Possibilities in Life Cycle Sustainability Assessment for integration of Resource Criticality - Geopolitical Related Supply Risk as an example -

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Overview

1. Resource Issue in LCIA
2. The Concept of Criticality
3. Broadening the Scope of LCA
4. LCSA – for Resource Criticality
5. Geopolitical related supply risk
6. Conclusions and Perspectives

Based on:

• Sonnemann, G., Gemechu, E.D., Adibi, N., De Bruille, V. and Bulle, C. From a critical review to a conceptual framework for integrating the criticality of resources into Life Cycle Sustainability Assessment. Journal of Cleaner Production, 94 (20–34), 2015.


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Resource Issue in LCIA

- No clear boundary between Environment and socio-economic system
- No intrinsic value
- Function to manmade environment and economy
- Human welfare

Stewart and Weidema, 2005
A new perspective of LCA

- Only based on geological availability – long-term time perspective
- Accessibility due to competition and other geopolitical factors are not well covered

- A new perspective of LCA is needed – to broaden its scope from assessing only depletion based on geological availability to include resource security aspects: Resource Criticality Assessment
The Concept of Criticality

- Increased resource demand
- Need of special materials for green technologies and water
- Price fluctuation
- Supply security issue

↓

Criticality

Graedel et al., 2012

- Importance
- Substitutability
- Susceptibility

Environmental Implications

Vulnerability to Supply Restriction

Supply Risk

Geological, Technological, Economic Considerations

Social & Regulatory Considerations

Geopolitical Considerations

Damage to Human Health

Damage to Ecosystem

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The Concept of Criticality

- Production concentration of some mineral raw materials

Source: EC, 2014
Broadening the scope of LCA

• Resource issue → Scarcity (of water)

Source: IWMI, 2007
Broadening the scope of LCA

Integrating criticality assessment

Environmental Impact
↓
Socio-Economic and Geopolitical Aspects
↓
Supply Risk
↓
Constraints for the access to resources
↓
Criticality
Broadening the scope of LCA

New applications of LCA

- Due to increased use of geographic information in LCA
  - Map supply chains of resources for companies’ materials and products
  - Identify potential future supply constraints

- Addressing for instance:
  - access to minerals due to the risks of supply constraints and conflicts
  - the availability of water due to risks related to changing weather and consumption patterns
LCSA – for Resource Criticality

Life Cycle Sustainability Assessment (LCSA)

• LCSA – Integration of
  – Environmental
  – Social
  – Economical

UNEPA (2011): Towards a Life Cycle Sustainability Assessment

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Role of geopolitical implications of resource use at different time scales

• For Mineral resources
  – Short term (up to 5 years)
    • Highly dependent on geopolitical factors
  – Mid term (5 to 20 years)
    • Increased effort (cost or energy) due to technology and demand side development
  – Long term (50 years or so)
    • Resource depletion

• For Water resources
  – Short term (up to 5 years)
    • Highly dependent on geopolitical factors
  – Mid term (5 to 20 years)
    • Decrease in water quality (cost or energy to supply a good quality water)
  – Long term (50 years or so)
    • Climate change → Water depletion (Green water)
LCSA – for Resource Criticality

Framework

LCI

LCSA

Inventory

Midpoints

Endpoints

Criticality

Environmental Dimension

Economic Dimension

Social Dimension

Environmental Implications (multiple midpoints)

Geological Resource Depletion

Geopolitically Related Availability

Geological Supply Risk Implications

Vulnerability to Supply Restriction

Social Implications

Damage to Human Health

Damage to Ecosystem Quality

Geopolitical Supply Risk Implications

Gemechu et al., 2015

Sonnemann et al., 2015

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LCSA – for Resource Criticality

Different work streams

De Bruille, V., Bulle, C., Jolliet, O., Dandres, T., Gaudreault, C., and Samson, R. Competition index for mineral resources based on functionality and substitutability (working paper)


Sonnemann et al., 2015 Gemechu et al., 2015

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Geopolitical related supply risk

Integrating geopolitical supply risk in LSCA

\[ SR_{c,i} = \left( \frac{1}{n} \sum_{k=1}^{n} s_{k}^2 \right) \times \left( \sum_{k=1}^{n} g_{k} \times f_{i,k} \right) \]

- \( s_{k} \) is the share of country \( k \) in the global production (mining or refining) of the commodity \( c \).
- \( g_{k} \) is the political instability indicator of country \( k \).
- \( f_{i,k} \) is the import share of country \( k \) in the supply-chain of country \( i \).

Gemechu et al., 2015
**GeoPolRisk** is expressed as a socio-economic risk oriented midpoint indicator with values between 0 and 1.

\[ SR_{c,i} = \left[ \left( \sum_{k=1}^{n} S_k^2 \right) \ast \left( \sum_{k=1}^{n} g_k \ast f_{i,k} \right) \right] \]

**Data**

- Annual mineral production - (USGS)
- Worldwide Governance Indicator (World Bank)
- Import data - UN Commodity Trade Statistics Database (UN comtrade)

Gemechu et al., 2015
Risk Contribution for Rare Earth Elements (REE)

GeoPolRisk REE, France

Case study published

Gemechu et al., 2015

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Conclusions

• There is high potential for LCSA to be used in the context of criticality assessment of resources.
• Criticality assessment of resources and LCA for products have a complimentary nature.
• Data generated for LCA provide a lot basic information on resource use that can be used in LCSA.
• Life Cycle Inventories need to become more geographically explicit to be relevant for use in LCSA.
• Challenges on LCIA refer to:
  – how to report on multiple resource criticality indicators at midpoint (and endpoint) level
  – difficulty of aggregation of different criticality aspects, i.e. as a single score or as a separate indicator?
Perspectives

- Various work streams on criticality assessment in LCSA need to advance for a meaningful AoP Resources.
- The GeoPolRisk method is starting point with limitations that need to be addressed in future research.
- From single to multilevel GeoPolRisk:
  - Include systematically mining $\rightarrow$ domestic production (e.g. smelter)
  - Focus on metals $\rightarrow$ other materials (case: carbon fibers)
  - Develop midpoint $\rightarrow$ endpoint characterization factor

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Merci pour votre attention !

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