Environmental Impacts of Consumption and Production: LCA and additional methods Input–Output

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Assessing the Environmental Impacts of Consumption and Production:

**Priority Products and Materials**

Key Messages
Acknowledgements

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- Janet Salem and Guido Sonnemann, UNEP, provided valuable input and comments.
The Working group used a five step approach:

1. **Relevant Impacts** - Which key environmental and resource pressures need to be considered?
2. **Production perspective** – What sectors have the highest impacts?
3. **Consumption perspective** – What consumption clusters drive most life cycle impacts?
4. **Material use perspective** – What materials have the highest impacts?
5. **Outlook and conclusions** – What are common denominators?
Methodological Framework
Step 1: Most relevant pressures and impacts

- **Based on**
  - Millennium Ecosystem Assessment
  - WHO Burden of Disease study
  - Life cycle impact studies

- **Most relevant**
  - **Human and ecosystem health:**
    - Climate change
    - Habitat change (land + water use)
    - Eutrophication (overfertilisation by nitrogen and phosphorus)
    - Urban and regional air pollution
    - Indoor air pollution
    - Other toxic emissions

  - **Resource depletion**
    - Fossil fuels and some metals
    - Unsustainable fish harvest
Step 2: Production perspective

- **Production perspective:**
  - Looks at direct emissions and primary resource use
  - Informs policy and producers where clean technologies are most needed

- **Sources used**
  - For global warming: IPCC
  - For other problems: US database as example (insufficient global data)

- **Most critical sectors:**
  - Processes involving fossil fuel combustion (Climate change, air pollution, eutrophication)
  - Agricultural activities using biomass (Water, land, eutrophication, toxicity)
  - Fisheries (Biotic resource depletion)
Step 3: Consumption perspective

- **Consumption perspective:**
  - Looks at life cycle impacts of final consumption
  - Informs policy and consumers on areas of desirable shifts to
    - low impact products
    - sustainable life styles

- **Food, mobility, housing** (including energy using products) drive > 70% of impacts

- **Pollution embodied in trade** increasingly relevant
Step 4: Material use perspective

- **Material use perspective:**
  - Use of materials and their life-cycle impact
  - Informs policy and producers how shifts in material base can contribute to lower impacts

- **Two approaches:**
  - Counting mass (MFA)
  - Calculating impacts (EMC)
Step 5: Outlook and conclusions

- The production, consumption and materials perspective point to:
  - Agriculture and food consumption
  - Processes engaging fossil fuels
    - Mobility,
    - Housing and energy using products

- New **patterns of consumption and production** needed: impacts rise with income

- **Trade relevant** for decoupling: pollution embodied in trade becomes more relevant

- Better **harmonized data** across countries will improve monitoring and decision making
Global Guidance Principles for Life Cycle Assessment Databases
A Basis for Greener Processes and Products

Adaptive Approaches

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Guido Sonnemann (UNEP) and Bruce Vigon (SETAC)
Stakeholder needs and demands are evolving, and additional information is allowing both old and new questions to be answered.
The purpose of this chapter is to identify the additional requirements for LCI data sets and databases to meet the evolving stakeholder needs and to fulfill the specific goal and scope of the study.
The structure of the economy
IO-LCA

- Uses input-output table as ‘ready-made’ supply-chain data.
- Environmental information needs to be added.
- Moriguchi et al. (1993); Hondo & Uchiyama (1994); Lave et al. (1995); Hendrickson et al. (1998); Joshi (1999).
- IOA became a useful element of LCA.
- Currently IO databases are included in commercial LCA software packages enabling hybrid analysis.
Applications of IOA in LCA

- As a background system
- Sector specific environmental characterization
- As a reference in analyzing LCA system boundaries
What is the benefits of a hybrid LCA?

- The number of processes linked to a product system is huge as the supply-chain propagates.
- It is very difficult, if not impossible, to gather process-specific data for all processes involved (cut-off).
- Thus a product system is in general ‘truncated’ in various degree.
'Which is the better’ arguments between process LCA and IO LCA

Two sides of a coin: Accuracy vs. precision

Process LCA

High precision but less accuracy

IO LCA

High accuracy but less precision
## Approaches in Life Cycle Inventory Modelling

<table>
<thead>
<tr>
<th>Model</th>
<th>Strengths</th>
<th>Weakness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hybrid LCA</td>
<td>Process specific</td>
<td>Truncation</td>
</tr>
<tr>
<td></td>
<td>Encompassing system boundary</td>
<td>Aggregation</td>
</tr>
</tbody>
</table>

### Implications on uncertainty
Limitations of IO-LCA

- IO industry classification distinguishes generally less than 1,000 industries and commodities.
- Linearity assumption, commodity inhomogeniety, price inhomogeniety.
- Usually at least several years old.
- High uncertainty for the imported commodities.
Tools and databases

- **IOTs**
  - US: [www.bea.gov](http://www.bea.gov)
  - Netherlands: [www.cbs.nl](http://www.cbs.nl)
  - OECD: [http://www.oecd.org/document/1/0,2340,en_2825_495684_34062721_1_1_1_1_1,00.html](http://www.oecd.org/document/1/0,2340,en_2825_495684_34062721_1_1_1_1_1,00.html)

- **Environmental IOTs**
  - [www.eio-lca.net](http://www.eio-lca.net)
  - [www.enviroinformatica.com](http://www.enviroinformatica.com) CEDA 3.
  - [www.nies.or.jp](http://www.nies.or.jp)
Tools and databases

- Physical IOTs
  - Denmark (Statistics Denmark)
  - Italy
  - Germany (Federal Statistics Office)
  - Netherlands (Central Bureau of Statistics)

- Available tools
  - Matrix calculation and numerical analysis:
    - Matlab
  - IO- and hybrid LCA
    - SimaPRO (after ver 6)
    - CEDA 3.0