The Importance of a Three-dimension Approach in LCA.
A Screening Study on Mining addressing Environmental, Social and Cost Aspects

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The meaningfulness of a LCA screening study

1. Prioritize efforts and resources -> **key issues**
2. Better shape the G&S of the study -> **sustainability hotspots**

- Environmental,
- Social,
- Cost

**WHY?**

- Burdens may be shifted from one dimension to another
- Indicators, impact categories and outcomes may be complementary, overlapping and/or contradictory
Integrated Mineral Technologies for more Sustainable Raw Material Supply

- H2020 issue “Sustainable selective low impact mining”
- 3 years: 1.6.2017 – 31.5.2020
- 7.9 M€ budget
- 16 partners
### Screening approach

<table>
<thead>
<tr>
<th>Areas</th>
<th>Process</th>
<th>Db</th>
<th>LCIAM</th>
<th>E-LCA</th>
<th>S-LCA</th>
<th>LCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finland, Portugal, South Africa, Europe, Latin America</td>
<td>ecoinvent, EXIOBASE</td>
<td>ILCD 2011 Midpoint+, ReCiPe, Boulay et al. (2011), CML-IA baseline, EXIOBASE built-in LCIAM</td>
<td>ecoinvent, EXIOBASE</td>
<td>ecoinvent, EXIOBASE</td>
<td>Finland, Portugal, South Africa, Brazil, US, Europe, Latin America</td>
<td>ecoinvent + literature research</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Social impacts weighting method in PSILCA</td>
<td>Added value calculation, engineering principles</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Metal ores</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mine construction, underground and open cast; copper mine operation; copper production, primary</td>
<td></td>
</tr>
</tbody>
</table>
The context of the mining activity

- Vulnerability of local communities, e.g. their dependence on local water reserves
- Availability and quality of water and mineral resources
- Conflicts with other industries
- Importance of mining for the local/national economy
- Risks on a national scale (not sector-specific)
- Steadiness of risks/impacts
Results: E-LCA screening

- Copper production, primary, RER, ecoinvent

Normalization set “EU 27 ILCD Midpoint+, 2010”

- Copper ores and concentrates, Finland, EXIOBASE
Results: S-LCA screening

- Metal ores, Finland, PSILCA
  
  ![Impact category](image)
  
<table>
<thead>
<tr>
<th>Contribution</th>
<th>Process</th>
<th>Impact category</th>
</tr>
</thead>
<tbody>
<tr>
<td>100.00%</td>
<td>Metal ores - FI</td>
<td>Industrial water depletion</td>
</tr>
<tr>
<td>&gt; 77.89%</td>
<td>Manufacture of basic metals - FI</td>
<td></td>
</tr>
<tr>
<td>&gt; 17.00%</td>
<td>Manufacture of chemicals and chemical products - FI</td>
<td></td>
</tr>
<tr>
<td>&gt; 00.20%</td>
<td>Iron and steel mills and ferroalloy manufacturing - US</td>
<td></td>
</tr>
<tr>
<td>&gt; 00.17%</td>
<td>Non-ferrous metals - CA</td>
<td></td>
</tr>
<tr>
<td>&gt; 00.11%</td>
<td>Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction excluding surveying - EE</td>
<td></td>
</tr>
<tr>
<td>&gt; 00.11%</td>
<td>Basic ferrous metals - DE</td>
<td></td>
</tr>
</tbody>
</table>

- Metal ores, Portugal, PSILCA

![Impact category](image)
Results: LCC screening

• Copper mine operation, sulfide ore, RER, ecoinvent

<table>
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<tr>
<th>Contribution</th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>100.00%</td>
<td>copper mine operation, sulfide ore</td>
</tr>
<tr>
<td>02.69%</td>
<td>electricity production, hydro, run-of-river, electricity, high voltage</td>
</tr>
<tr>
<td>02.03%</td>
<td>market for aluminium hydroxide factory, aluminium hydroxide factory</td>
</tr>
<tr>
<td>01.66%</td>
<td>market for blasting, blasting, Cutoff, U - GLO</td>
</tr>
<tr>
<td>01.43%</td>
<td>market group for electricity, medium voltage, electricity, medium voltage</td>
</tr>
<tr>
<td>00.71%</td>
<td>market for steel, chromium steel 18/8, hot rolled, steel, chromium steel 18/8, hot rolled</td>
</tr>
<tr>
<td>00.63%</td>
<td>market for chemical, organic, chemical, organic, Cutoff, U - GLO</td>
</tr>
</tbody>
</table>

• LCC beyond databases

1. Cost Breakdown Structure
2. Location factors
3. Cost indexes
4. Scaling factors for equipment cost
5. Sensitivity analysis for energy cost in different countries

Operating cost estimation (mining in US)

- Equipment operation: 45%
- Blasting: 18%
- Tailings and waste rock management: 23%
- Energy supply: 13%
- Other: 1%
## Results: summary and interpretation

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<th>E-LCA</th>
<th>S-LCA</th>
<th>LCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hotspots: electricity and tailings management</td>
<td>1. Importance of the supply chain (China, India)</td>
<td>1. Hotspots: energy and tailings and waste rock handling</td>
</tr>
<tr>
<td>2. Toxicity categories</td>
<td>2. Hotspots: machineries, chemicals and basic metals manufacturing</td>
<td>2. Costs vary by region and country</td>
</tr>
<tr>
<td>3. Impacts are not globally widespread</td>
<td>3. Local communities</td>
<td>3. Costs are influenced by the scale of the mine and type of ore</td>
</tr>
<tr>
<td>4. Differences in location</td>
<td>4. Potential opportunities (employment, fair salary)</td>
<td>4. Difficult to collect data</td>
</tr>
</tbody>
</table>
Complementarity, overlapping and tradeoffs

- Tailings leaking
- Soil contamination from heavy metals
- Freshwater ecotoxicity
- Destruction of ecosystems

- Cost for tailings management
- Poor water quality
- Groundwater resources contamination
- Cost for water treatment
- Destruction of material resources
- Health problems for local community
- Poverty
- Resettlement
- Destruction of local economies

- Water withdrawal
- Water resource depletion
- Water consumption

- Closed loop water cycle
- Process instability
- Efficient water recycling
- Monitoring cost
- Energy input
- Energy production
- Impacts on human health

ITERAMS
greenDeLTa
Where are the limitations

- Data quality (old data, technical conformance)
- Different data sources (gaps, assumptions, harmonization)
- Background data should always be related to the context
- The LCA screening results should be complemented with other tools, e.g. literature, causal loop diagram

Impact results, data quality - Metal ores, Finland, PSILCA
Conclusions and further development

• Valuable **inputs** to the project

• **Environmental** and **cost** impacts end up in impacts on social stakeholders

• The **social** dimension is the most difficult to measure

• If one or two dimensions had been excluded, an **incomplete picture** of the impacts would have been provided

• **Dialogue** among the project partners
References

• Ecological statuts of surface water in Portugal, slide 6. Available at: https://snirh.apambiente.pt/index.php?idMain=1&idItem=1.5. Last accessed: 15.08.18
• Ecological status of surface waters in Finland, slide 6. Available at: http://www.ymparisto.fi/en-US/Waters/State_of_the_surface_waters. Last accessed: 15.08.18
Thank you!

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