GLOBIO3
State and trends of ecosystem condition on multiple levels of scale

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UN SEEA Experimental Ecosystem Accounting
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New York
PBL Netherlands Environmental Assessment Agency

- National institute for strategic policy analysis on environment, nature and spatial planning

- Outlook studies, analysis and policy evaluations

- Always an integrated, interdisciplinary approach

- Always policy-relevant

- Solicited and unsolicited research, independent, and scientifically sound
New cooperation on testing accounts

- Cooperation between UNSD, Statistics Netherlands and PBL Netherlands Environmental Assessment Agency
- Financed by Ministry of Foreign Affairs
- 2015 - 2017

Goals:
- Test ecosystem accounting in the Netherlands
- Test the applicability of GLOBIO type model and metrics in ecosystem accounting
www.globio.info

Roads from Rio+20
Pathways to achieve global sustainability goals by 2050

Rethinking Global Biodiversity Strategies
Global application

Impacts on biodiversity, 1970 – 2050

2010

Mean Species Abundance

Source: PBL
Global application

Impacts on biodiversity, 1970 – 2050

2050

Mean Species Abundance

0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9

Source: PBL
Ecosystem condition: Area * quality
Measuring quality: MSA

- Baseline is 100%, species abundance in undisturbed situation
- Non-original species are excluded, original species topped off at 100%
- Average response of *total* set of species
- Measure of ecosystem condition (intactness)
Why driver-pressure based?

- Monitoring not everywhere available, costly to set up measurement campaigns and networks
- Interested in the process of change
- Therefore, model state of ecosystems from existing information
- MSA able to scale different pressures to common indicator
Environmental pressures included in GLOBIO3

Effect of pressures on MSA value:
1. Land-use change (agriculture expansion, forestry)
2. Infrastructure & settlement
3. Fragmentation
4. Climate change
5. N-deposition

Cause – effect relations for each pressure based on meta-analysis of literature.
- Meta-analysis of scientific literature
- Comparisons between undisturbed state and categories of land use
Output

Global MSA in baseline scenario

- MSA values per grid cell (quality and extent)
- Per pressure contribution to change in MSA
- Beware of the interactions and double-counting
- Which are most important in linking to ESS?

Figure 1 Ecosystem condition as represented by the SEEA-EEA

Table 4.3 Measures of ecosystem condition and extent at end of accounting period for an EAU

<table>
<thead>
<tr>
<th>Ecosystem extent</th>
<th>Characteristics of ecosystem condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>Vegetation: Indicators (e.g. Leaf area index, biomass, mean annual increment)</td>
</tr>
<tr>
<td>Type of LCEU</td>
<td>Forest tree cover</td>
</tr>
</tbody>
</table>

* Medium to large fields rainfed herbaceous cropland
Criteria for models

- Bagstad (2013) criteria for models to be used to measure ESS in ecosystem accounting:
  - quantification and uncertainty, time requirements, capacity for independent application, generalizability, non-monetary and cultural perspective, affordability, insights and integration with existing environmental assessment.

- Also think of criteria for the metrics and indicators:
TABLE 6: Set of headline indicators agreed on by the Conference of the Parties to the CBD through decision VII/30 and VIII/15

<table>
<thead>
<tr>
<th>FOCAL AREA</th>
<th>INDICATOR</th>
</tr>
</thead>
</table>
| Status and trends of the components of biological diversity | • Trends in extent of selected biomes, ecosystems, and habitats  
• Trends in abundance and distribution of selected species  
• Coverage of protected areas  
• Change in status of threatened species  
• Trends in genetic diversity of domesticated animals, cultivated plants, and fish species of major socioeconomic importance |
| Sustainable use                                       | • Area of forest, agricultural and aquaculture ecosystems under sustainable management  
• Proportion of products derived from sustainable sources  
• Ecological footprint and related concepts |
| Threats to biodiversity                               | • Nitrogen deposition  
• Trends in invasive alien species |
| Ecosystem integrity and ecosystem goods and services  | • Marine Trophic Index  
• Water quality of freshwater ecosystems  
• Trophic integrity of other ecosystems  
• Connectivity / fragmentation of ecosystems  
• Incidence of human-induced ecosystem failure  
• Health and well-being of communities who depend directly on local ecosystem goods and services  
• Biodiversity for food and medicine |
| Status of traditional knowledge, innovations and Practices | • Status and trends of linguistic diversity and numbers of speakers of indigenous languages  
• Other indicator of the status of indigenous and traditional knowledge |
| Status of access and benefit-sharing                  | • Indicator of access and benefit-sharing |
| Status of resource transfers                          | • Official development assistance provided in support of the Convention  
• Indicator of technology transfer |

*Indicators shown in bold typeface have been assessed in this study. Indicators in italics are still in development.*
Three complementary state indicators

Mean species abundance relative to baseline

Ecosystem extent

Species abundance

Ecosystem quality

Threatened Red List Index

RLI

Habitat loss
Policy relevance

- Future projections (baseline)
- Provide order-of-magnitude perception, and interactions between drivers
- Policy options based on changing drivers of loss
National applications

GIS part

calculation

current

biodiversity

Example Zambia

Intermediate output

Pressure impact

Output

Overall impact pressures

Input layers

drivers / pressures

land use

eco-regions

infrastructure

population

climate

MSA_lu

MSA_infra

MSA_frag

MSA_clim

MSA_total

Cause – Effect relations

GIS raster multiplication

MSA_{tot} = MSA_{lu} \times MSA_{infra} \times MSA_{frag} \times MSA_{clim}
National applications

Remaining MSA and pressures by region in 2000

Remaining MSA and its pressures in 2000
National application: Adjusting MSA values of land use classes with the help of expert knowledge

**Original GLOBIO 3 Land Use MSA value table**

<table>
<thead>
<tr>
<th>Biodiv class name</th>
<th>MSA value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary forests</td>
<td>1.0</td>
</tr>
<tr>
<td>Forest plantations</td>
<td>0.2</td>
</tr>
<tr>
<td>Secondary forests</td>
<td>0.5</td>
</tr>
<tr>
<td>Light used primary forests</td>
<td>0.7</td>
</tr>
<tr>
<td>Agro forestry</td>
<td>0.5</td>
</tr>
<tr>
<td>Extensive agriculture</td>
<td>0.3</td>
</tr>
<tr>
<td>Irrigated intensive agriculture</td>
<td>0.05</td>
</tr>
<tr>
<td>Intensive agriculture</td>
<td>0.1</td>
</tr>
<tr>
<td>Perennials &amp; bio fuels</td>
<td>0.2</td>
</tr>
<tr>
<td>Natural grass &amp; shrub lands</td>
<td>1.0</td>
</tr>
<tr>
<td>Man made pastures</td>
<td>0.1</td>
</tr>
<tr>
<td>Livestock grazing</td>
<td>0.7</td>
</tr>
<tr>
<td>Natural Bare, rock &amp; snow</td>
<td>1.0</td>
</tr>
<tr>
<td>Natural inland water</td>
<td>null</td>
</tr>
<tr>
<td>Artificial water</td>
<td>null</td>
</tr>
<tr>
<td>River/stream</td>
<td>null</td>
</tr>
<tr>
<td>Built up areas</td>
<td>0.05</td>
</tr>
</tbody>
</table>

**Vietnam adapted Land Use MSA value table**

<table>
<thead>
<tr>
<th>Code</th>
<th>Lu original (2002)</th>
<th>Local MSA value</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Natural Timber Forest</td>
<td>0.9</td>
</tr>
<tr>
<td>11</td>
<td>Rich Forest</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>Medium Forest</td>
<td>0.8</td>
</tr>
<tr>
<td>13</td>
<td>Poor Forest</td>
<td>0.6</td>
</tr>
<tr>
<td>20</td>
<td>Young Forest</td>
<td>0.55</td>
</tr>
<tr>
<td>21</td>
<td>Reforestation Rich</td>
<td>0.45</td>
</tr>
<tr>
<td>22</td>
<td>Reforestation Medium</td>
<td>0.4</td>
</tr>
<tr>
<td>23</td>
<td>Young forest with volume</td>
<td>0.55</td>
</tr>
<tr>
<td>24</td>
<td>Young forest with no volume</td>
<td>0.45</td>
</tr>
<tr>
<td>31</td>
<td>Dipterocarp forest (deciduous)</td>
<td>0.95</td>
</tr>
<tr>
<td>32</td>
<td>Semi- deciduous forest</td>
<td>0.95</td>
</tr>
<tr>
<td>41</td>
<td>Natural conifer forest</td>
<td>0.95</td>
</tr>
<tr>
<td>42</td>
<td>Mix forest (Broad leaf and conifer forest)</td>
<td>0.8</td>
</tr>
<tr>
<td>51</td>
<td>Bamboo forest</td>
<td>0.45</td>
</tr>
<tr>
<td>52</td>
<td>Mix forest (Timber+bamboo forest)</td>
<td>0.55</td>
</tr>
<tr>
<td>60</td>
<td>Mangrove forest</td>
<td>0.8</td>
</tr>
<tr>
<td>70</td>
<td>Plantation forest</td>
<td>0.2</td>
</tr>
<tr>
<td>71</td>
<td>Speciality forest</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Adjustment of values based on local expertise.
Input data required for GLOBiO3

LULC map

Land use

Nitrogen deposition

Climate change

(rail-) roads

Land-use effect

Nitrogen effect

Climate effect

Fragmentation effect

Infrastructure effect

GLOBiO

Biodiversity (MSA) of land ecosystems
Applied on different scales of analysis

- Assessments using GLOBIO3:
  - UNEP’s Global Environment Outlook
  - CBD’s Global Biodiversity Outlooks
  - OECD Environmental Outlook
  - TEEB (Rethinking and Quantitative Assessment)
  - 25 countries trained to use GLOBIO3
  - In 2013 three workshops (~60 countries total), sponsored by Japan and the Netherlands, capacity building GLOBIO3 application on national scale for 5th national report to CBD

- Model available for anyone (number of countries use own adaptations)

- Main work comes from creating the input (LULC maps mainly)

- Complications in use come with future projections; current state is not complicated
Creating a global baseline

- Two ways to improve on our current global baseline:
  - More precise land use maps (country level) that use globally nested LULC categories (to maintain projection ability)
  - Improve and add MSA estimates for different LULC with regional experts

- Adaptable to national ambition levels; always zero-order available (current baseline)

Example Vietnam case

- Split the model into the parts per pressure type
- Resolution in GLOBIO set to 1*1 km
- National land use map with > 43 land classes, MSA values per land use class based on local expert knowledge
Degraded Degrading

Cstorage & climate

• Km3 soil water prist, LU, degra, to 2050
• Change in waterstress days
• Figure: Nr days/km2 flooded
• Map all year / seasonal rivers

Water retention & floods

• Mln km2 arable / grazing
  good condition & degraded & abandoned & reserve, tot 2050 Stapel diagram
• Lost food production former & current agri land in Kcal & kg proteins tov potential, tot 2050

Agri area & food

• Mln km2 forestry
  good condition & degraded & lost & reserve, tot 2050 Stapel diagram
• Lost timber & fiber production former & current forestry land in m3 & tons per Y tov potential, tot 2050

Forestry area & fiber

• Remaining MSA & loss due to agri, forestry, climate, infra/urban, Ndep, degradation from former LU & indirect from degradation from current LU

Biodiversity

• Map % prim sector/GDP
• Lost GDP due to degradation Map
• Figure: x-as 100- 0% env income y-as Nr people
• Nr of high env dependent people in degrading areas tot 205

Environm dependency
Species richness vs. naturalness

**Original**
- First strike: Large animals lost

**Hunting & gathering**
- Second strike: Habitat loss

**Extensive agriculture**
- Third strike: intensification

**Intensive agriculture**
- Counter move: Protected areas

**Current ecosystem**
- Decreasing biodiversity in natural ecosystems

- Decreasing biodiversity in agri-ecosystems
- Settlement
- Protected area

*Time*
Recent PBL global assessments

PBL global assessments aim to:
- Identify socio-economic and environmental trends
- Show interactions between trends
- Provide order-of-magnitude estimates of potential change
- Assess effects of alternative ‘options’ or system changes
Projections of accelerating economic growth

Global economics in the Trend scenario

GDP per region

Range from literature

Developing countries
- Central and South America
- Middle East and North Africa
- Sub-Saharan Africa
- South Asia
- China region
- Southeast Asia

Industrialised countries
- North America
- West and Central Europe
- Russian region and Central Asia
- Japan, Korea and Oceania

History
- Trend scenario

Range from literature
- 10 – 90%
- 25 – 75%
Projections of increased demands of food ....

Food demand

Index (2000 = 100)

- Sub-Saharan Africa
- Middle East and North Africa
- India and South Asia
- Latin America
- China and Southeast Asia
- Developing countries
- World
... and water

Figure 5.4. Global water demand: Baseline, 2000 and 2050

Notes: This graph only measures “blue water” demand (see Box 5.1) and does not consider rainfed agriculture.
Source: OECD Environmental Outlook Baseline; output from IMAGE.
Projections of increased pressure on the environment

Global CO$_2$ emissions, air pollutants and biodiversity

- **CO$_2$ emissions**
- **Air pollutants**
- **Biodiversity**

- CO$_2$ emissions
- Black carbon
- Nitrogen oxides
- Organic carbon
- Sulphur oxides
- Conferences in Stockholm (1972) and Rio (1992)

% Mean Species Abundance (MSA)
No projections of feedback from environmental degradation on economy
Different approaches

- Different policy options

**Rethinking global biodiversity strategies (2010)**

![Bar chart showing prevented global MSA loss compared to baseline scenario, 2000 – 2050](chart)

Prevented global MSA loss of options expanding protected areas and reducing deforestation by 2030
Different approaches

- Sector-oriented

Protein Puzzle, (2011)
Different approaches

- Backcasting from global policy goals

_Roads from Rio+20 (2012)_
Work on biodiversity and ecosystems

- Biodiversity (GLOBIO 3)
- Aquatic biodiversity (GLOBIO Aquatic)
- Global land degradation (current and ongoing)
- Functions: SOC & carbon storage, water retention
- Water demand, drought and flood models
- Ecosystem services (production from IMAGE)
- Environmental dependency