Quantifying ecosystem functions & services under different management regimes

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Solutions for Sustaining Natural Capital and Ecosystem Services
Session I. A: Integrated quantification .. (Probensaal) - June 8th, 2010
Outline

- Background
- A conceptual framework applied
  - Indicators, indicators & indicators
  - Case-study
  - Matrices
- Database
- Challenges
Introduction

- Three multidisciplinary PhD research projects
  - To quantify, model and value the relations between management regimes, biodiversity and the provision of the total bundle of ecosystem services at regional / landscape level

- Supervision Dr. Dolf de Groot (ESA - Wageningen UR), Dr. Rob Alkemade (PBL) & Prof. Rik Leemans (ESA)

- Remaining challenge (ICSU/UNESCO/UNU, de Groot et al., TEEB)
  - “the quantification of relationship .. mgmt systems & ES”
  - “overview and model to integrate these dependencies is exceedingly necessary to evaluate the emerging policies“
Background (1)

- **Millennium Ecosystem Assessment (MA 2005)**
  - “Benefits people obtain from ecosystems”
  - Basis for valuation and conservation studies
  - Global (State & Trends) / Sub-Global Assessments (SGMA)

- **Difficulties:**
  - (Local) empirical evidence on relationship between land mgmt - biodiversity & ESS provision missing
  - Decision-making frameworks and valuation schemes: double-counting and neglecting (other) service values
Background (2)

The Economics of Ecosystems & Biodiversity (TEEB)

- “The direct & indirect contributions to human well-being”
- Distinguishes between ES and economic benefits
- Values no supporting, but habitat services (rest underlying)
- “Cascade” – pathway from Ecosystem Structure & Processes to human wellbeing
Case Study - Conc. Framework applied

- National landscape “Groene Woud”
- Area about 338 km²
- Services targeted:
  - Food production
  - Air Quality regulation
  - Recreation / tourism
  - Habitat service
  - Water retention
  - Habitat service
  - Biocontrol
Conceptual Framework – Case Study

Positive / negative impact may lead to (a need for) renewed decision making - pressure

Policy / decision making
Based on the current and potential value of the ecosystem as well as response from stakeholders.

1

The "Groene Woud" is a national landscape, i.e. the unique core values / qualities of the area have to be protected:
- visible historical landscape elements & traditional land-use practices
- green area amidst urban areas (for recreation, biodiversity, etc.)
- an area in which local economic activity / collaboration is stimulated

Because it is also part of ecological networks such as Natura 2000, the "Groene Woud" has an important function in maintaining biodiversity.
Conceptual Framework – Case Study

**ECOSYSTEM (Supply / "State")**

3b

**Capacity (function)**

- Coniferous trees have a higher capacity to capture PM10 than deciduous trees (63 vs 36 kg/ha/yr). Even solitary trees & grassland have a significant contribution.

3a

**Property**

The processes / elements / characteristics of an ecosystem that determine whether a service can at all be provided.

- Whether vegetation / land cover is able to capture PM10, depends, among others on the species composition, size & volume, degrees of openness and porosity. The location also plays an important role.

**Pressures**

2b

Either external or internal, other pressures that have to be taken into account.

- Expanding urban areas, increasing demand for food production and intensifying emissions are pressures.

**Land Use Change**

2a

A result of the Management State. Human intervention & "naturalness" determine the management intensity.

- The area is a "cultural-ecological" landscape, mainly with extensively managed maize & grass land, rural settlements and larger patches of forest & heathland. Because of this heterogeneity, management focusing on agriculture, tourism, air quality and / or biodiversity measures can have different impacts.

**Ecosystem Service (Actual use / Performance)**

4

The direct and indirect contributions of the ecosystem to human well-being.

- We estimate the PM10 capture to be around 600 tons / yr. The contribution to the concentration reduction (in the area) is difficult to determine, although comparing the (point source) emissions and concentrations can provide useful insights.

**HUMAN WELL-BEING ("Demand")**

5a

**Benefit**

- The welfare gains generated by the service to fulfill human needs.

- In the Netherlands, about 3000 people die prematurely due to short-term exposure to PM10 annually. For long-term exposure the number is about 18,000 / yr. Reducing this number and the number of health complaints and doctors visits can be seen as a clear benefit.

5b

**Value**

- The ecological, socio-cultural & economic value attached to the services.

- If air quality targets are met, this is valued by the local population, recreationists and (national) government. Although difficult to quantify, economic impacts can be especially felt in the recreation / tourism branch.

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3b
Capacity (function)
.. of the ecosystem to provide the service (function)

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Conceptual Framework – Case Study

ECOSYSTEM (Supply / "State")

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Pressures 2b
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Land Use Change 2a
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**3b Capacity (function)**

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From (applied) framework to matrix

- Management state & (selected) ecosystem type
  - Intensive cropland, pristine wetland, agro-forestry, etc.
- Case study: *woodland*, grassland, etc. - ext. managed

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<td>Species composition, size, density, openness, distance</td>
<td>PM10 capture: grass (36)</td>
<td>PM10 captured: Δ emissions</td>
<td>20,000 † / yr (Long-T)</td>
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<td>Habitat cohesion (species dependent)</td>
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<td>&quot;Nature bridges&quot;, Buffer zones, crossings</td>
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<td>Elements with stated appreciation: woodlands = #1 + openness, naturalness</td>
<td>How many recreants within circle &lt; 15 km 75% (NL)</td>
<td># people / yr. (NL)</td>
<td>Relaxation, health, togetherness, restaurant visits, etc.</td>
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**Air Quality Regulation: PM 10 removal**

**Habitat service: habitat cohesion**

**Recreation & Tourism: Recreation - cycling**
Output – (Capacity) Maps

- Many “capacity” / potential maps;
  - Link capture (3. Capacity) & $\Delta$ emissions (4. Service)
  - “ probability (3. Capacity) & occurrence of species (4. Service)
## From (applied) framework to matrix

- **Management state & (selected) ecosystem type**
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<td>How many recreants within circle &lt; 15 km. 75% (NL)</td>
<td># people / yr. 8.4 mln trips/yr (NL)</td>
<td>Relaxation, health, togetherness, restaurant visits, etc.</td>
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Usage / availability of data

- Lots of “Management x Ecosystem” matrices can be compared.
Database

- Data points, that can be used in these matrices
  - Basic info the same (location, ecosystem, mgmt, study, etc.)
  - Service-specific information
  - Sub-service level (lowest aggr. level - can be upscaled)
- Describe per data point:
  - Its “usability” / application (scale, region, etc.)
  - References (has it been confirmed by others, reliability)
- End Goal: Online accessible database:
  - Indicators “shopping list” (descriptive)
  - (Benchmark) values – quantitative ( / qualitative?)
Challenges

- Ecosystem sub-services (at the moment > 70)
- Ecosystem Services Indicators:
  - All steps of framework, generic & specific per sub-service
  - Comparable between services
  - Different scales - ok for data, NB when applying (model / map)
  - (Over) simplification (biodiversity / “risk of interdisciplinary”)
  - Enable addressing sustainability
  - Causality / correlation
- The indicators + matrix form “skeleton” of the database
Challenges, continued

- Indirect vs. direct: underlying services vs. services that “actually” deliver services
- Not always possible to fill in every cell of the matrix
  - Property vs. Capacity / Service vs. Benefit (Causality)
- Qualitative / quantitative information
- Model output + maps can also deliver data “in return”
Conclusions

- Lots of data available
  - Studies / reports (not always called “ES” (grey literature))
  - Models’ / mapping output
- Framework allows for stepwise analysis, if explained
  - Information on service / benefit, indicators needed!
  - Capacity can also be valued (just like in economics)
- Comparing / “overlaying” matrices enables;
  - Assessing trade-offs
  - Bundle of ecosystem services
- Sustainability assessed through demand / supply
  - Sustainability indicators have to be established
  - “Safe Minimum Standard” (Fisher et al., 2008)
Thank you for your attention

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www.es-partnership.nl / indicators