Environmental and economic assessment of regional building materials industries combining material-flow-analysis, input-output-analyses and life-cycle-assessment

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High construction activity and limited resources call for circular economy!

Ellen MacArthur Foundation; World Economic Forum; Boston Consulting Group
"Co-Evolution of Business Strategies in Material and Construction Industries and Public Policies"
Research Questions

“Co-Evolution of Business Strategies in Material and Construction Industries and Public Policies” – “CUBIC”

Research project funded by the Swiss National Science Foundations (2017-2021).

Guiding research questions:

• What are the central co-evolution mechanisms driving alternative business models and regulation in the Swiss construction industry?
• How can this co-evolution process be directed towards sustainability?
The Challenge

- We need to understand the consequences of public policies or alternative business models regarding a sustainable industry, especially in a regional context.

- We need **instruments** that evaluate the environmental and economic effects of public policies on a region or an industry in terms of sustainable development and circular economy.

**How to assess an industry?**
<table>
<thead>
<tr>
<th>Issue of concern</th>
<th>Specific concerns related to environmental impacts, supply security, technology development within certain businesses, economic activities, countries, regions</th>
<th>General environmental and economic concerns related to the throughput of substances, materials, manufactured goods at the level of</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Object of interest</strong></td>
<td><strong>Substances</strong>&lt;br&gt;chemical elements or compounds</td>
<td><strong>Materials</strong>&lt;br&gt;raw materials, semi-finished goods</td>
</tr>
<tr>
<td><strong>Products</strong>&lt;br&gt;(manufactured goods)&lt;br&gt;batteries, cars, computers, textiles</td>
<td><strong>Businesses</strong>&lt;br&gt;establishments, enterprises</td>
<td><strong>Economic activities</strong>&lt;br&gt;mining, construction, chemical industry, iron &amp; steel industry</td>
</tr>
<tr>
<td><strong>Countries/regions</strong>&lt;br&gt;total materials&lt;br&gt;groups of materials, particular materials</td>
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<td></td>
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<table>
<thead>
<tr>
<th>Type of analysis</th>
<th>Substance Flow Analysis</th>
<th>Material System Analysis</th>
<th>Life Cycle Assessment</th>
<th>Business level MF Analysis</th>
<th>Input-Output Analysis</th>
<th>Economy-wide MF Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of measurement tool</strong></td>
<td>Substance Flow Accounts</td>
<td>Individual Material Flow Accounts</td>
<td>Life Cycle Inventories</td>
<td>Business Material flow accounts</td>
<td>Physical Input-Output Tables, NAMEA-type approaches</td>
<td>Economy-wide Material Flow Accounts</td>
</tr>
</tbody>
</table>

Source: OECD, based on Bringezu and Moriguchi (2002).
# Which Methods to use?

<table>
<thead>
<tr>
<th></th>
<th>MFA</th>
<th>IOA</th>
<th>LCA</th>
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<tbody>
<tr>
<td><strong>Purpose</strong></td>
<td>• investigate <strong>technical processes</strong></td>
<td>• <strong>economic</strong> tool for analysing interindustrial interdependences</td>
<td>• <strong>decision-support</strong> tool</td>
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<td></td>
<td>• systematic evaluation of flows and stocks</td>
<td></td>
<td>• bottom-up methodological framework encompassing all the <strong>impacts</strong> of a product</td>
</tr>
<tr>
<td><strong>System definition</strong></td>
<td>• Functional or geographical</td>
<td>• Geographical</td>
<td>• Functional</td>
</tr>
<tr>
<td><strong>Allocation</strong></td>
<td>• Mass proportional</td>
<td>• Value proportional</td>
<td>• various choices (Mass or value proportional, System expansion, …)</td>
</tr>
<tr>
<td><strong>Advantage</strong></td>
<td>• Flexibility with regard to model assumptions</td>
<td>• Represents the <strong>whole economy/industry</strong></td>
<td>• <strong>Detailed</strong> evaluation of a product</td>
</tr>
<tr>
<td></td>
<td>• <strong>Mass balancing</strong> (filling data gaps)</td>
<td>• Public data available (on nationwide level)</td>
<td>• Product comparisons</td>
</tr>
<tr>
<td></td>
<td>• Basis for impact assessment methods</td>
<td>• Possibility to extend (MRIO, EEIO)</td>
<td>• Multi-dimensional</td>
</tr>
<tr>
<td><strong>Disadvantage</strong></td>
<td>• Availability of data</td>
<td>• Low resolution due to <strong>high aggregation</strong></td>
<td>• subjective <strong>definition of the system boundary</strong> (e.g. EoL-Phase)</td>
</tr>
<tr>
<td></td>
<td>• One-dimensional</td>
<td>• partial simplifications and assumptions</td>
<td>• How to represent services?</td>
</tr>
<tr>
<td></td>
<td>• Services are not represented</td>
<td>• Spatial boundaries</td>
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**Single methods can’t provide a comprehensive economic and environmental assessment of a complex system in the context of a circular economy**
Proposal: Combination of Methods

Increase the resolution:
Industry-wide MFA

Economy-wide MFA
[kg]
Hybrid-LCA / EEIOA
[per CHF]

MFA
[kg]

IOA
PIOT
[kg]
MIOT
[CHF]

LCA
[per unit]

Combination enables us to assess the impacts of all processes in the regional industry

Availability of Data:
MFA-Database (KAR-Modell)
Case-Studies
Assessment-Model

Translation into monetary units can promote communication with a wide audience and raise social awareness of environmental issues.
Assessment-Model – System Boundary

System Boundary:
Output of the Buildings-Materials-Industry in the defined Region over a specified period

Focus:
- Regional comparison
- Boundary analysis in the context of a change in regional demand
With this Assessment-Model, we can …

- indicate the **impacts of changing material flows** or innovations on the life cycle most relevant for generating value added, causing emissions and consuming natural resources on a regional level

- highlight the **impact of a specific business-model** and show how this effects environmental and economic performance of a regional building materials industry

- derive **policy recommendations** which promote the development of a circular economy in the building materials industry in a regional context
THANK YOU FOR YOUR ATTENTION

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