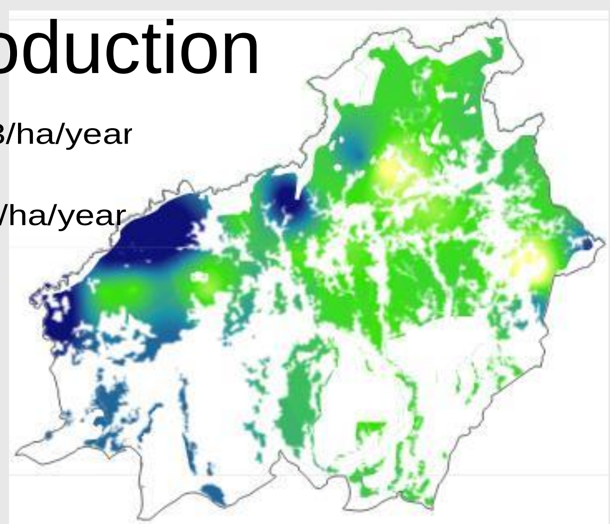
Low : 32.34 ton/ha



Timber production

High : 1.67 m3/ha/year

Low : 0.42 m3/ha/year



Model used

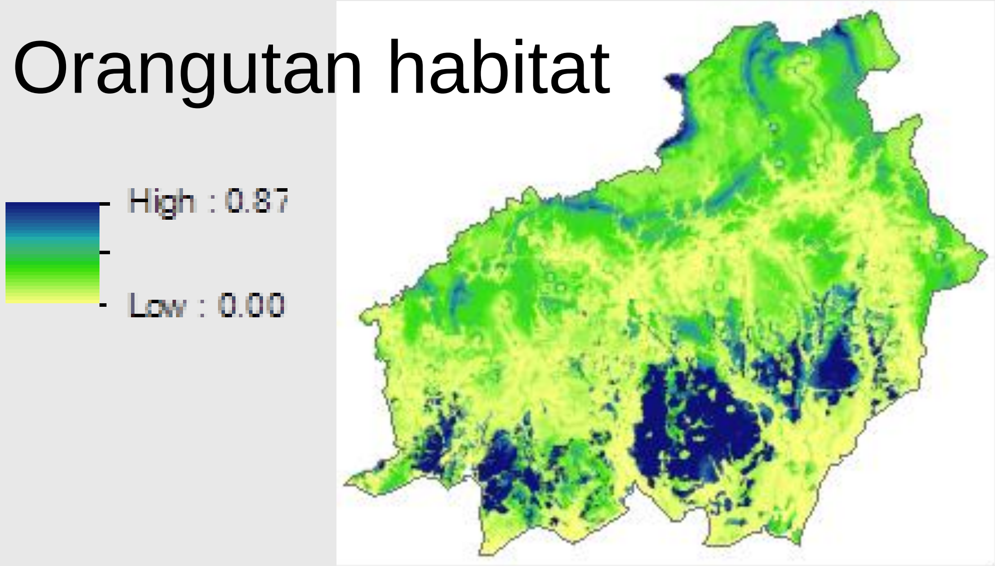
Look Up Tables (every land cover class is attributed a specific carbon storage value)

Kriging
(values are interpolated from samples)

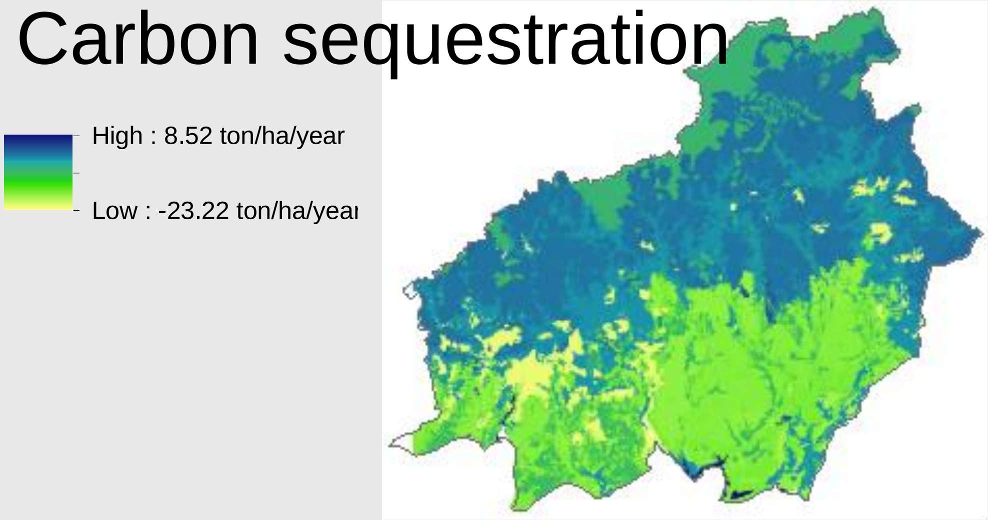
Source: Sumarga and Hein, 2014

Ecosystem services Central Kalimantan

Orangutan habitat



Carbon sequestration



Model used:

Statistical model (Maxent) (habitat suitability predicted on the basis of forest cover, distance from road, etc.)

Process-based Model (primary ecosystem production minus soil respiration)

Source: Sumarga and Hein, 2014

Modelling ecosystem services

- Can be done in stand-alone GIS packages such as ArcGIS or Q-GIS (freeware) or
- Modelling packages such as ARIES or InVEST
- Advantages of ARIES and InVEST is that some modules are pre-defined;
- Advantage of standard packages is that they are fully flexible and not dependent upon (knowledge of) a specific modelling program

Question 1

- Which four types of spatial models can be distinguished?
- What is the differences between them? Explain in your own words.

Four types of spatial models

- **Look-up tables**: specific values are attributed to every pixel in a certain class, usually a land cover class.
- **Statistical approaches**: ecosystem services flow, asset or condition is related to explanatory variables such as soils, land cover, climate, distance form a road, etc., using a statistical relation derived from survey data.
- **Geostatistical interpolation**: techniques such as kriging rely on statistical algorithms to predict the value of un-sampled pixels on the basis of nearby pixels in combination with other characteristics of the pixel.
- **Process based modeling**: involves predicting ecosystem services flows based on modelling of the ecological and/or ecosystem management processes involved.

Question 2

- Select one or two ecosystem services relevant for your case study area of interest
  - Which different sets of data are required to map this service?
  - How can these datasets be combined?

Level 2: Biophysical Modelling

- References

- Hein, L., Van Koppen, K., De Groot, R. S., & Van Ierland, E. C. (2006). Spatial scales, stakeholders and the valuation of ecosystem services. Ecological Economics, 57(2), 209-228.
- Sumarga, E. And Hein, L., 2014. Mapping Ecosystem Services for Land Use Planning, the Case of Central Kalimantan. Environmental management, pp. 1-14.

- Further Information
  - SEEA Experimental Ecosystem Accounting (2012)
  - SEEA-EEA Technical Guidance (forthcoming)
    - Detailed supporting document on “Biophysical Modelling” by Lars Hein

Evaluation of the training module

- Please complete the evaluation form for this module
- For this module
    - What did you learn that you could apply in your work?
    - Was the presentation clear and informative?
    - Was it too simple? Too complex?
    - Was there anything you did not understand?
    - What additions or deletions would you suggest (recognizing that the unit is intended for a general audience)?
    - Do you have any suggestions as to how the SEEA-EEA may be improved (concepts, principles) in this area?

Acknowledgements

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United Nations

UNEP

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