Biodiversity in LCA methods
Some proposals to bridge the gap

François Danic\textsuperscript{1}, Benjamin Lévêque\textsuperscript{2}, Stéphane Le Pochat\textsuperscript{1}, Lénaïc Moniot\textsuperscript{2}, Guillaume Neveux\textsuperscript{2}, Jade Garcia\textsuperscript{3}

\textsuperscript{1}Evea
\textsuperscript{2}I Care Environnement
\textsuperscript{3}Score LCA
• Context and objectives
• Definitions
• Steps
• Findings
• Proposals for improvement
• Conclusion
• Context

- A study ordered by Score LCA:
  “How to use LCA flows, indicators, and methods for biodiversity impact assessment?”
- A study carried out by Evea and I Care
- A study delivered in 2014
• Objectives

• Achieve a state of the art on
  – biodiversity indicators and methods (LCA and others)
  – ongoing research about the integration of biodiversity in LCA
  – the current level of consideration of biodiversity in LCA

• Identify ways to take into account biodiversity in LCA methods

• [Compare methods, indicators and flows used in LCA with regulatory requirements for industrial sites]
• Definitions (scope of the study)

**Biodiversity [CBD, UN 1992]**

« Biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems. »

**Ecosystem [CBD, UN 1992]**

« A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit. »

Biodiversity can not be reduced to ecosystems. Ecosystems are only one of the dimensions of biodiversity.
• Steps

1. Inventory of indicators of biodiversity
2. Analysis of indicators (potential for LCA)
3. LCA versus biodiversity studies: a case study
4. Recommendations for improvement
Inventory of indicators of biodiversity

Typology of indicators

LCA
  - Endpoints
  - Midpoints

Ecosystem services
  - Ecological functions
  - Monetarized indicators

Biodiversity
  - Biodiversity status and trends
  - Drivers of biodiversity loss
  - Dependance on ecosystem services
• Some identified indicators for biodiversity assessment

Existing and developing indicators in LCA

• 3 midpoints related to biodiversity: land use, ecotoxicity, acidification / eutrophication
• 2 endpoints related to biodiversity: Ecosystem Quality: characterization of the impacts on ecosystems by the PDF/PAF factors

• A lot of research supporting the development of the land use indicator

Biodiversity indicators

• 451 biodiversity indicators identified
  – Biodiversity status and trends: 172
  – Drivers of biodiversity loss: 264
  – Dependence on ecosystem services: 15
• Not limited to species and including all dimensions of biodiversity
  – Habitats, species, ecosystem services

• A lot of research supporting indicators of ecosystem services
  – Ongoing development of indicators of ecological functions, at the origin of ecosystem services
  – First series of “monetarized” indicators by ecosystem service and biome

• Some indicators trying to assess biodiversity in LCA methods exist, providing a limited vision of biodiversity issues
• Richness and diversity of indicators existing in biodiversity studies
• Synthesis on drivers of biodiversity loss taken into account by existing LCA methods

<table>
<thead>
<tr>
<th>Pressures on biodiversity</th>
<th>Sub-types of pressure</th>
<th>Consideration in LCA methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat change</td>
<td>Land occupation</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Land transformation</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Fragmentation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disturbances</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Protection of habitats and biodiversity</td>
<td></td>
</tr>
<tr>
<td>Alien species</td>
<td>Introduction of alien species</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Use of means of spread of alien species</td>
<td></td>
</tr>
<tr>
<td>Overexploitation</td>
<td>Water consumption</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Endangered species</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Participation in species diversity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Participation in genetic diversity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sustainable use of natural resources</td>
<td></td>
</tr>
<tr>
<td>Pollutions</td>
<td>Pollution of water bodies</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Soil pollution</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Air pollution</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Acidification / Eutrophication</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Pollutants and wastes emissions</td>
<td></td>
</tr>
<tr>
<td>Climate change</td>
<td>GHG emissions</td>
<td>✓</td>
</tr>
</tbody>
</table>

• A limited number of sub-types of drivers is taken into account
• « Habitat change » and « Pollutions » are the more detailed drivers in the LCA methods

[From Curran et al., 2011]
LCA methods

• Modeling on the software Simapro7 by 3 methods
  – Eco-indicator 99
  – Impact 2002+
  – ReCiPe

Biodiversity studies

• Analysis of biodiversity studies on:
  – Impacts by drivers and sub-type of drivers of biodiversity loss
  – Impacts on habitats, species and ecological functions
  – Geographically located case studies

Methodology

• LCA methods show interesting midpoints to assess biodiversity issues and a relevant hierarchy between technologies at the endpoint step
• An important weight attributed to the PDF factor for Climate change in ReCiPe
• Some issues are clearly missing compared with biodiversity studies (fragmentation, ...)

Illustrations

3 modes of electricity supply (kWh of coal, gas, and photovoltaic)

Legend:
- Ecoindicator 99
- ReCiPe
- Climate change
- Acidification /eutrophication
- Ecotoxicity
- Land occupation/transformation
- High voltage elec.
- Medium voltage elec.
- Low voltage elec.

- Charbon
  • Destruction et pollution de l'eau et air (prise en compte des émissions de CO2)
  • Émissions de CO2

- Gaz
  • Destruction et pollution de l'eau et air (prise en compte des émissions de CO2)
  • Émissions de CO2

- PV
  • Destruction et pollution de l'eau et air (prise en compte des émissions de CO2)
  • Émissions de CO2

- Fabrication pénicaux
  • Production
  • Transport
  • Transformation

- Transport multi chalandage, perturbations des espaces (reprise des lieux)

- Construction et exploitations installations
  • Electricité
  • Ébullition
  • Transport multi chalandage, perturbations des espaces (reprise des lieux)

- Acidification /eutrophication
- Ecotoxicity
- Climate change
- High voltage elec.
- Medium voltage elec.
- Low voltage elec.

ECA
- Focus on methodological differences within LCA methodologies

<table>
<thead>
<tr>
<th>Study of land transformation</th>
<th>Study of climate change applied to ecosystems</th>
<th>Number of « substances » considered</th>
<th>Differentiation by type of impacted ecosystems</th>
<th>Aggregation factors</th>
<th>Spatialization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eco-indicator 99 (unit: PDF<em>m²</em>yr)</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Use of the PAF factor, not very specific</td>
<td>No</td>
</tr>
<tr>
<td>IMPACT 2002 + (unit: PDF<em>m²</em>yr)</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Unavailability of acidification/eutrophication factors</td>
<td>Terrestrial/aquatic</td>
</tr>
<tr>
<td>ReCiPe (unit: species.yr)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Good accuracy of factors</td>
<td>No</td>
</tr>
</tbody>
</table>

Legend:  
[Green] Strength  
[Red] Weakness
• Proposal: 5 ways to improve the calculation of biodiversity in LCA methods

1. Improvement of existing indicators and methods
2. Flow spatialization
3. Integration of indicators of drivers of biodiversity loss
4. Linking impacts and ecosystems
5. Focus on the most critical impacts
### Approaches with higher or lower consideration of biodiversity and different horizons of implementation

#### Proposal: 5 ways and in-depth approaches

<table>
<thead>
<tr>
<th>Level of complexity</th>
<th>Approach A</th>
<th>Approach B</th>
<th>Approach C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Improvement of existing indicators and methods</td>
<td>Improvement of land use and land use change indicators</td>
<td>Improvement of the PDF coefficient</td>
</tr>
<tr>
<td>2</td>
<td>Flow spatialization</td>
<td>Coupling GIS and LCA</td>
<td>Data acquisition on the different scales</td>
</tr>
<tr>
<td>3</td>
<td>Integration of indicators of pressures on biodiversity</td>
<td>Integration of an indicator by pressure</td>
<td>/</td>
</tr>
<tr>
<td>4</td>
<td>Linking impacts and ecosystems</td>
<td>Crossing impact and risk level for ecosystems</td>
<td>Modeling impacts on ecosystem services</td>
</tr>
<tr>
<td>5</td>
<td>Focus on the most critical impacts</td>
<td>Prioritization of impacts in a lifecycle step</td>
<td>Prioritization on the most impactful lifecycle steps</td>
</tr>
</tbody>
</table>

*Approaches with higher or lower consideration of biodiversity and different horizons of implementation*
• Toward a progressive implementation of biodiversity complexity in LCA
• Conclusion

– It will take time and efforts for LCA methodologies to increase relevance regarding biodiversity issues because of:

  • Intrinsic complexity (ecosystem dynamics, predictability issues, ...)
  • No common culture between LCA & Biodiversity communities

– In LCA:

  • At endpoint level: ecosystem quality
  • At midpoint level: Land Use is a very representative indicator
  • Numerous methodological limits, but well known and well documented

– First: improve the LU indicator

– In a second time: enlarge the scope to “global biodiversity”

  • Via drivers on biodiversity loss
  • Via ecosystem services (integrating ecological function)

– Real improvements can be expected from coupling with GIS

– Problematic of weighting and aggregation for a biodiversity endpoint still remain
THANK YOU

Report available at [ScoreLCA website] :

http://www.scorelca.org/scorelca/ressources_internes.php