GreenDelta

sustainability consulting + software

H2020 ITERAMS project. Sustainability of a portfolio of solutions for water and tailings management in mining

Claudia Di Noi[1], Dr. Andreas Ciroth[1], Salwa Burhan[1]

[1]GreenDelta GmbH

ACLCA LCA XIX | 24-26 September 2019 | Tucson, Arizona

Major issue in mining (I)
water use

- Freshwater intake
- Water discharge
- Environmental limits/water quality
- Environmental limits/water quantity
- Water recycling
- Costs/water pumping
- Costs/waste water treatment

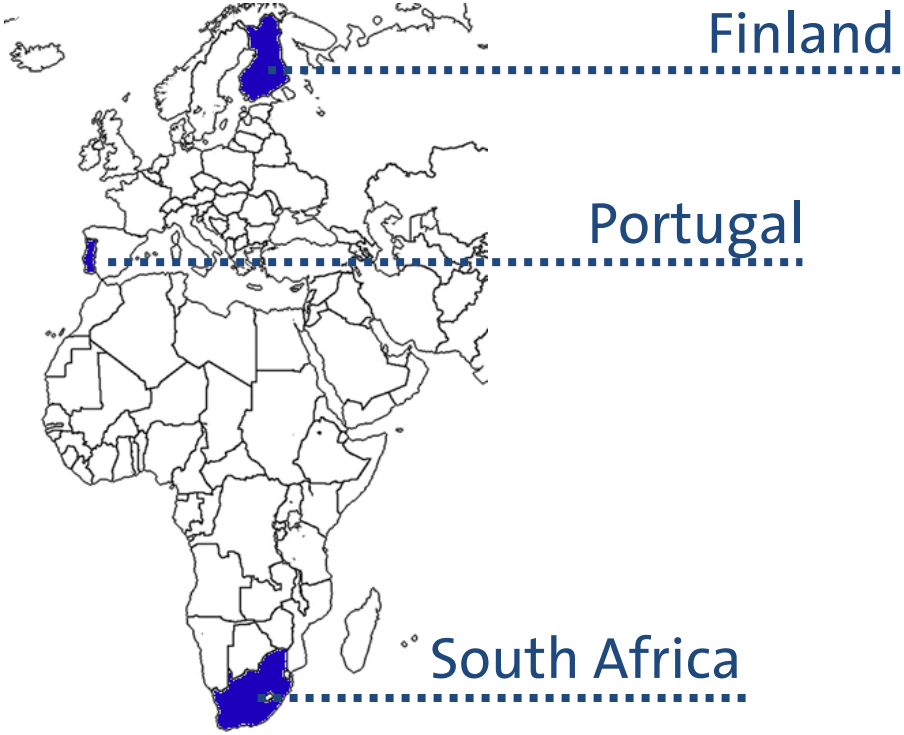
Major issue in mining (II) tailings disposal

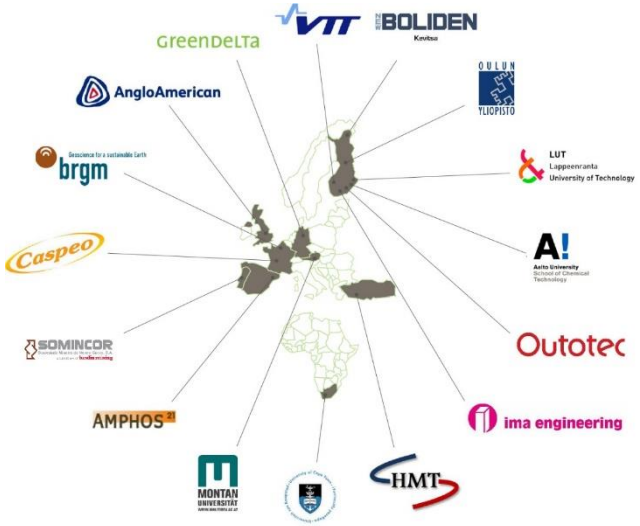
- Land use
- Emissions to freshwater
- Acid Mine Drainage (AMD)
- Conflicts with local communities
- Risk of ecological disasters, e.g. dam failure
- Costs/tails management
- Wet tailings disposal will probably be banned in the future

https://www.theguardian.com/world/2018/feb/28/brazil-dam-collapse-samarco-fundao-mining

H2020 ITERAMS project | Figures

- Integrated Mineral Technologies for More Sustainable Raw Material Supply
- 3 years: 1.6.2017 – 31.5.2020
- 7.9 M€ budget
- 16 partners
- 3 validation sites





H2020 ITERAMS project: closing the water loop

- Closure of water cycles at each process stage
- Isolation of process waters from other water systems

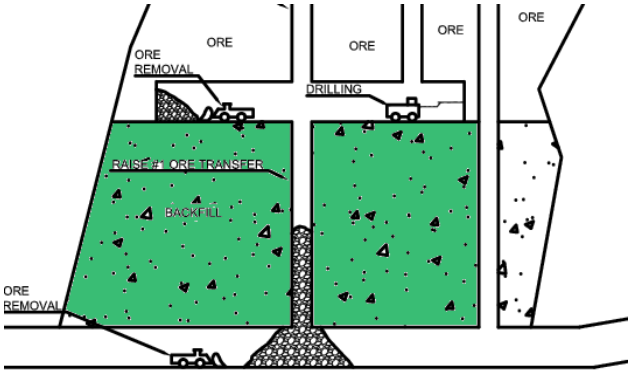
How does this affect…

- **process water quality?**
  Water temperature increases->bacterial growth
- **water treatment effort?**
  Electricity, chemicals
- **process stability?**
  Closed water cycle->thermodynamic and kinetic instability
- **plant performance?**
  Concentrate grade, recovery rate

H2020 ITERAMS project: tailings valorization

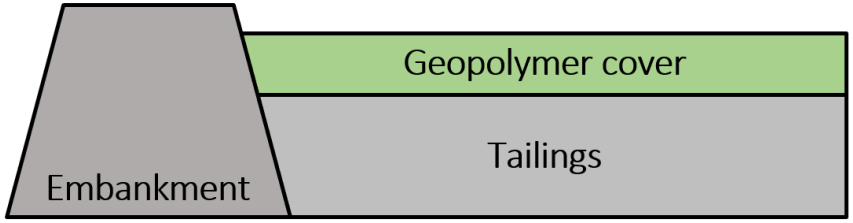
- Use tailings/waste rocks to create new mineral phases
  -> **Geopolymers** to be used as:

- Backfill material for underground mining

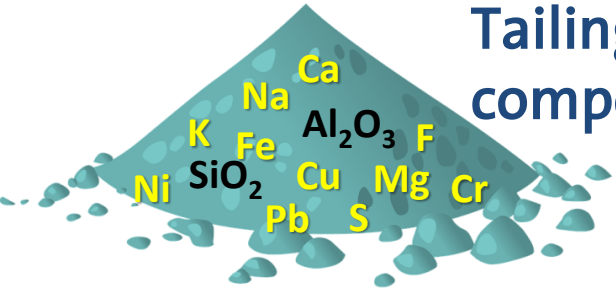


http://minewiki.engineering.queensu.ca/mediawiki/index.php/Backfill

- Cover material for surface deposits (to avoid AMD)



Obenaus-Emler et al. (2017) ITERAMS Integrated Mineral Technologies for More Sustainable Raw Material Supply, Conference presentation RICON17



Tailings composition?

Activator?

Additional treatments?

How to assess ITERAMS sustainability

Can the sustainability of mining operations be enhanced with ITERAMS? And how can we evaluate it?

- A comparative sustainability assessment of impacts and risks **with and without** the implementation of the novel technologies

The comparison is not straightforward!

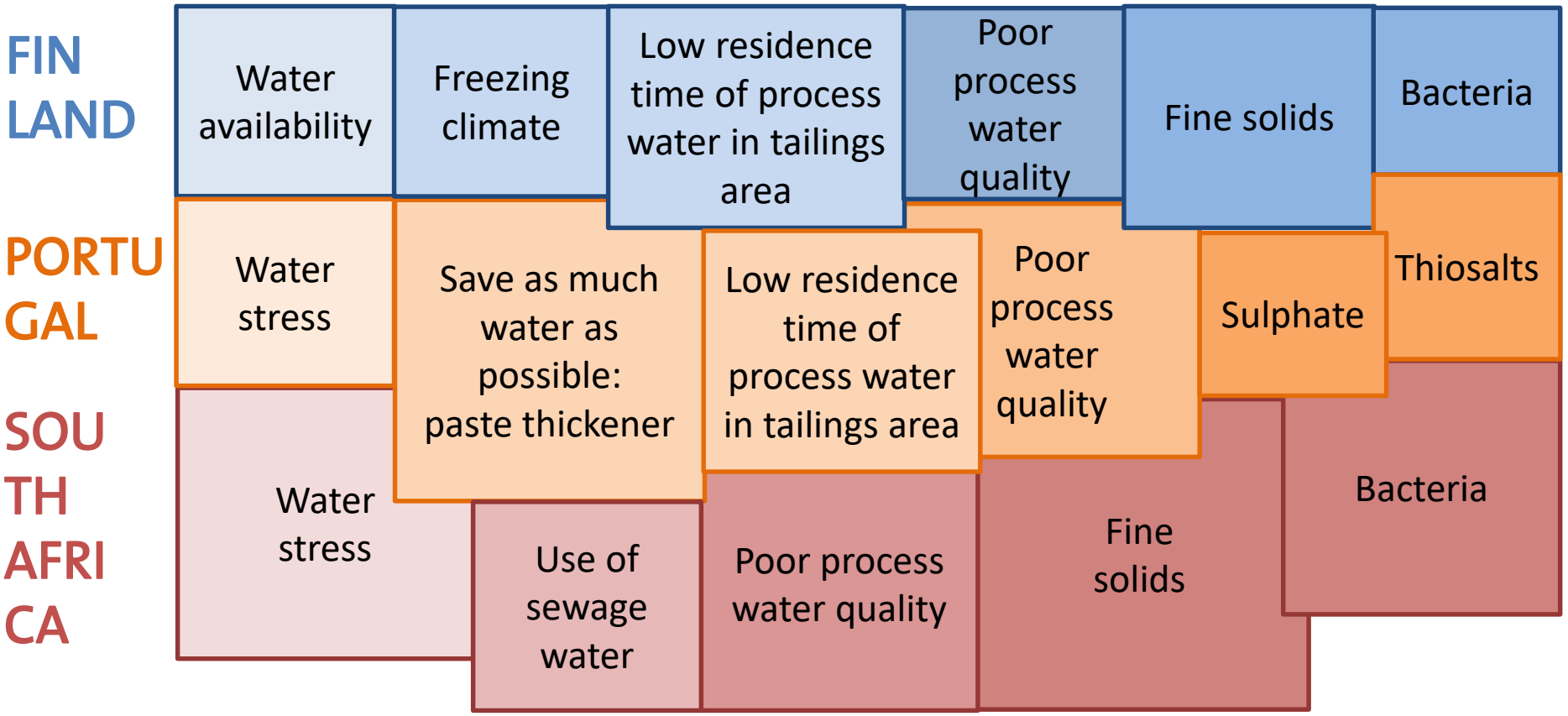
Why the comparison is not straightforward

- Plant performance and output change over time and are likely to be affected by the novel technologies
- Functional unit definition
- Every mine site is different

There will not be one "block" of technologies, but a portfolio of technologies adapted to each site:

- Different water cleaning technologies
- Different ways to create geopolymers

Every mine site is different – example water quality



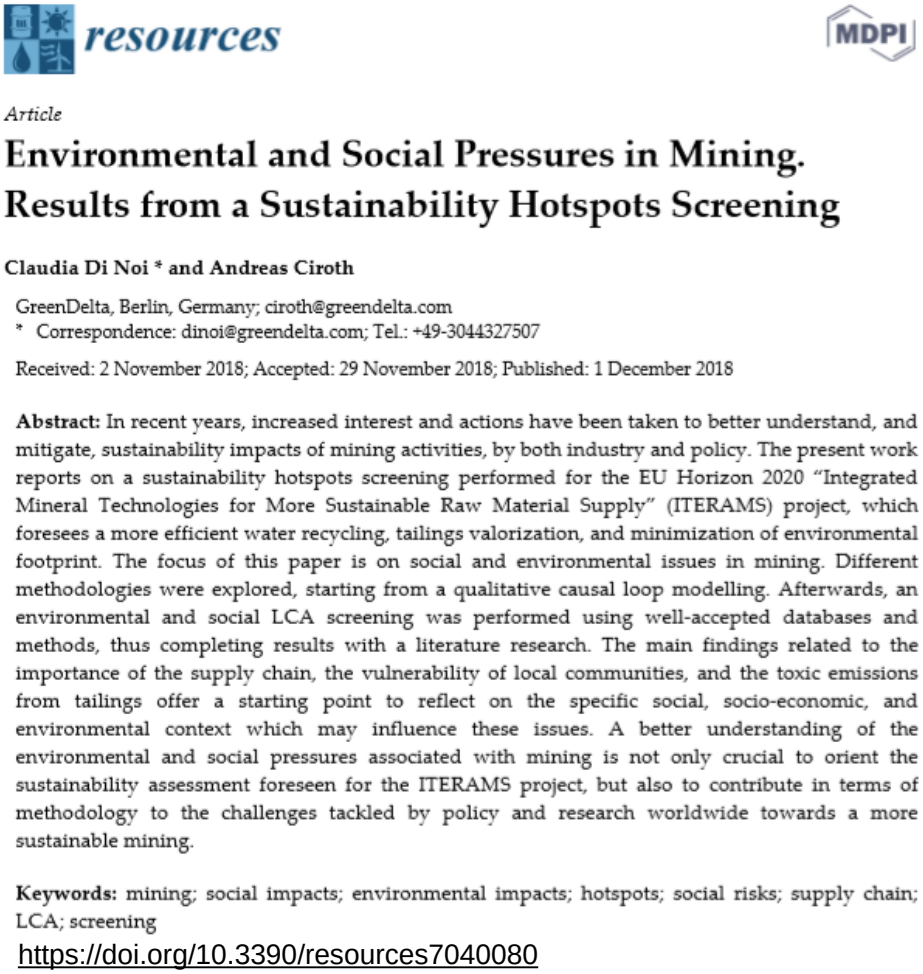
A portfolio of ITERAMS solutions

- A simple “black and white” comparison (“with or without” “the” ITERAMS solution) is not realistic
- …nor useful

->We assess the sustainability of a portfolio of ITERAMS solutions for water and tailings management in mining

Modelling the ITERAMS portfolio | hotspots

- Starting with insights from a previous hotspots screening and qualitative ITERAMS modelling



resources

MDPI

Article

Environmental and Social Pressures in Mining. Results from a Sustainability Hotspots Screening

Claudia Di Noi * and Andreas Ciroth

GreenDelta, Berlin, Germany; ciroth@greendelta.com
* Correspondence: dinoi@greendelta.com; Tel.: +49-3044327507

Received: 2 November 2018; Accepted: 29 November 2018; Published: 1 December 2018

Abstract: In recent years, increased interest and actions have been taken to better understand, and mitigate, sustainability impacts of mining activities, by both industry and policy. The present work reports on a sustainability hotspots screening performed for the EU Horizon 2020 "Integrated Mineral Technologies for More Sustainable Raw Material Supply" (ITERAMS) project, which foresees a more efficient water recycling, tailings valorization, and minimization of environmental footprint. The focus of this paper is on social and environmental issues in mining. Different methodologies were explored, starting from a qualitative causal loop modelling. Afterwards, an environmental and social LCA screening was performed using well-accepted databases and methods, thus completing results with a literature research. The main findings related to the importance of the supply chain, the vulnerability of local communities, and the toxic emissions from tailings offer a starting point to reflect on the specific social, socio-economic, and environmental context which may influence these issues. A better understanding of the environmental and social pressures associated with mining is not only crucial to orient the sustainability assessment foreseen for the ITERAMS project, but also to contribute in terms of methodology to the challenges tackled by policy and research worldwide towards a more sustainable mining.

Keywords: mining; social impacts; environmental impacts; hotspots; social risks; supply chain; LCA; screening

https://doi.org/10.3390/resources7040080

Modelling the ITERAMS portfolio | FU

- Copper equivalent as functional unit

$$CuEq.\% = Cu\% + (\sum_i R_i V_i G_i) / (V_{Cu} R_{Cu})$$

where,

R is the metallurgical metal recovery rate

V is the metal price

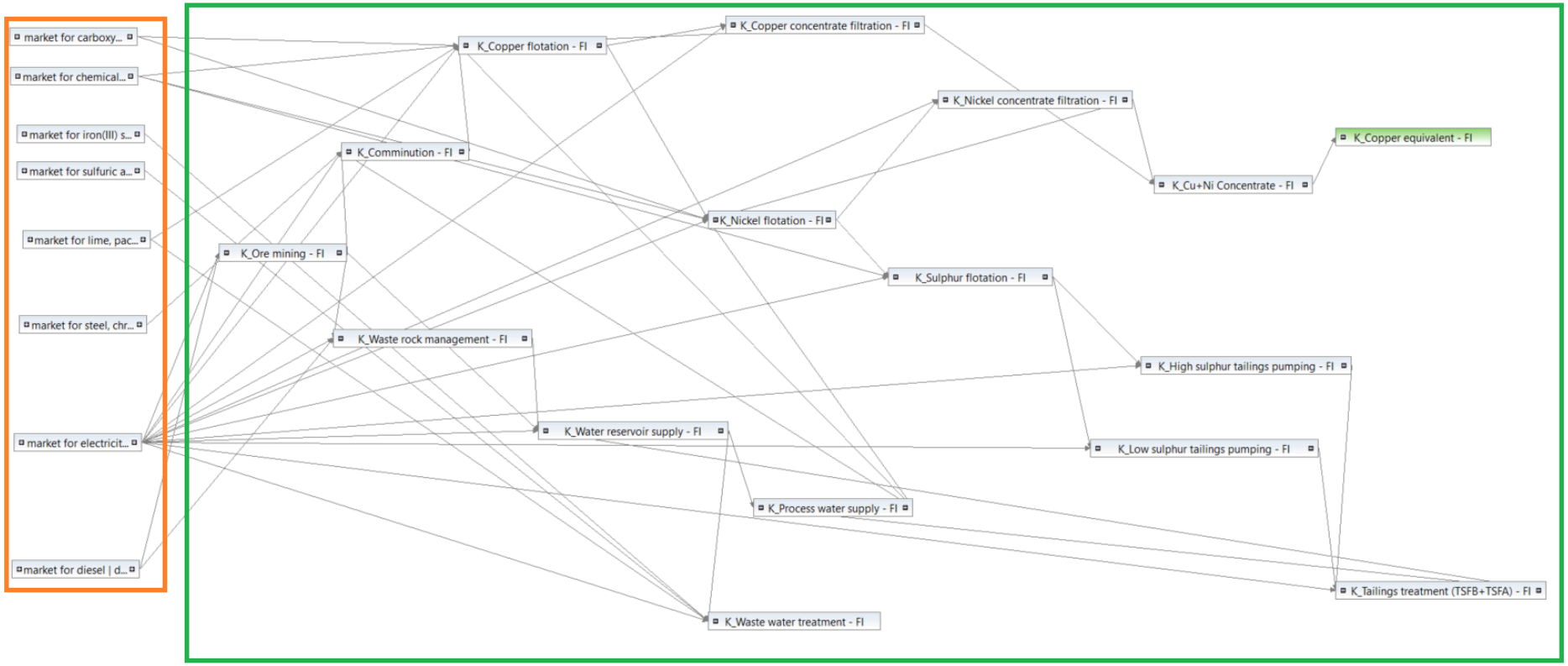
G is the metal grade in percent of concentrate

Copper equivalent means the percentage of marketable metals or minerals contained in mineralized material

https://www.lawinsider.com/dictionary/copper-equivalent

Modelling the ITERAMS portfolio | current situation

- Model of the "current situation" on site for the 3 locations:
- Primary data from the mining companies for the **foreground** models
- Link with **background** data from LCA databases



Modelling the ITERAMS portfolio | modules (I)

- Use the LC model for the current situation on site as the basis for a second system where ITERAMS technologies are added

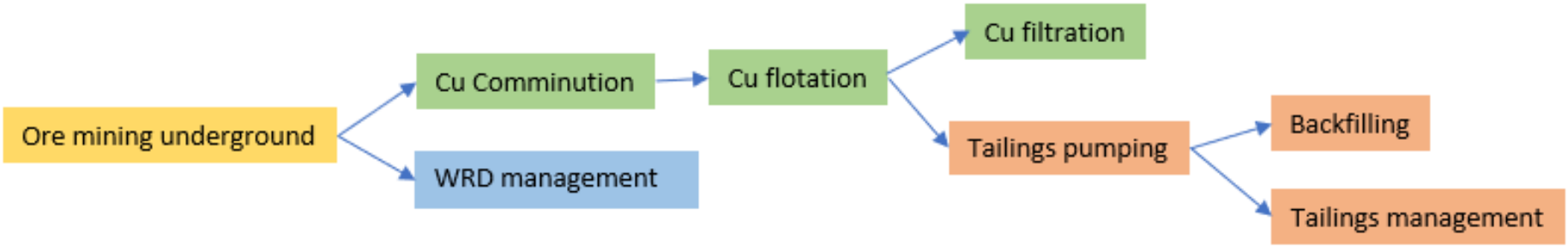
- for each site and

- in a modular way with **process modules**

- To reflect the plant layouts
- To adapt the model to different cases and over time
- To adapt the model to different locations

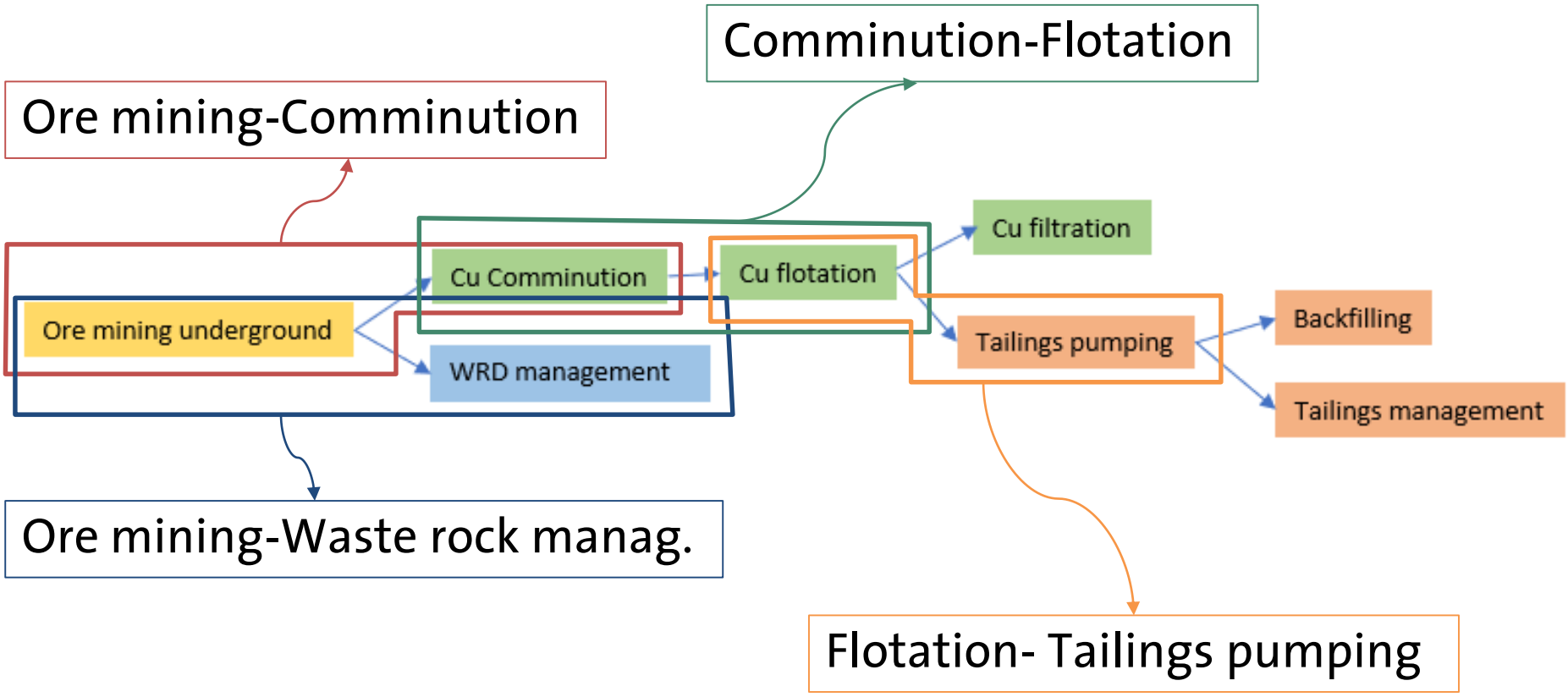
Step by step modular modelling

- Identification of **site-specific** processes (current situation)



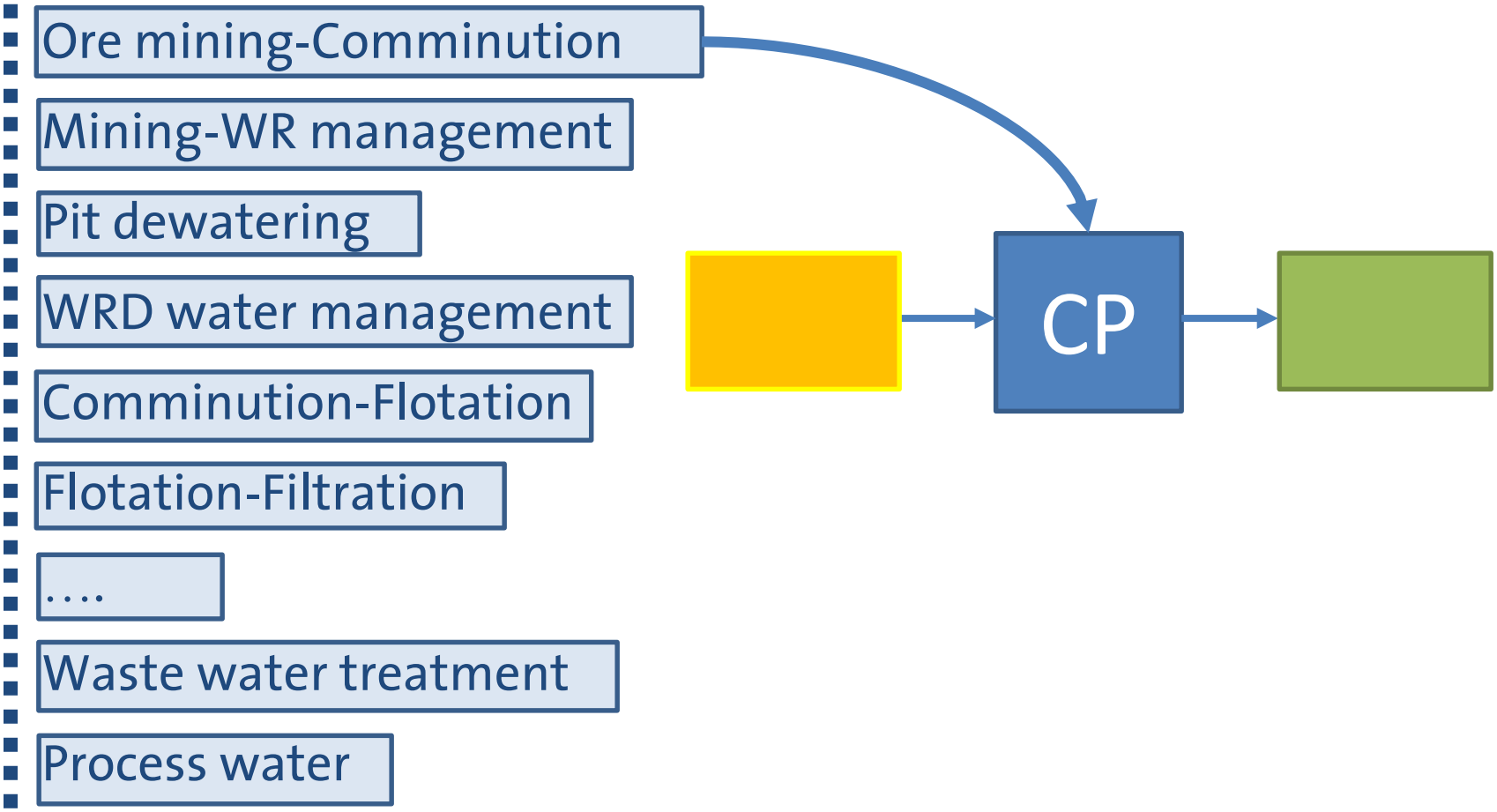
Step by step modular modelling

- Identification of **sector-specific** processes



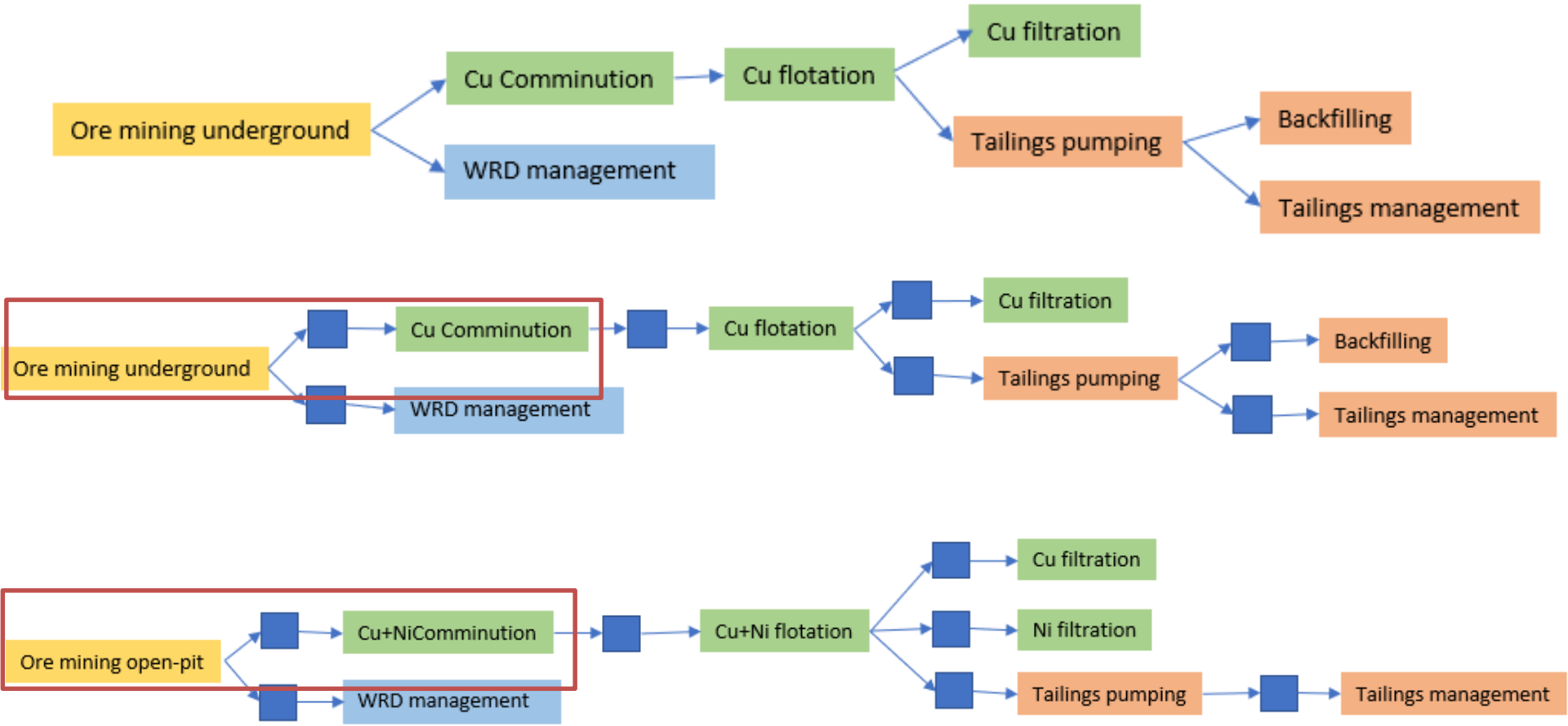
Step by step modular modelling

- **Sector-specific** processes become connecting processes (CP) for **site-specific** processes



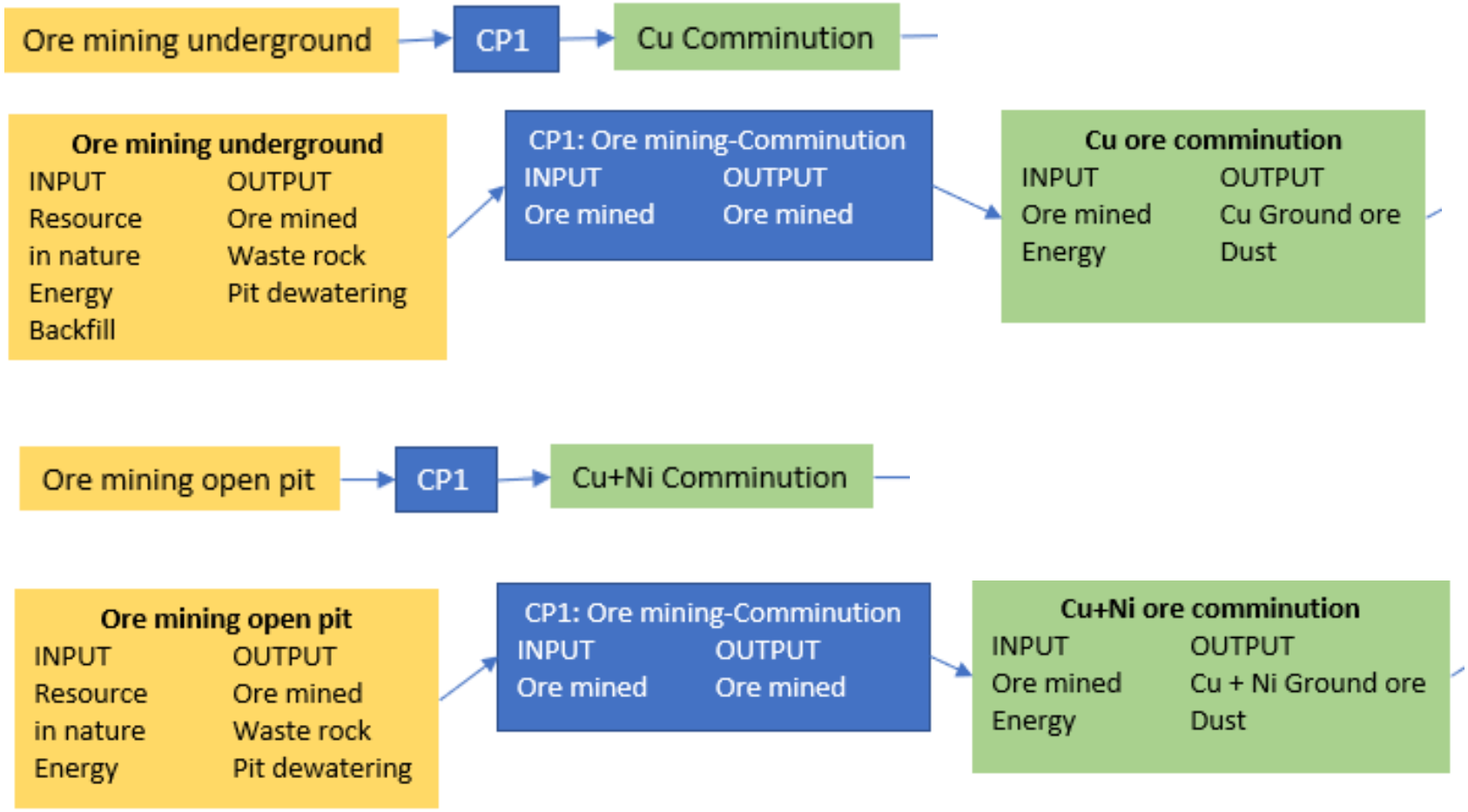
Step by step modular modelling

- Connecting modules are used to link site-specific process in a flexible way



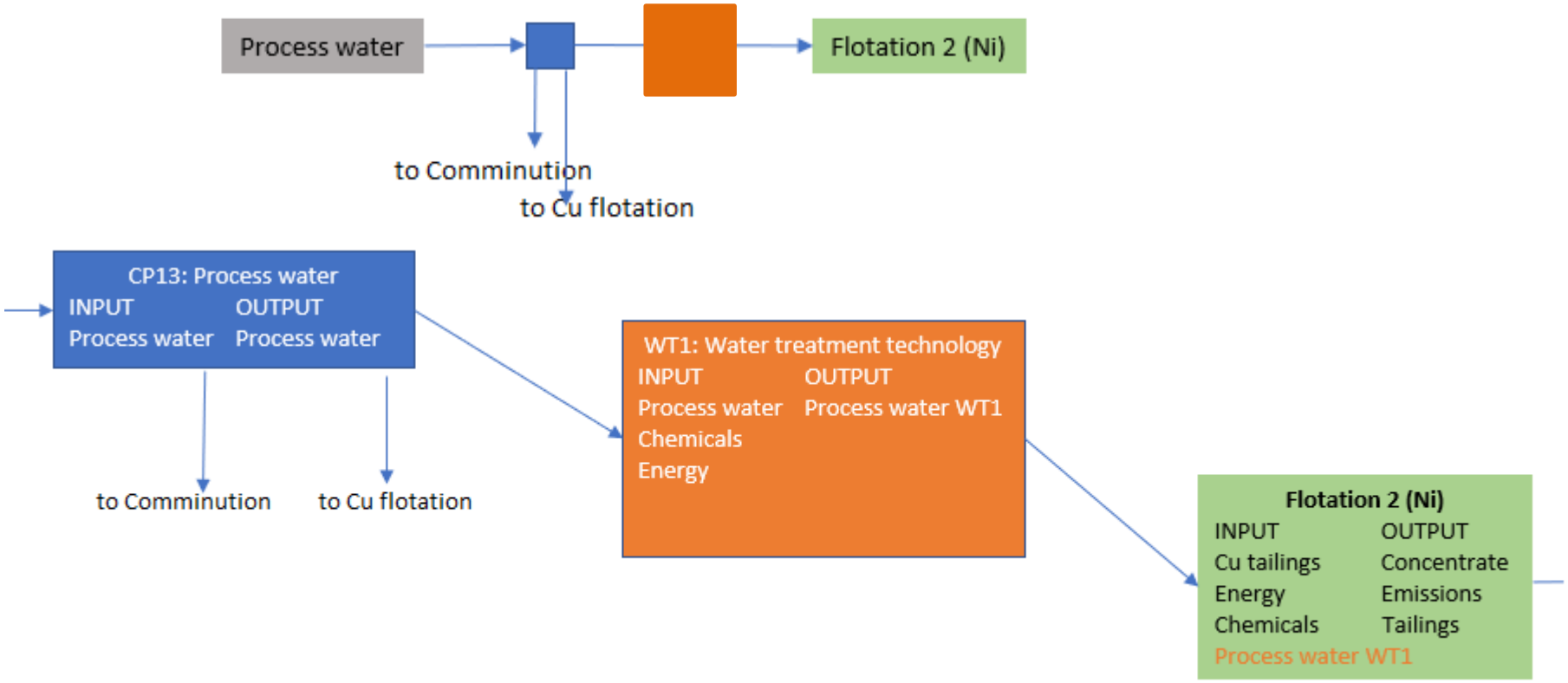
Step by step modular modelling

- Shaping connecting processes (modules)



Step by step modular modelling

- Following the same logic, the ITERAMS technologies can be added at any point in the model and differently for each site



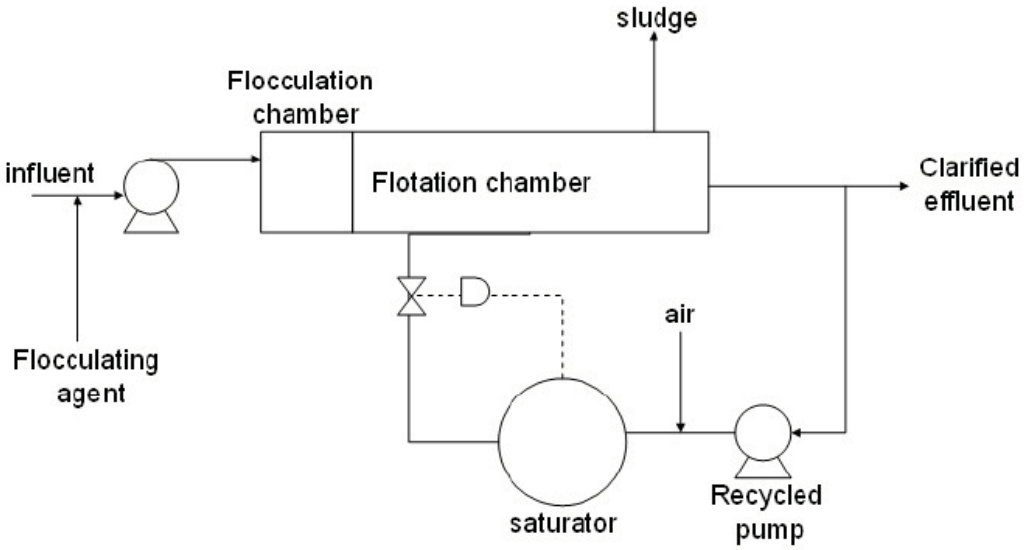
Modelling the ITERAMS portfolio | DAF technology

- Dissolved Air Flotation (DAF) for the Finnish site

Issue: Fine solids in Ni flotation circuit

Cause: Short circuiting of recycled water flow due to freezing

Solution: DAF

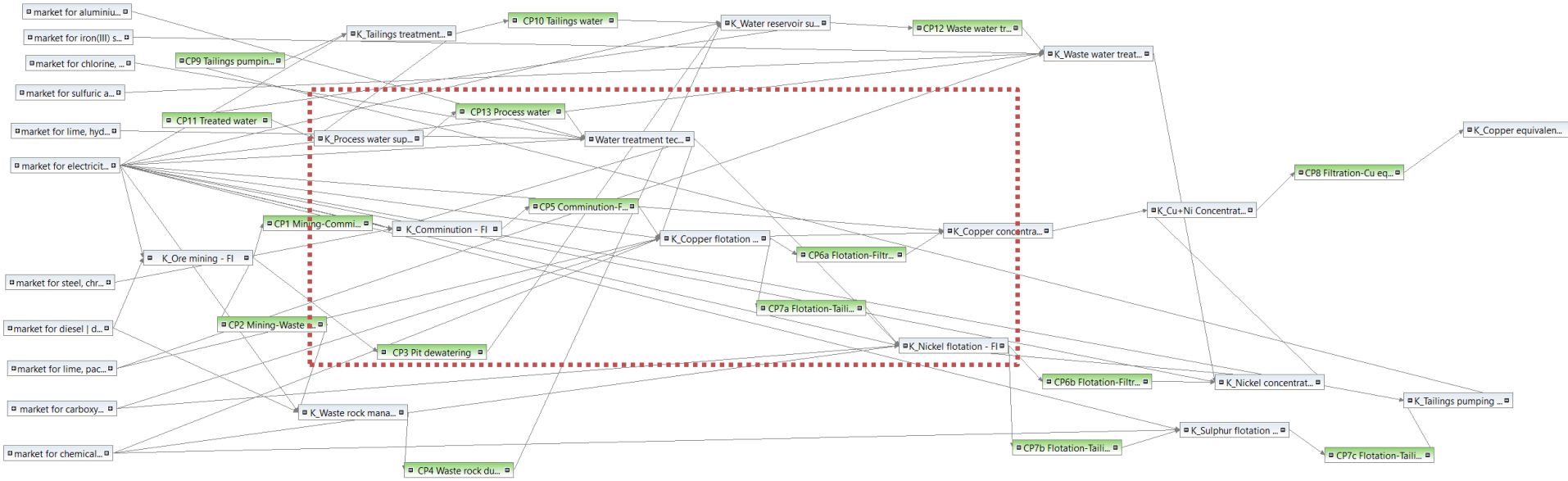


Sharaai, A. H., Mahmood, N. Z., bin Sulaiman, A. H. Life Cycle Impact Assessment (LCIA) of Potable Water Treatment Process in Malaysia: Comparison Between Dissolved Air Flotation (DAF) and Ultrafiltration (UF) Technology Australian Journal of Basic and Applied Sciences, 3(4): 3625-3632, 2009 ISSN 1991-8178

Effects on Ni flotation

- Freshwater intake
- Chemicals
- Recovery rate
- Electricity

Implementation of process modules in openLCA



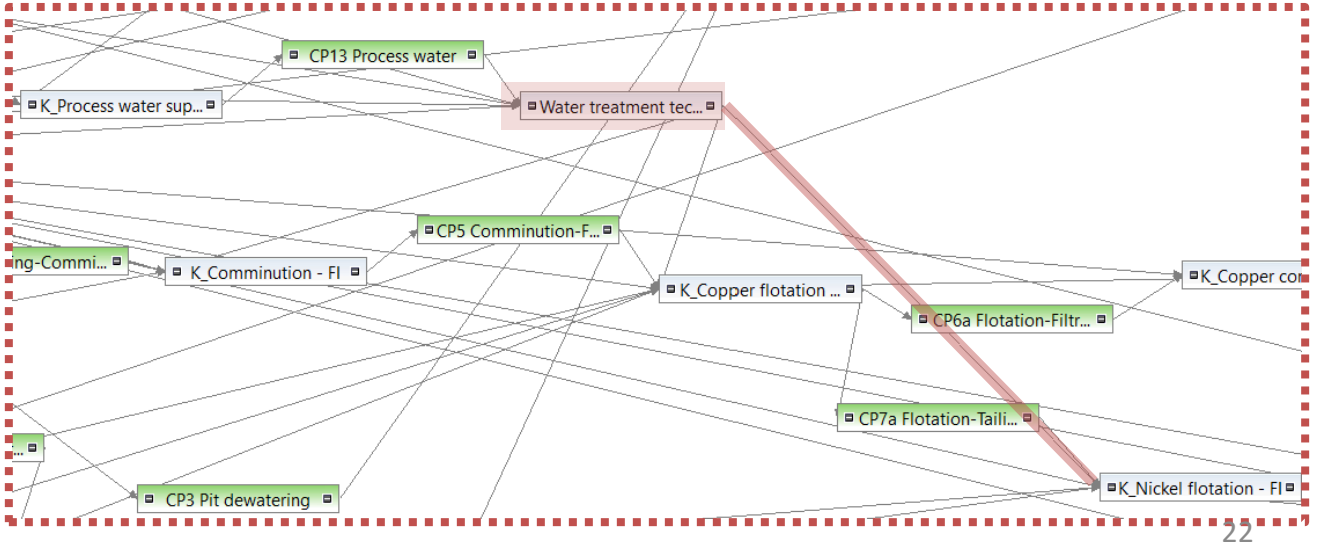
Inputs/Outputs: Water treatment technology: DAF

Inputs

Flow	Category
Air	Resource/in air
aluminium sulfate, powder	201:Manufacture of basic chemicals, fe...
chlorine, liquid	242:Manufacture of basic precious and...
electricity, medium voltage	239:Manufacture of non-metallic mine...
K_Process water	ITERAMS/Kevitsa
lime, hydrated, packed	239:Manufacture of non-metallic mine...

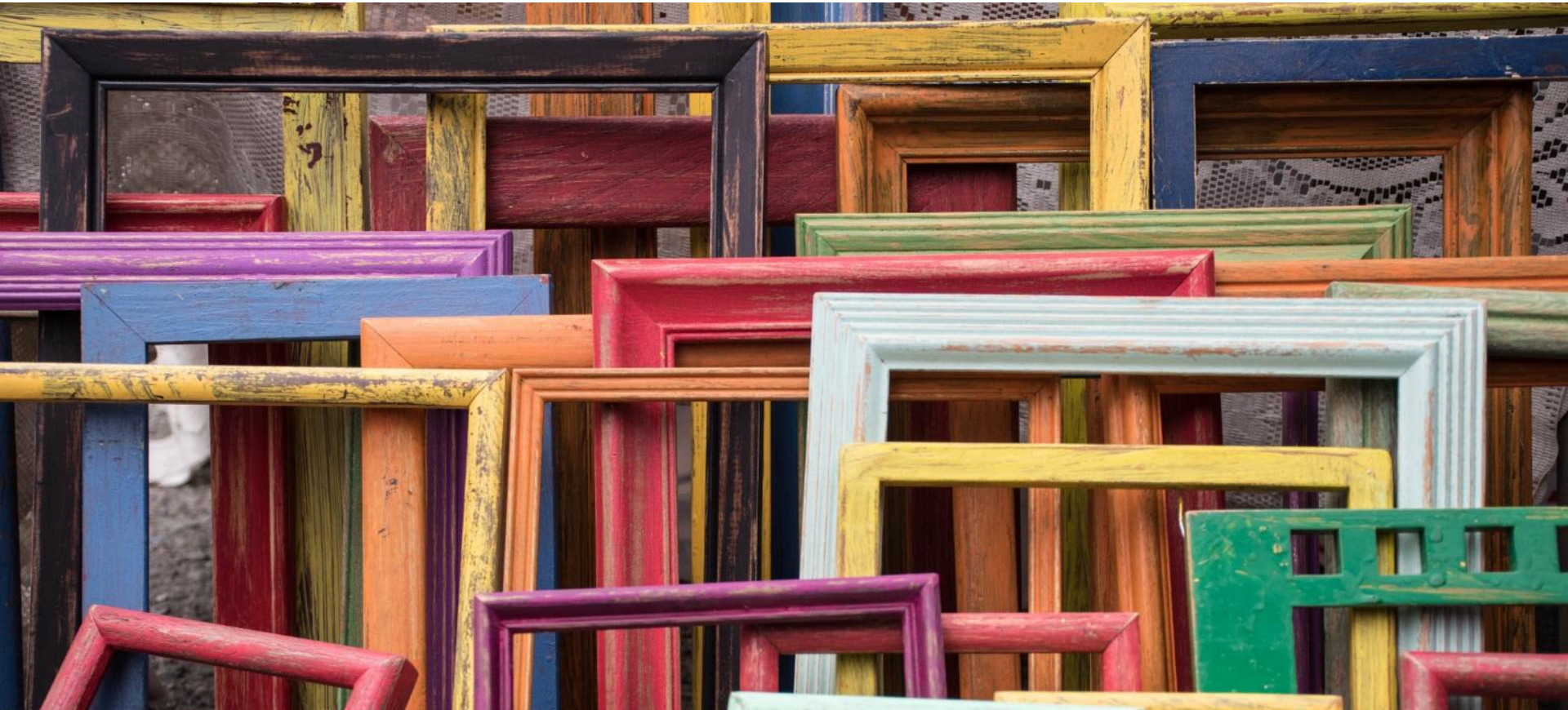
Outputs

Flow	Category
Process water, treated	**ITERAMS**
Sludge from DAF	ITERAMS



Modelling the ITERAMS portfolio | modules (II)

- The ITERAMS portfolio is affected by and affects local conditions, e.g. water availability and indigenous presence
- These “background situations“ are also studied in a modular way

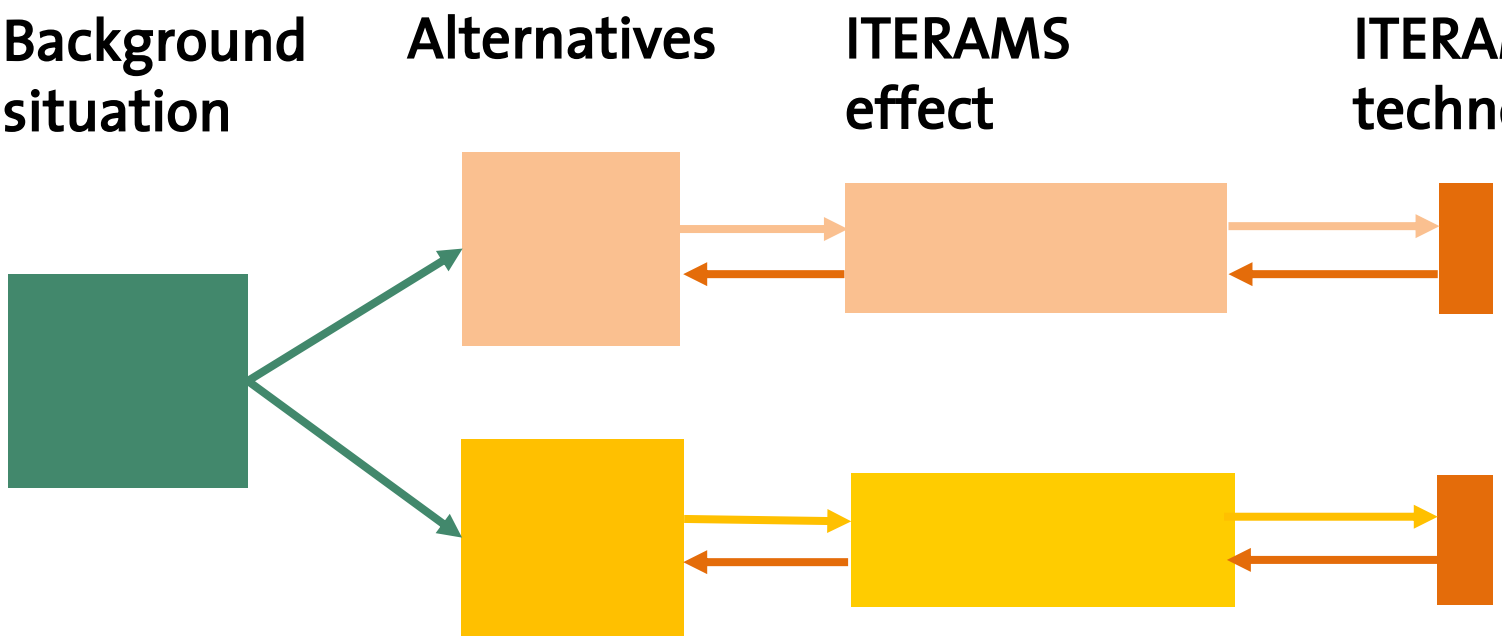


A portfolio of background situations

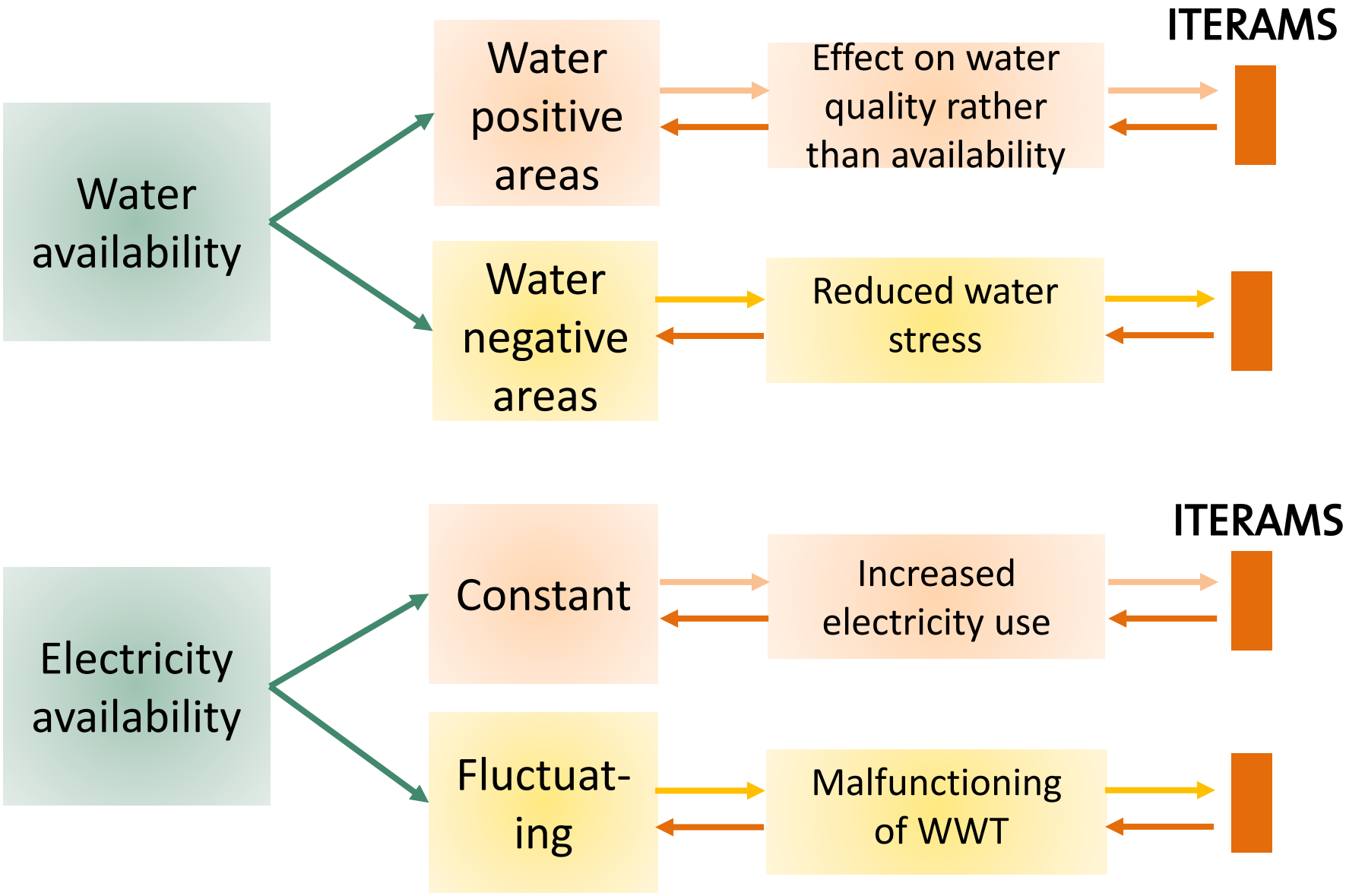
Categories:

- Vulnerability of local communities
  indigenous populations, employment
- Conflicts with other economy sectors
  tourism, reindeer farming
- Local resources
  water availability and quality, groundwater
- National and sub-national risks
  energy supply, natural disasters
- Importance of the sector for the national and local economy
  share of the sector in the GDP

Background situations as modules

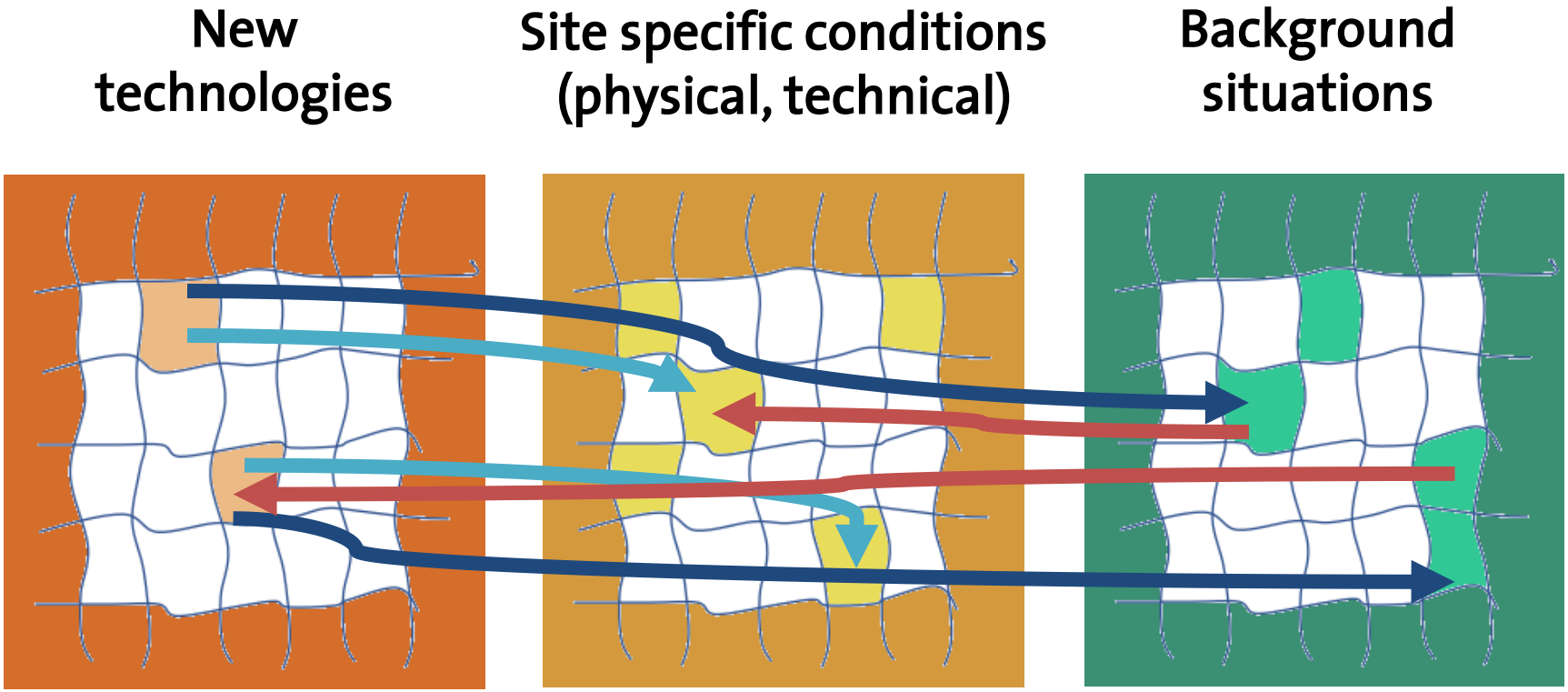


Background situations as modules - examples



Conclusions

- A system than can evolve from time to time with the specific nature of the system under study



Conclusions and further outlook

- When assessing the sustainability of new technologies in mining, it is often unrealistic to consider a “unique block of new solution”
- How to include background situations in the LC model?
- How to include risks in the LC model?
- Test the modular approach for other cases, also beyond the mining sector

Thank you!

This Project has received funding from the European Union H2020 programme under grant agreement nº 730480

GreenDelta
sustainability consulting + software

Contact
Claudia Di Noi
GreenDelta GmbH
Müllerstrasse 135, 13349 Berlin
dinoi@greendelta.com
www.greendelta.com