Influence diagrams and scoping for Life Cycle and Sustainability Assessment
an example from sustainable mining

Andreas Ciroth, Claudia Di Noi¹, Helena Wessman-Jääskeläinen²
¹GreenDelta, ²VTT

Setac Rome, May 16, 2018
Influence diagrams and scoping for LCA and Sustainability Assessment

1. A motivation
2. Influence diagrams
3. Influence diagrams for life cycle sustainability assessment of a mining site and mining technology
4. How to use the diagrams, scoping
5. Status and outlook
1 A motivation
Why influence diagrams?

- LCA is an established, standardised, “science-based” approach for holistically assessing environmental and potentially other impacts over the life cycle of a product or service:

  “LCA considers all attributes or aspects of natural environment, human health and resources. By considering all attributes and aspects within one study in a cross-media perspective, potential trade-offs can be identified and assessed. “
  ISO 14040 2006, 4.1.7, comprehensiveness

→ LCA is a very useful approach for understanding sustainability impacts of mining.
Why influence diagrams?

• However,

  • level of detail of the LCA set by goal and scope; expert knowledge, guessing, and study conditions are common for specifying goal and scope

  • LCA is a linear model -> feedback loops hard to detect (e.g.)

  • uncertainty, lack of knowledge prevail for some products: GMO, nanotech-products, mine-site products
Why influence diagrams?

→ LCA by design “does not see everything” (linear, typically deterministic model)

→ The extent can be further reduced by goal and scope settings

→ Influence diagrams, established before starting the LCA modelling, are a way to
  → identify the toolset needed for a comprehensive understanding of a problem
  → identify relevant and irrelevant aspects for a life cycle model
2 Influence diagrams
Influence diagrams, an introduction

Influence diagrams / causal loop diagrams are visual diagrams about a situation or issue, with longer tradition in modelling\(^1\):

- variables are connected with arrows, showing relations between variables
- arrows have an indication of whether the relation is enforcing (+, more creates more) or the opposite (-, more creates less)
- qualitative modelling, unrestricted

\(^1\) e.g. Bossel, H.: Modellbildung und Simulation, Kassel 1994
Influence diagrams, an introduction, 2
Effects of policy decisions on livelihood and water security, Pollard et al 2014

Influence diagrams, an introduction, 3

Steps to create the diagram

- identify the variables
- identify the causes and relations
- add the direction of the cause, a ‘+’ indicating increase, a ‘-’ decrease
- check that only direct relations are represented
- check that all other relations are frozen when one relation is considered
- clearly define the state and starting point for the diagram
3 Influence diagrams for life cycle sustainability assessment of a mining site & technology
Influence diagrams for mining

Iterams, EU H2020 project, 2017-2021, www.iterams.eu:

a new, innovative technology is proposed and tested which promises to reduce water input and output flows of a mine and produces „concrete-like“ material from mining residues, to be used within the mine.

Tested in mine sites, e.g. for copper, in Finland, Portugal, South Africa

→ is this new technology more sustainable, over the life cycle?
Influence diagrams for mining: Iterams
Influence diagrams for mining: Iterams
Inputs: water, land use, energy, materials -> link to life cycle
Influence diagrams for mining: Iterams Impacts on sustainability
Influence diagrams for mining: Iterams
Other elements

Relations, and status variables
Influence diagrams for mining: Iterams
Other elements

External variables
Influence diagrams for mining: Iterams

Other elements

Risks
4 How to use the influence diagrams
How to use the diagrams

• Visualise and discuss relations
• Find hot spots and trade-offs
• Determine goal and scope for LCA (extended)
How to use the diagrams: hot spots and trade-offs

GreenDelta A. Ciroth, H. Wessman-Jääskeläinen, Cl. Di Noi: Influence diagrams
How to use the diagrams: hot spots and trade-offs

- leakings treatment effort
- o&amp;r wet separation effort
- rainwater treatment effort
- water cleaning effort
- environmental conditions sensitivity, vulnerability
  - dam size
  - (leakings treatment effort)
  - (o&amp;r wet separation effort)
  - (rainwater treatment effort)
- materials input
- share of geopolymers used in mine "fortifications"
  - (water cleaning effort)
- ecosystems impacts
  - pond size
  - pond seepage
  - risk of breakage and damage
  - (environmental conditions sensitivity, vulnerability)
  - (pond size)
- risk of untreated, uncaptured leakings
  - dry tailings protection
  - tailings quality, dryness
- risk of treated, captured leakings
  - tailings quality, dryness
- water quality
  - pond size
  - pond seepage
  - risk of breakage and damage
  - (environmental conditions sensitivity, vulnerability)
  - (pond size)
- risk of untreated, uncaptured leakings
  - dry tailings protection
  - tailings quality, dryness
  - pond size
  - pond seepage
  - risk of breakage and damage
  - (environmental conditions sensitivity, vulnerability)
  - (pond size)
- risk of treated, captured leakings
  - dry tailings protection
  - tailings quality, dryness
  - pond size
  - pond seepage
  - risk of breakage and damage
  - (environmental conditions sensitivity, vulnerability)
  - (pond size)
- energy input
  - leakings treatment effort
  - o&amp;r wet separation effort
  - rainwater treatment effort
  - water cleaning effort
How to use the diagrams: hot spots and trade-offs

- leakings treatment effort
- (leakings treatment effort)
- (o&v wet separation effort)
- (rainwater treatment effort)
- (water cleaning effort)
- water quality
- pond size
- pond seepage
- (environmental conditions sensitivity, vulnerability)
- (pond size)
- risk of breakage and damage
- risk of untreated, uncontrolled leakings
- dry tailings protection
- tailings quality, dryness
- tailings leakings
- ecosystems impacts
- energy input
- leakings treatment effort
- o&v wet separation effort
- rainwater treatment effort
- water cleaning effort
- environmental conditions sensitivity, vulnerability
- dam size
- materials input
- share of geopolymers used in mine "fortifications"
- (water cleaning effort)
- pond size
How to use the diagrams: goal and scope

- leakings treatment effort
- o&r wet separation effort
- rainwater treatment effort
- water cleaning effort
- environmental conditions sensitivity, vulnerability
  - dam size
    - (leakings treatment effort)
    - (o&r wet separation effort)
    - (rainwater treatment effort)
  - materials input
  - share of geopolymers used in mine "fortifications"
  - (water cleaning effort)
- water quality
  - pond size
  - pond seepage
  - (environmental conditions sensitivity, vulnerability)
    - (pond size)
- (leakings treatment effort)
  - risk of breakage and damage
  - risk of untreated, uncaptured leakings
  - dry tailings protection
  - tailings quality, dryness
  - tailing leakings
5 Conclusions
Conclusions

• Influence / causal loop diagrams are a good way to show and „get into“ the topic of an extended LCA study
• Easy to build, no method- or toolbased limitations
• Purposes
  • display relations
  • Identify hot spots and trade offs
  • structure and motivate goal and scope
Thank you!

Contact: Dr. Andreas Ciroth  
GreenDelta GmbH  
Müllerstrasse 135, 13349 Berlin, Germany  
ciroth@greendelta.com  
www.greendelta.com