ETH zürich

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Drawing a framework to assess prospective technologies of tailings valorization

Lugas Raka Adrianto
Chair of ecological system design, ETH Zurich

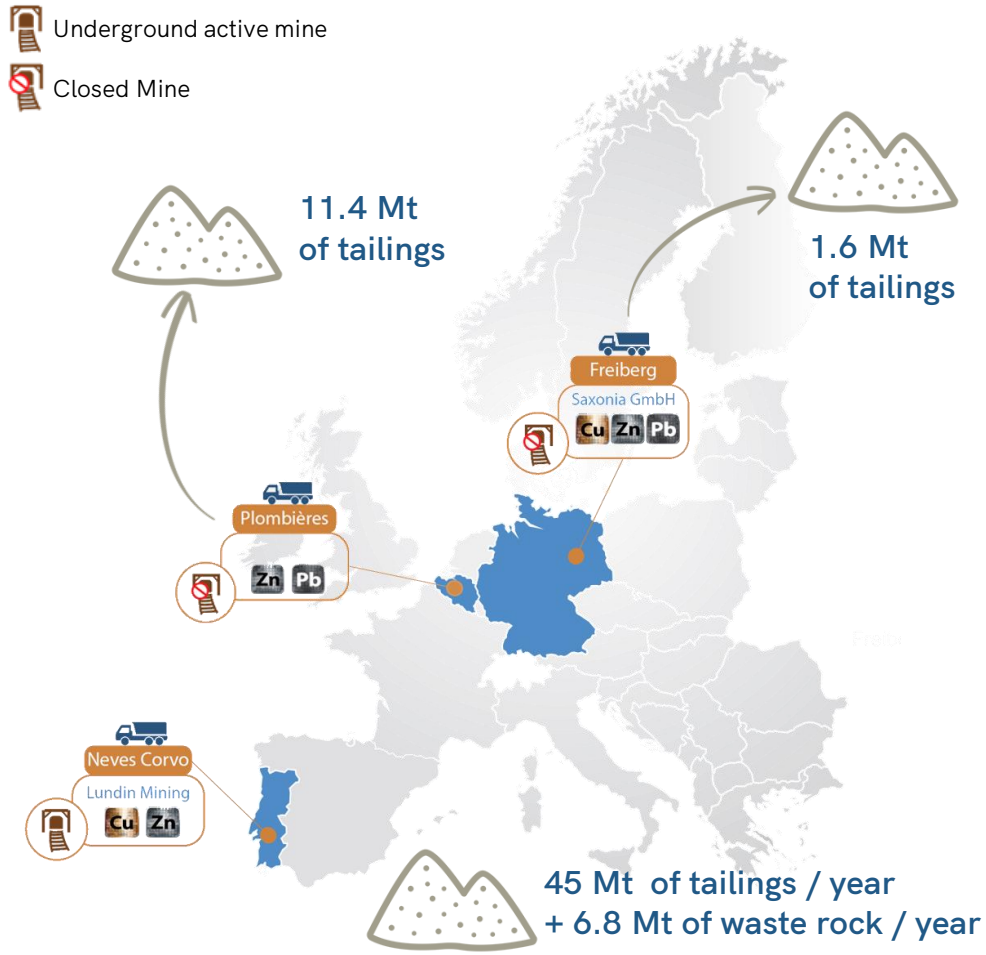
MSCA-ETN SULTAN

ESD ecological systems design

What is MSCA-ETN SULTAN ?

- Objectives
  - Remediation and reprocessing of mining waste
  - Knowledge transfer and implementation

- Collaborative project
  - Interdisciplinary along value chain
  - 8 Universities + research institutions, and 7 partner organizations in EU



https://etn-sultan.eu/sultan-project/

Content

- The dilemma: Supplying metals under resource constraints
- Complex valorization processes
- Understanding relevant prospective elements
- Recap and outlook

What is the problem with primary mining?

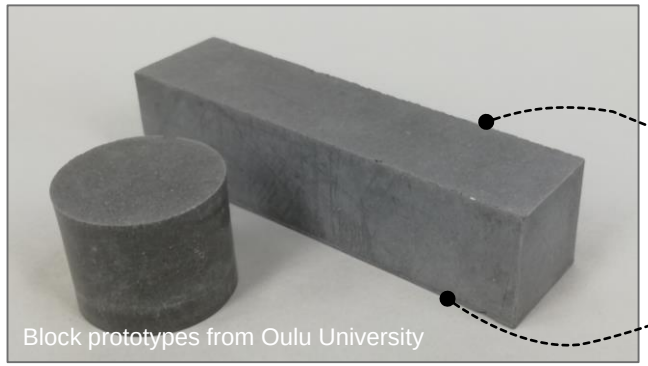
- Metal demands inevitably will grow
- Dumping activity also increases
- When badly managed: a catastrophe!
- Long-term risk: metal pollution

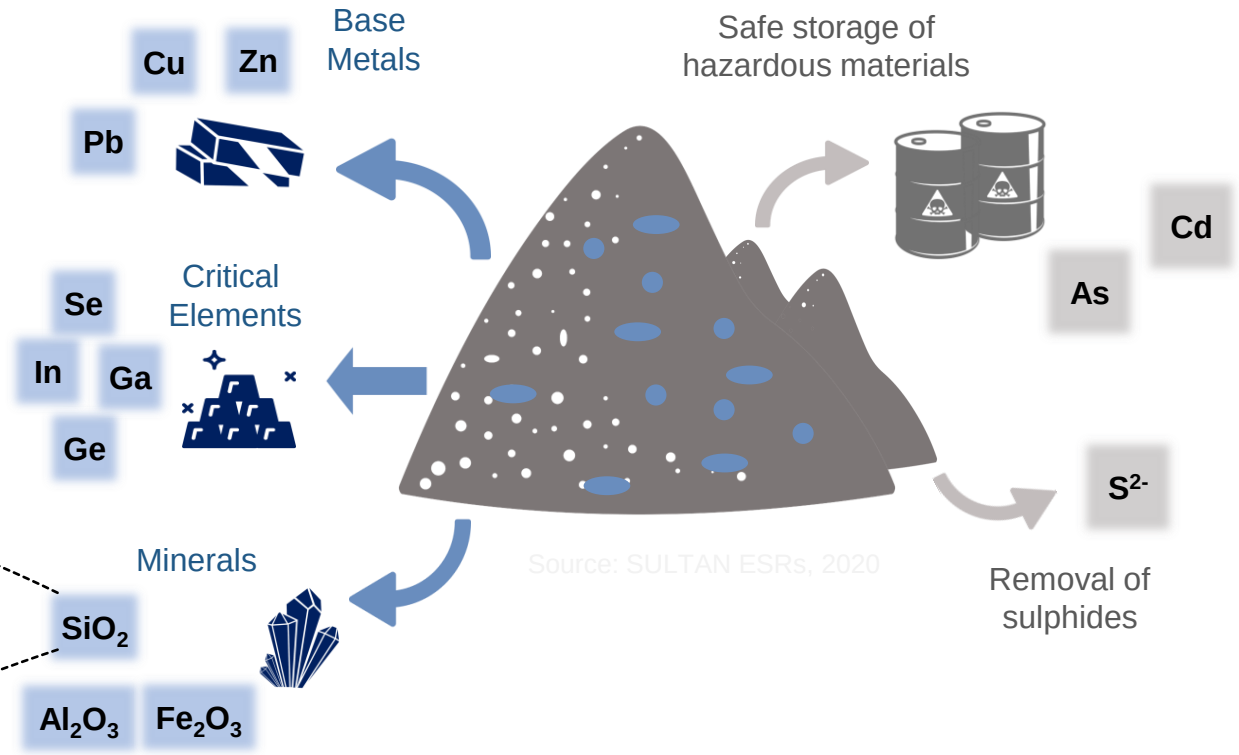
Proposal

What if we recover the valuables and valorize the residue?

Tailings: Materials left after the process of separating valuable fractions from the ores

The idea: make something from “nothing”





Our wish

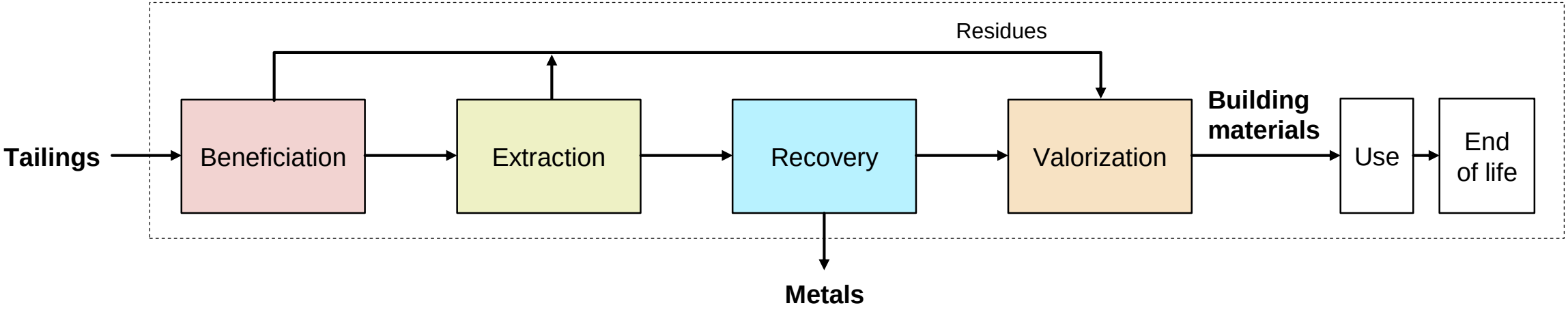
We can expect another recycling bonus (to mine less and to avoid burdens)

The issue

But the valorization processes are still in development

The value chain: an overview

- Collaboration in perspectives: from raw waste to final products
- The value chain can be divided into four groups (numbers in bracket indicate technology choices and PhD investigators)
  - Beneficiation (**2**)
  - Extraction + recovery (**5**)
  - Valorization (**3**)



Starting point: to disentangle the data

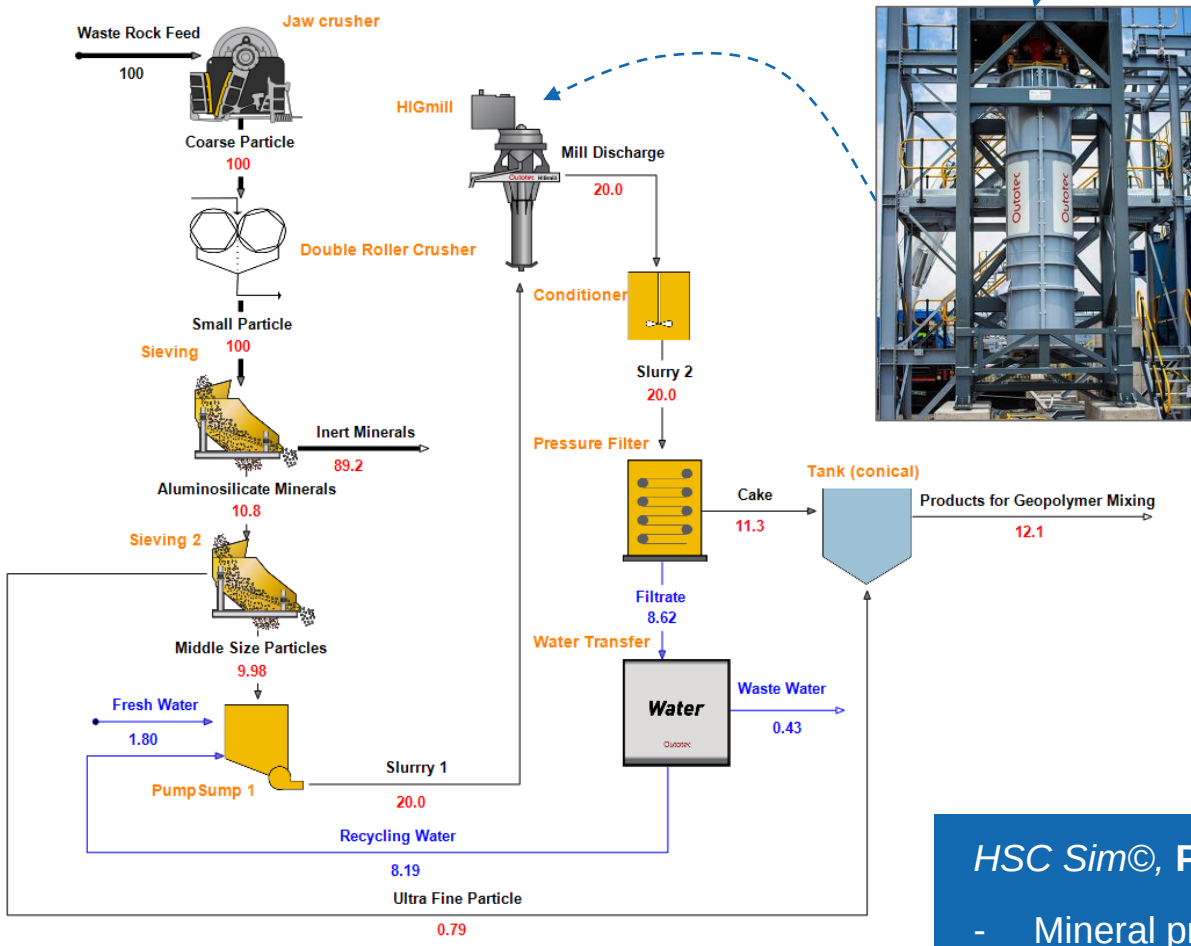
Future → **1) upscaled technologies** and 2) background data changes

Foreground and background:

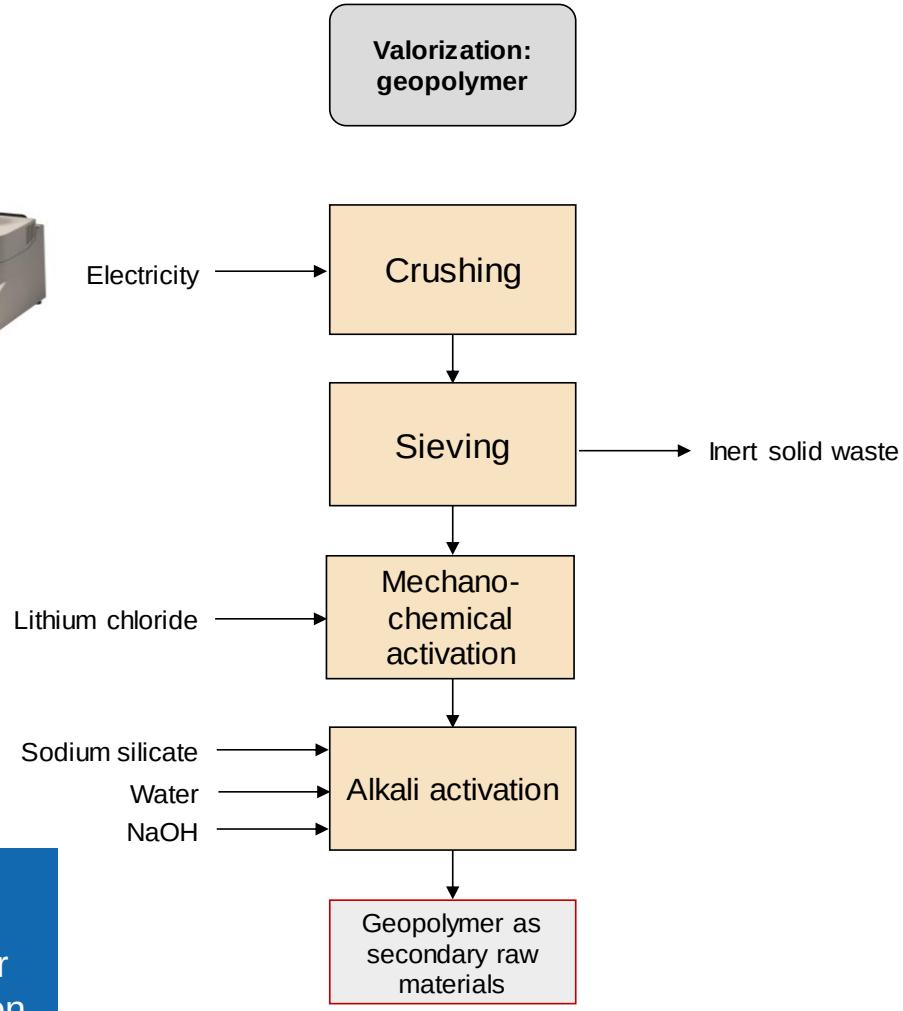
- Process-related inventory: metallurgical process simulation, engineering approach, proxy data
- External variables: background data (ex: energy mix, share of technologies)

Upscaling example: Flowsheet simulation

Expectation



Current scale



HSC Sim©, **Plus points:**

- Mineral processing and other metallurgical parameterization
- Connectivity

Accounting for nuances in prospective studies

- Adding prospective elements in the foreground
- One can not just perform LCA separately
- In a route → different maturity levels exist!

Froth flotation (mature)

Solvo-metallurgy (rather new)
Ion flotation (breakthrough)

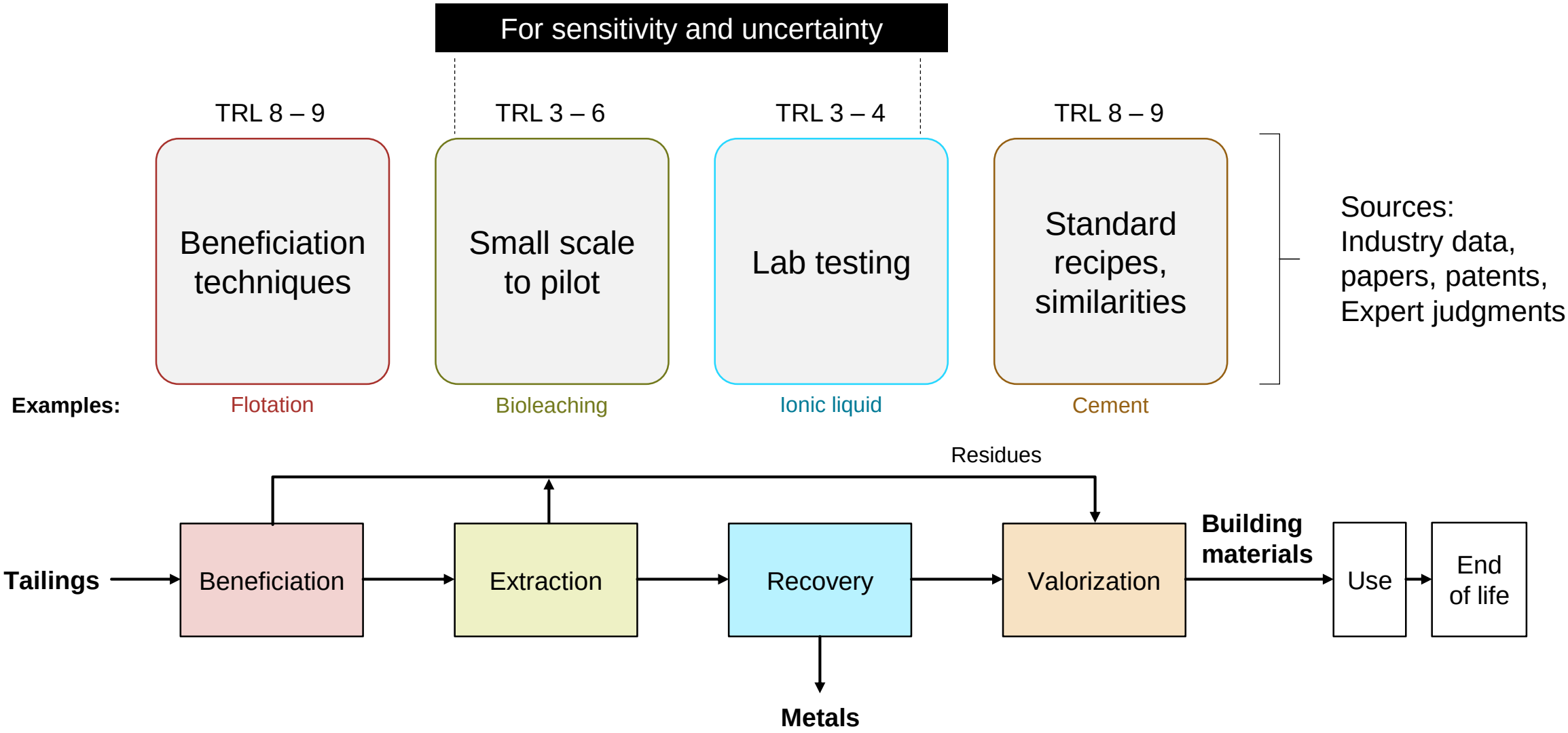
Prototype development

1 2 3 4 5 6 7 8 9

Fundamental research and proof of concept

Demonstration and large-scale use

Understanding manufacturability as a whole



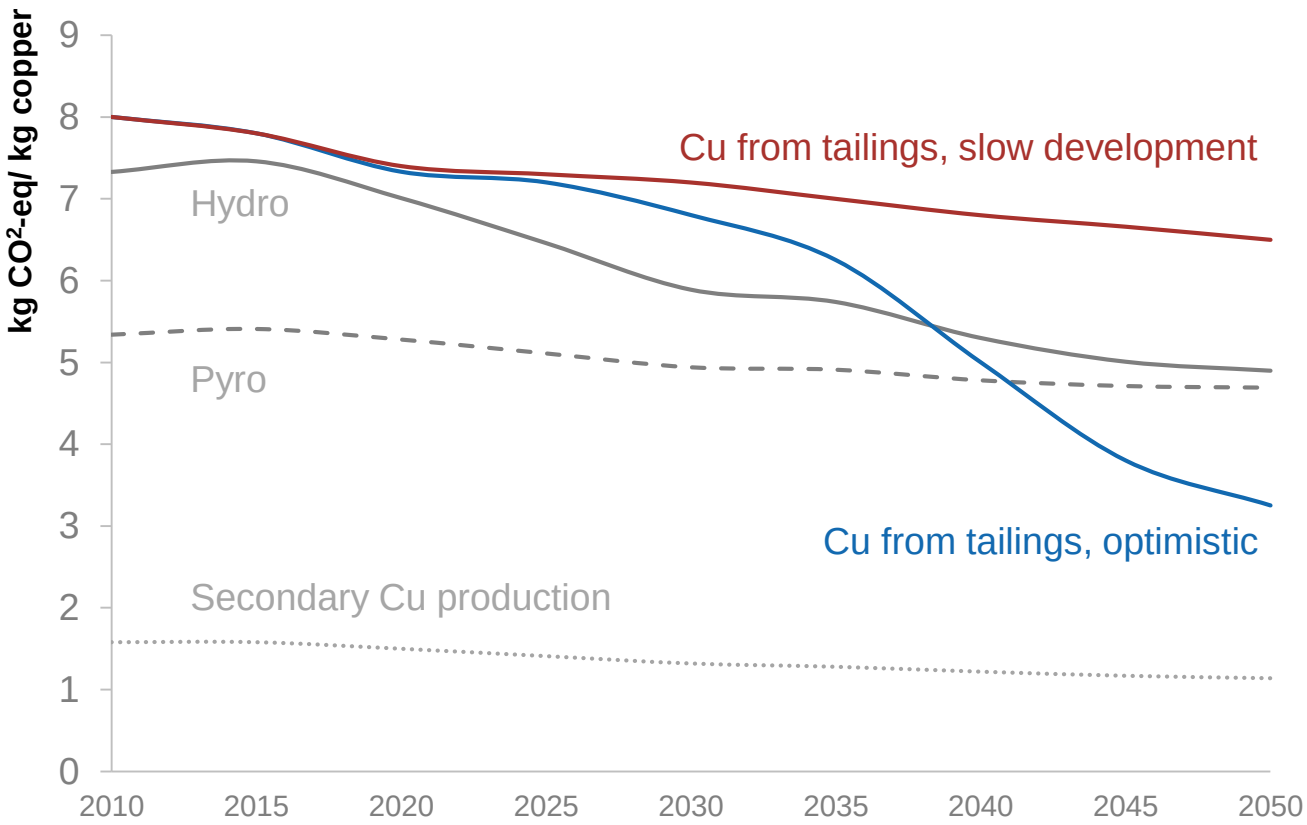
Consequences of technological changes

- Future options to supply copper
- Competition with the traditional tech
- Diffusion of technology (Bass, 2004)
  - Market adoption through imitation and innovation
  - Will technologies survive?

What are the implications?

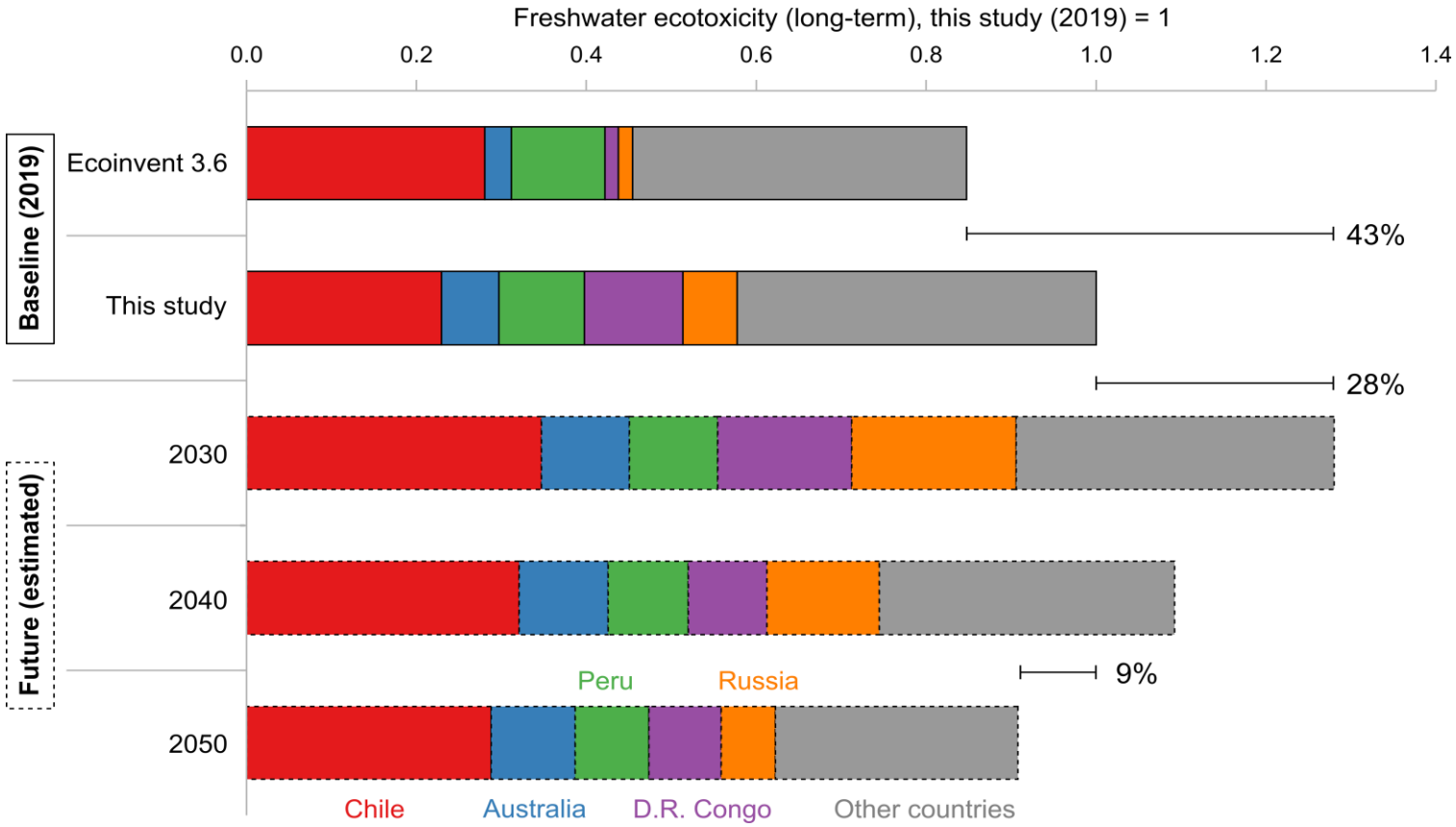
- Other secondary production
- Other impact categories: environmental trade-off?

Supply scenarios of 1 kg copper (Kuipers et al., 2018)



Towards future assessments: (other) background matters

- Spatially-resolve copper emissions from tailings
- Combine with supply projection up to 2050
- Less copper from primary mining → shifts of ecotoxicity impacts



Adrianto et al., in preparation

Conclusions

From sketches to the implementation of prospective LCAs

- Systematically map potential routes to recover wasted materials
- Upscaling: accuracies depending on manufacturability (e.g., low TRLs of extraction and recovery of metals)
- Further studies are needed to fully parameterize and develop technology narratives

To be continued: Can these concepts replace incumbent technologies?

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Thank you

Lugas Raka Adrianto
PhD student
adrianto@ifu.baug.ethz.ch

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ESD ecological systems design https://esd.ifu.ethz.ch/

MSCA-ETN SULTAN https://etn-sultan.eu/

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Picture credits: own work, our site visit in Portugal (Feb '20)

RQ: How do we **quantify resource-recovery benefits** that are originally lost in the waste streams?

What we do

- Draw the overall processes involved
- Collect technical data for specific processes
- Review (future) inventory modelling approaches
- Deal with foreground and background data

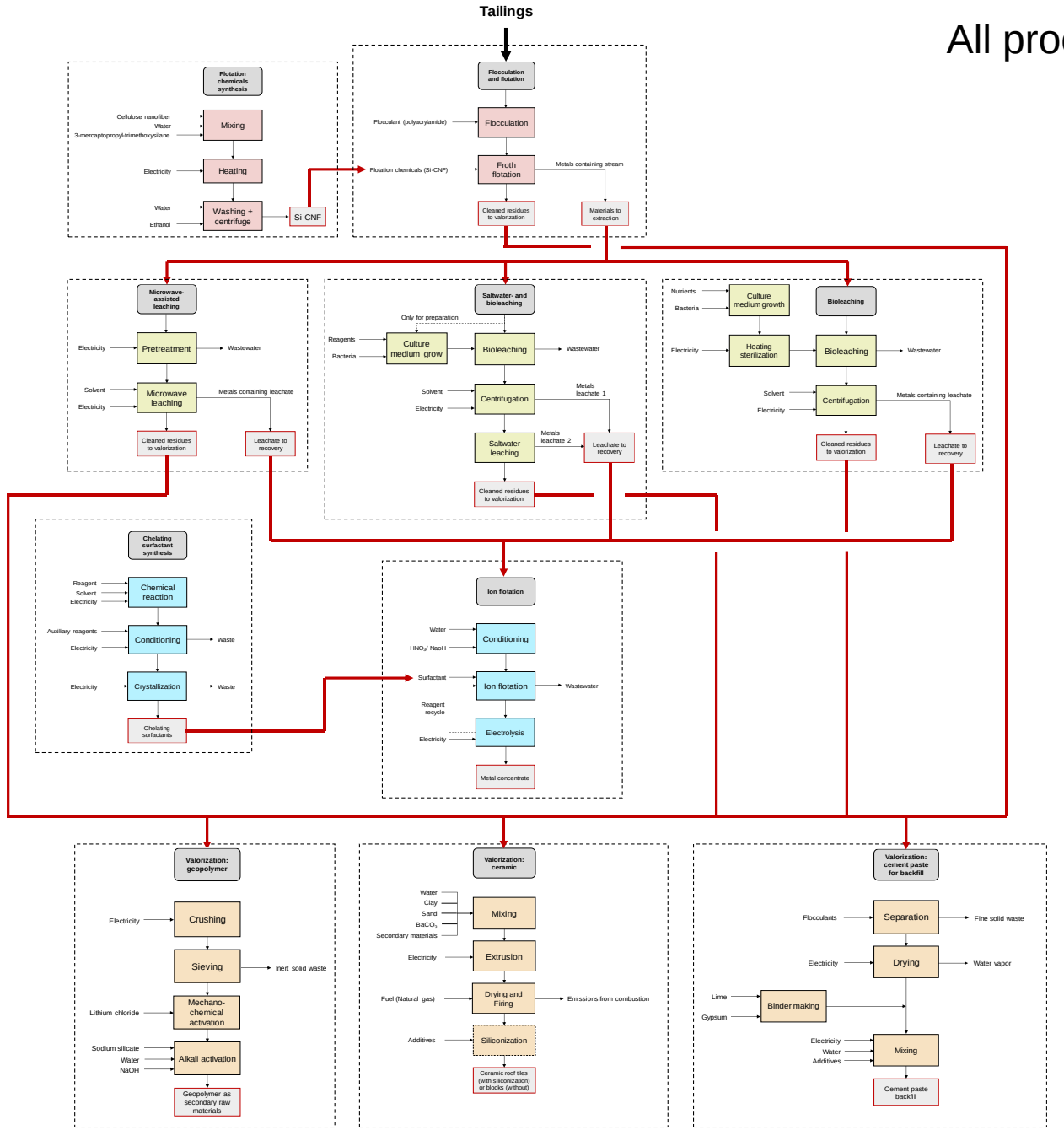
A quick glance

All processes in the value chain

1

2

3



Extra outlook

- More investigations are necessary to further perfect our proposed approach
- Close-exchange with other researchers for primary data collection
- Building up knowledge: experts‘ opinions and industry insights

Lessons learned

- Best practice in prospective LCAs: scattered, but a bunch of gems out there
- Holistic approaches: a view to keep in mind
- Prepare scenario analysis in future research