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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

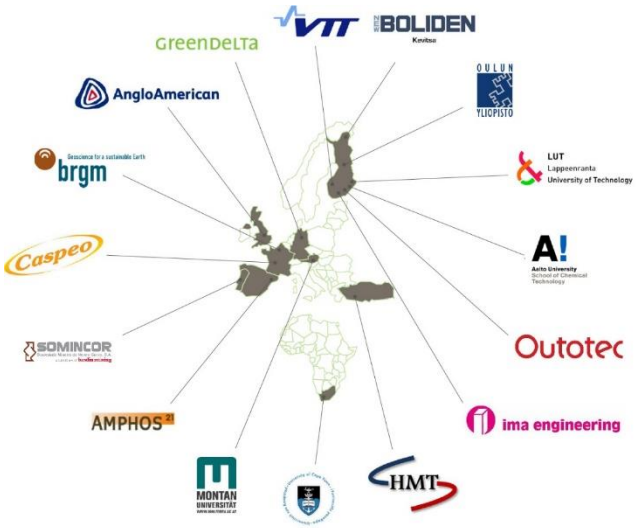
1. Prioritize efforts and resources -> **key issues**
2. Better shape the G&S of the study -> **sustainability hotspots**

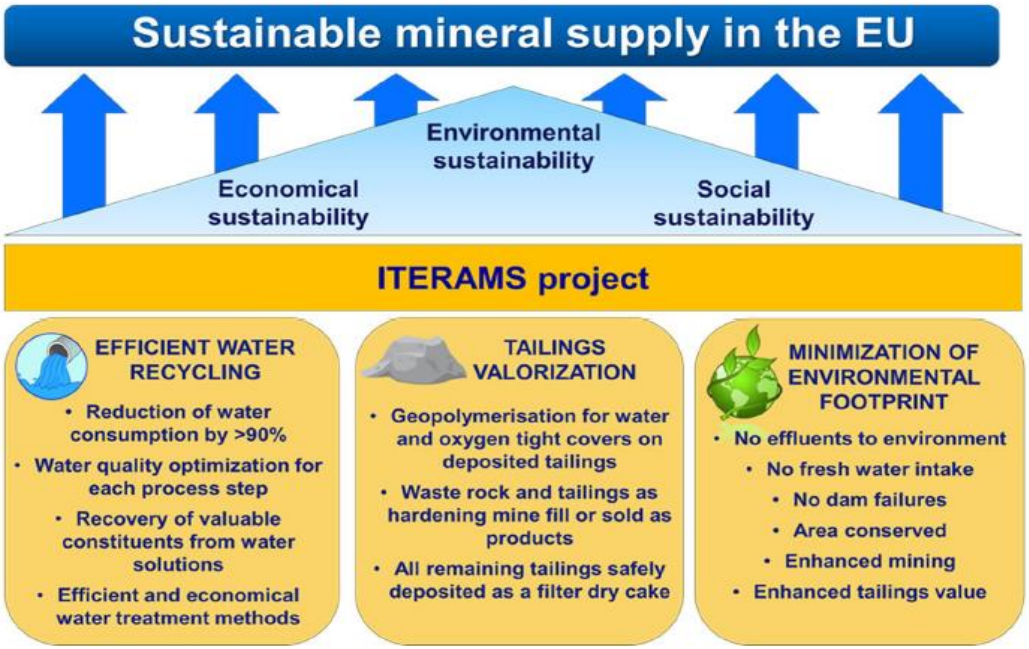
WHY?

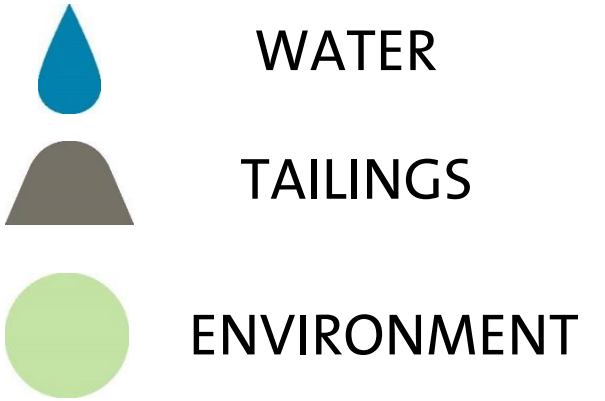
- Burdens may be shifted from one dimension to another
- Indicators, impact categories and outcomes may be complementary, overlapping and/or contradictory

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





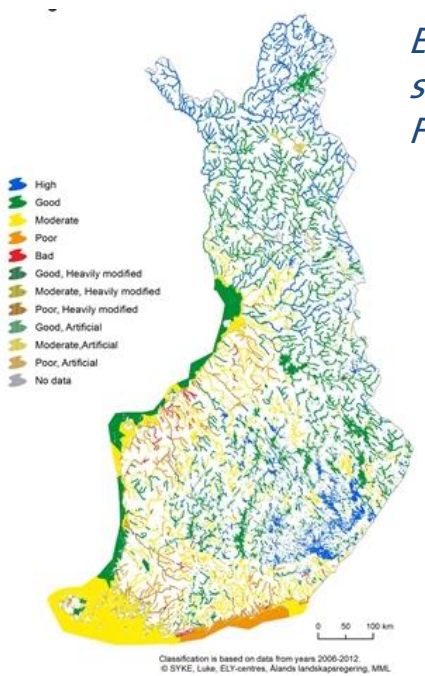


Screening approach

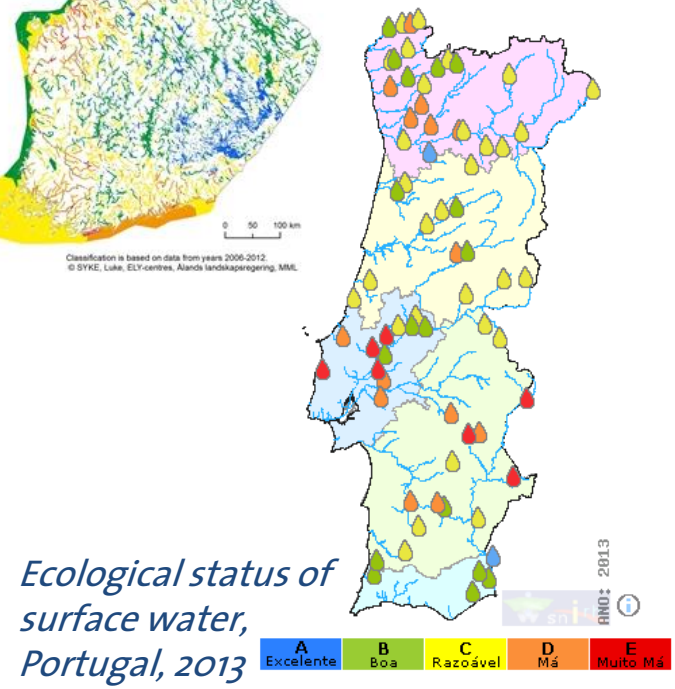
	E-LCA	S-LCA	LCC
Areas	Finland, Portugal, South Africa, Europe, Latin America	Finland, Portugal	Finland, Portugal, South Africa, Brazil, US, Europe, Latin America
Db	ecoinvent, EXIOBASE	PSILCA	ecoinvent + literature research
LCIAM	ILCD 2011 Midpoint+, ReCiPe, Boulay et al. (2011), CML-IA baseline, EXIOBASE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

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



Ecological status of surface water, Finland, 2015



Ecological status of surface water, Portugal, 2013

Results: E-LCA screening

- Copper production, primary, RER, ecoinvent

Normalization set "EU 27 ILCD Midpoint+, 2010"

Normalization

Impact category
Freshwater ecotoxicity - ILCD 2011 Midpoint+
Human toxicity, non-cancer effects - ILCD 2011 Midpoint+
Human toxicity, cancer effects - ILCD 2011 Midpoint+
Freshwater eutrophication - ILCD 2011 Midpoint+
Mineral, fossil & ren resource depletion - ILCD 2011 Midpoint+
Particulate matter - ILCD 2011 Midpoint+
Photochemical ozone formation - ILCD 2011 Midpoint+
Terrestrial eutrophication - ILCD 2011 Midpoint+
Marine eutrophication - ILCD 2011 Midpoint+
Acidification - ILCD 2011 Midpoint+
Land use - ILCD 2011 Midpoint+
Climate change - ILCD 2011 Midpoint+
Water resource depletion - ILCD 2011 Midpoint+

Impact category: Freshwater ecotoxicity - ILCD 2011 Midpoint+

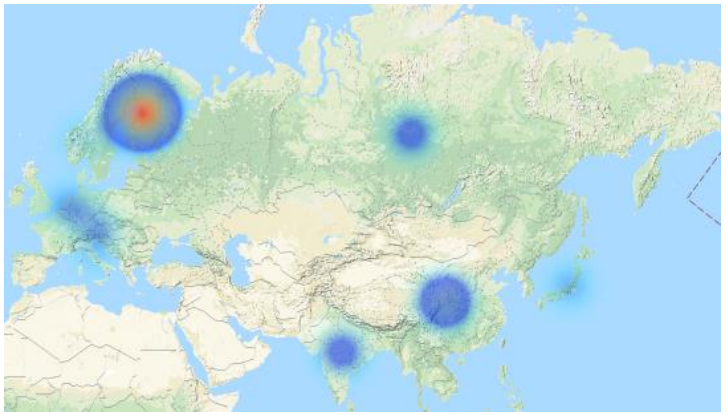
Contribution	Process
100.00%	copper production, primary | copper | Cutoff, U - RER
97.12%	copper mine operation, sulfide ore | copper concentrate, sulfide ore | Cutoff, U - RER
95.62%	market for sulfidic tailing, off-site | sulfidic tailing, off-site | Cutoff, U - GLO
95.62%	treatment of sulfidic tailing, off-site | sulfidic tailing, off-site | Cutoff, U - GLO
00.48%	market for steel, chromium steel 18/8, hot rolled | steel, chromium steel 18/8, hot rolled | Cutoff, U - GLO

Impact category: Human toxicity, non-cancer effects - ILCD 2011 Midpoint+

Contribution	Process
100.00%	copper production, primary | copper | Cutoff, U - RER
87.88%	copper mine operation, sulfide ore | copper concentrate, sulfide ore | Cutoff, U - RER
86.10%	market for sulfidic tailing, off-site | sulfidic tailing, off-site | Cutoff, U - GLO
86.10%	treatment of sulfidic tailing, off-site | sulfidic tailing, off-site | Cutoff, U - GLO
00.33%	market for mine infrastructure, open cast, non-ferrous metal | mine infrastructure, open cast, non-ferrous metal | Cutoff, U - GLO

- Copper ores and concentrates, Finland, EXIOBASE

Name	Category
Water Withdrawal Blue - Total	
P Electricity by gas - RU	EXIOBASE / Russian Federation
P Electricity by nuclear - RU	EXIOBASE / Russian Federation
P Electricity by petroleum and other oil derivatives - EE	EXIOBASE / Estonia
P Electricity by biomass and waste - FI	EXIOBASE / Finland
P Plastics, basic - FI	EXIOBASE / Finland
P Paper and paper products - FI	EXIOBASE / Finland
Water Withdrawal Blue - Manufacturing	
P Plastics, basic - FI	EXIOBASE / Finland
P Paper and paper products - FI	EXIOBASE / Finland
P Chemicals nec - FI	EXIOBASE / Finland
P P- and other fertiliser - FI	EXIOBASE / Finland
Water Consumption Blue - Manufacturing	
P Plastics, basic - FI	EXIOBASE / Finland
P Paper and paper products - FI	EXIOBASE / Finland
P Chemicals nec - FI	EXIOBASE / Finland



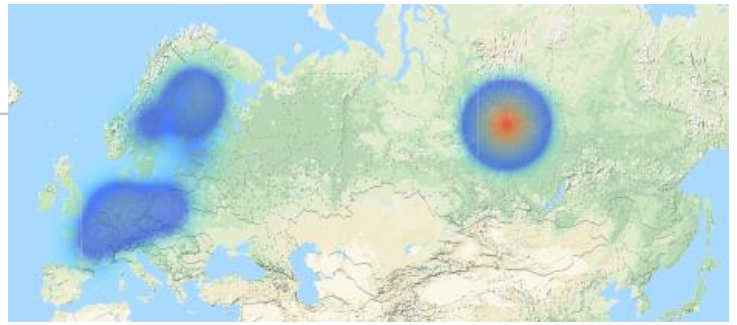
Impact localization: Water withdrawal - Manufacturing

Results: S-LCA screening

- Metal ores, Finland, PSILCA

Impact category: Industrial water depletion

Contribution	Process
100.00%	Metal ores - FI
77.89%	Manufacture of basic metals - FI
17.00%	Manufacture of chemicals and chemical products - FI
00.20%	Iron and steel mills and ferroalloy manufacturing - US
00.17%	Non-ferrous metals - CA
00.11%	Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction excluding surveying - EE
00.11%	Basic ferrous metals - DE



- Metal ores, Portugal, PSILCA

Results: LCC screening

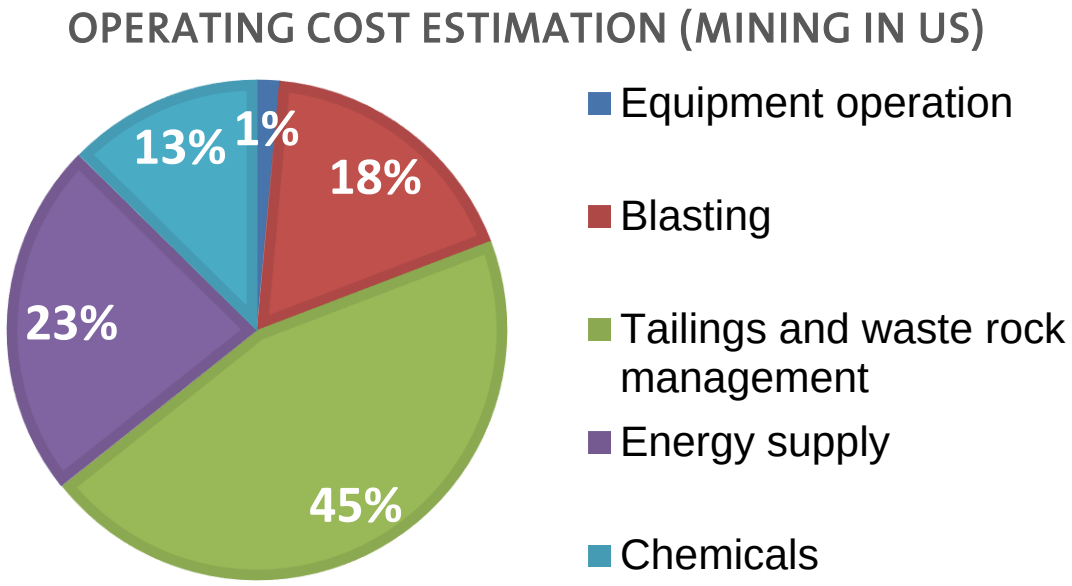
- Copper mine operation, sulfide ore, RER, ecoinvent

Cost category | $¥ Added value

Contribution	Process
100.00%	copper mine operation, sulfide ore | copper concentrate, sulfide ore | Cutoff, U - RER
02.69%	electricity production, hydro, run-of-river | electricity, high voltage | Cutoff, U - RoW
02.03%	market for aluminium hydroxide factory | aluminium hydroxide factory | Cutoff, U - GLO
01.66%	market for blasting | blasting | Cutoff, U - GLO
01.43%	market group for electricity, medium voltage | electricity, medium voltage | Cutoff, U - RER
00.71%	market for steel, chromium steel 18/8, hot rolled | steel, chromium steel 18/8, hot rolled | Cutoff, U - GLO
00.63%	market for chemical, organic | chemical, organic | Cutoff, U - GLO

- 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



Results: summary and interpretation

E-LCA

1. Hotspots: electricity and tailings management
2. Toxicity categories
3. Impacts are not globally widespread
4. Differences in location

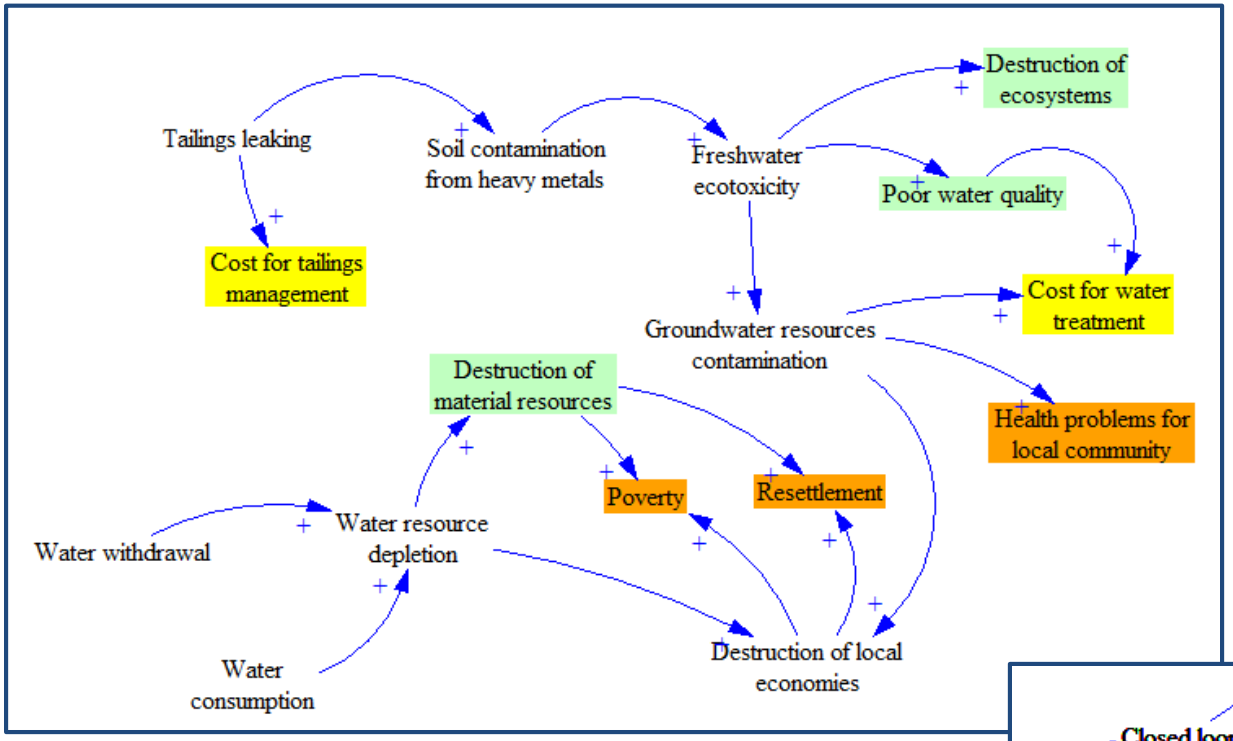
S-LCA

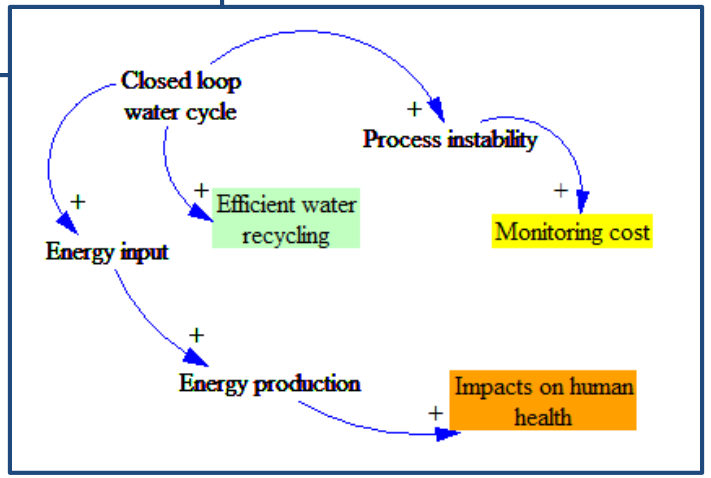
1. Importance of the supply chain (China, India)
2. Hotspots: machineries, chemicals and basic metals manufacturing
3. Local communities
4. Potential opportunities (employment, fair salary)

LCC

1. Hotspots: energy and tailings and waste rock handling
2. Costs vary by region and country
3. Costs are influenced by the scale of the mine and type of ore
4. Difficult to collect data

Complementarity, overlapping and tradeoffs





Where are the limitations

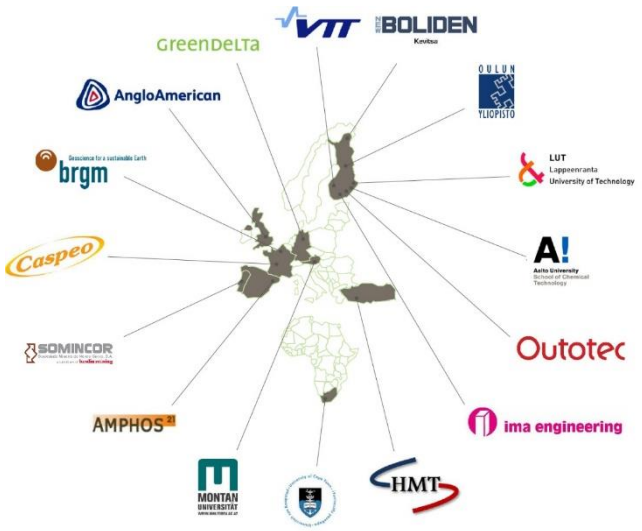
- Data quality (old data, technical conformance)
- Different data sources (gaps, assumptions, harmonization)
- Background data should always be related to the context
- The LCA screening results should be complemented with other tools, e.g. literature, causal loop diagram

Name	R	C	T	G	F
Contribution to environmental load	2	2	2	1	1
Social responsibility along the supply chain	2	4	2	1	2
Public sector corruption	4	3	1	1	
Certified environmental management system	1	4	2	1	3
Minerals consumption	2	1	4	1	5
Industrial water depletion	2	2	5	1	5
Sanitation coverage	2	2	2	1	
Trade unionism	2	2	4	1	5
Safety measures	1	2	1	4	2
Non-fatal accidents	2	3	4	1	2
Active involvement of enterprises in corruption and bribery	2	2	2	2	3
Drinking water coverage	2	1	2	1	
Trafficking in persons	2	1	1	1	
Biomass consumption	2	1	4	1	5
Pollution	3	3	1	1	5
Fair Salary	2	2	2	1	1
Health expenditure	1	1	4	1	
Anti-competitive behaviour or violation of anti-trust and monopoly legislatio	2	2	5	1	2
Fatal accidents	2	2	5	1	2

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



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Thank you!

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