



Environmental assessment and decision support for the process design of tailings valorization

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Motivation (1)

★ **Trends:** Demand of metals , but the ore grade  (Van der Voet et al., 2019)

Environmental burdens



Mining operation

Primary resources processing

*Waste
rock*

Tailings



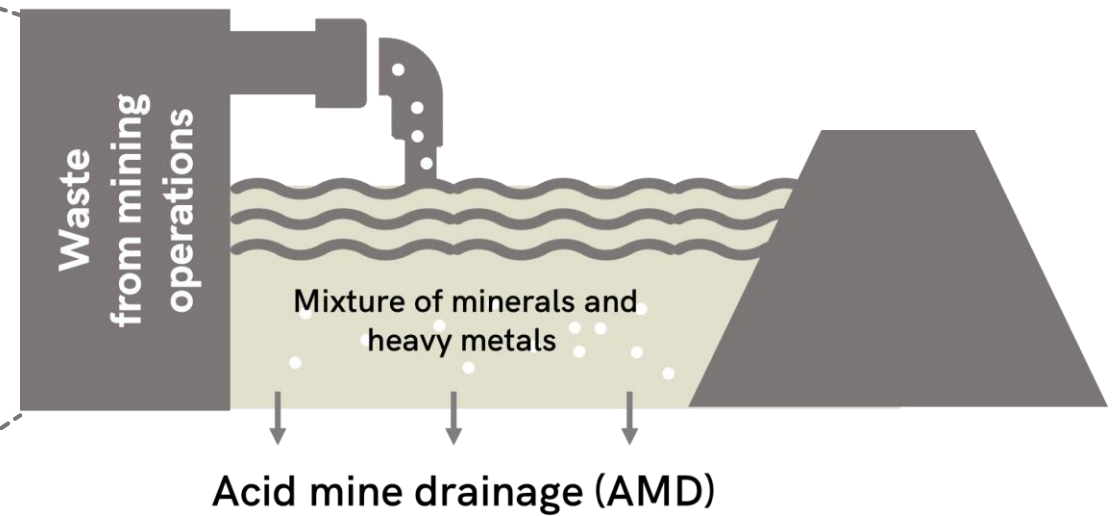
*Slag,
dust, etc.*



Metal production

Motivation (2)

Tailings



The problem

Leaching and long-term environmental impacts (Lottermosser, 2010)

The opportunity

If properly managed, it could be future resources (JRC, 2019)

The SULTAN project



Transforming **extractive-waste problem** into a **resource-recovery opportunity**

15 PhD students/
“ESR”

8 Universities and
research institutes

4 Work packages
(WP)



My role in WP4:

- Environmental assessment

On what?

1

Metals
recovery

2

Minerals
valorization

State of current research

Emissions from
tailings storage

Empirical models

Doka (2017, 2008)

Reactive transport

*Steele
Parsons*

Time perspective

*(Bakas et al 2015)
(Doka and Hischier, 2005)
(Hellweg et al, 2005)*

**LCA of tailings
management**

Song et al, 2017

Adiansyah

Reichardt

Sarkki

**Regionalized
assessment**

*Northey et al, 2017
Werner et al, 2019*

Assessing
impacts of
mining

**Prospective LCA
for emerging
technologies**

**Upscaling
frameworks**

*Piccino et al, 2016
Zhou et al, 2017*

**Process
simulation**

*Abadías et al, 2019
Reuter et al, 2015*

Learning effects

*Gavankar et al, 2015
Caduff et al, 2012*

**Sustainability
benefits of mine
waste's valorization**

**Industrial ecology
in mining**

*Segura-Salazar et al, 2019
Kinnunen, 2019*

**LCA of mine
residues'
valorization**

*Joyce et al, 2019
Rahul et al, 2019*

**Future metal
demand**

*Van der Voet et al, 2019
Elshkaki et al, 2016*

Starting points and research gaps

Emissions from
tailings storage

Assessing
impacts of
mining

Prospective LCA for
emerging technologies

Sustainability benefits
of mine waste's
valorization

Available
leaching models

Basis

Gaps

Lacking
applicability on
other sites

Ignoring tech-
dependent
aspects

Frameworks for
upscaling and
simulations

Limited
LCA
studies

Missing
inventories
for tailings
conversion

1) Environmental
performance metrics
2) Demand model

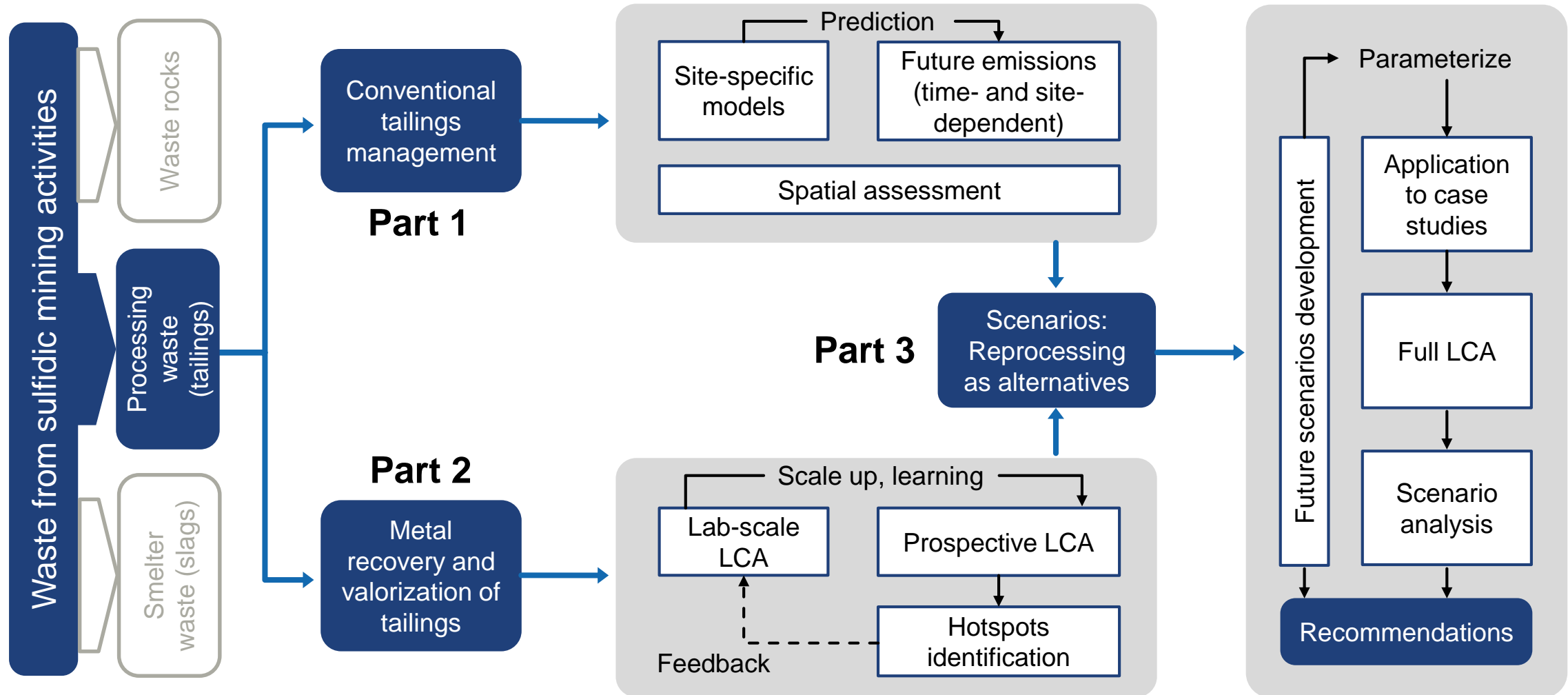
Unclear
phase
and scale

No
scenario
coupling

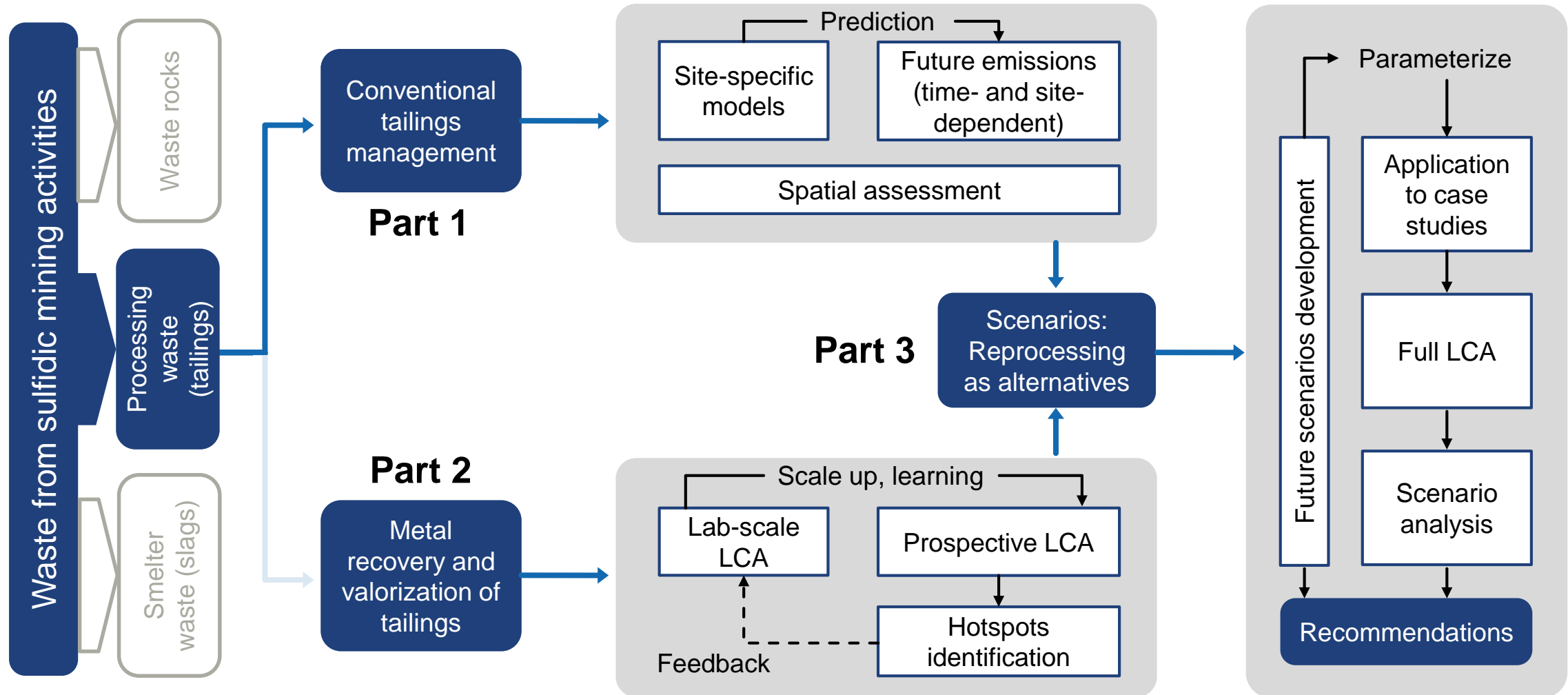
Research questions

1. How can mine tailings storage's emissions be modelled as a function of **site-specific characteristics**? How do pollutant emissions **evolve over time**?
2. How can various **small-scale** results be compared with **larger scale** systems from a life cycle assessment point of view?
3. What **recommendations** can be provided for process designers of tailings valorization technologies and policy makers?

Methodology – Research parts

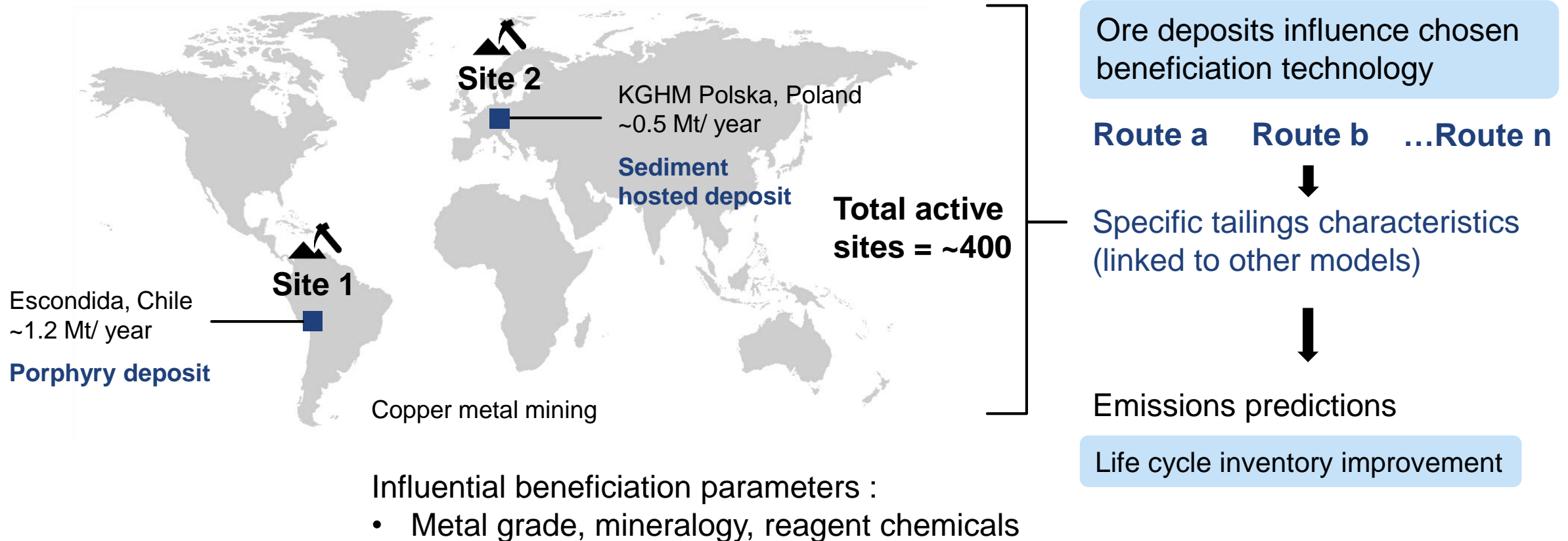


Part 1 – Conventional tailings management

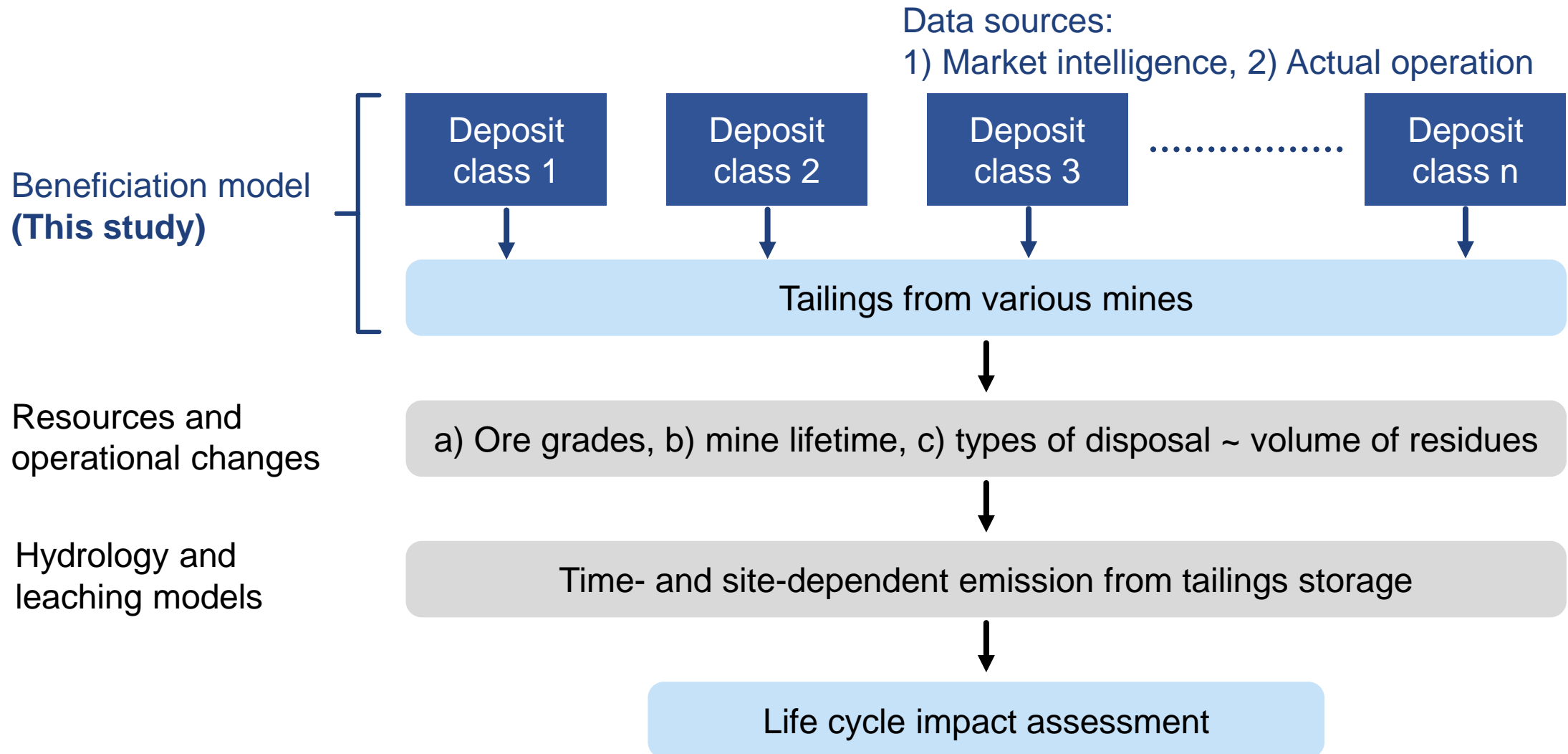


Part 1 – Conventional tailings management

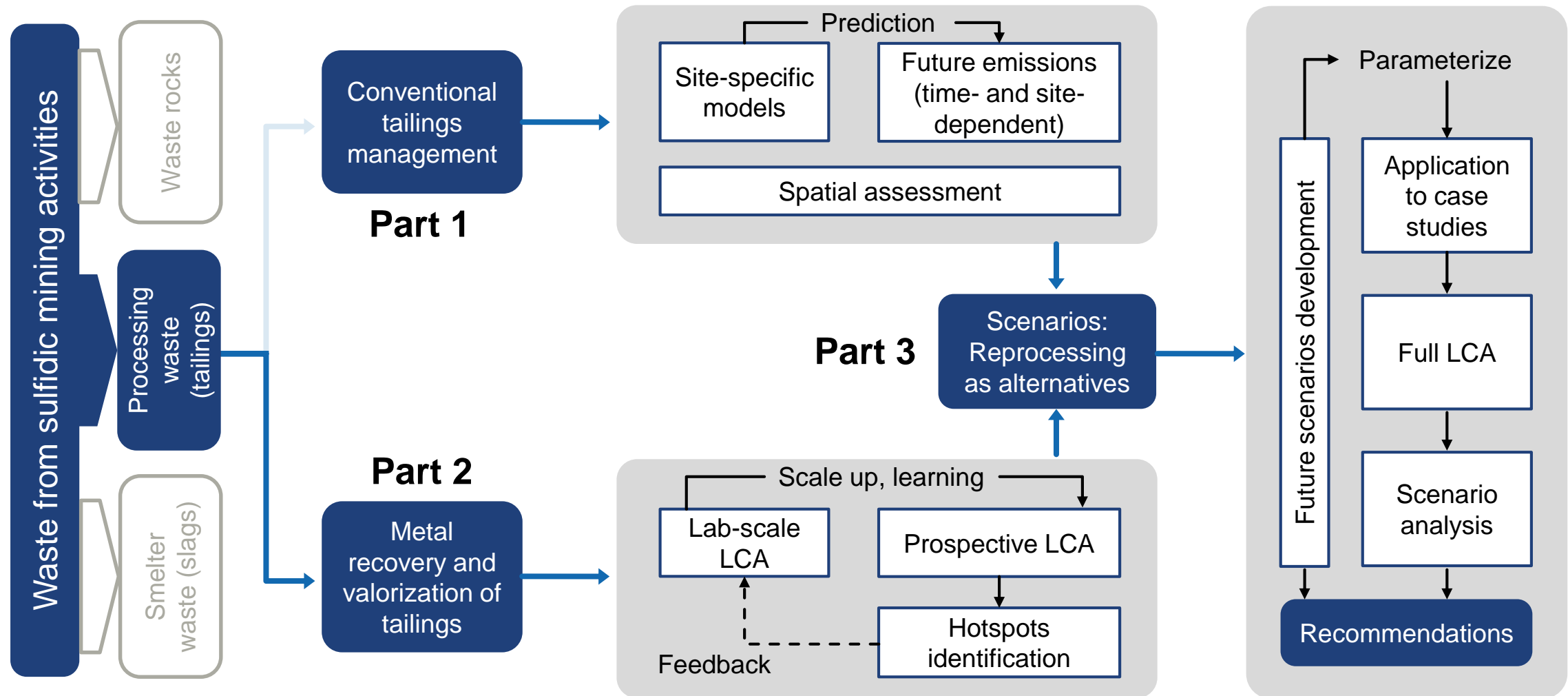
Aim: Highlight potential hotspot regions and mines



Part 1 – Conventional tailings management



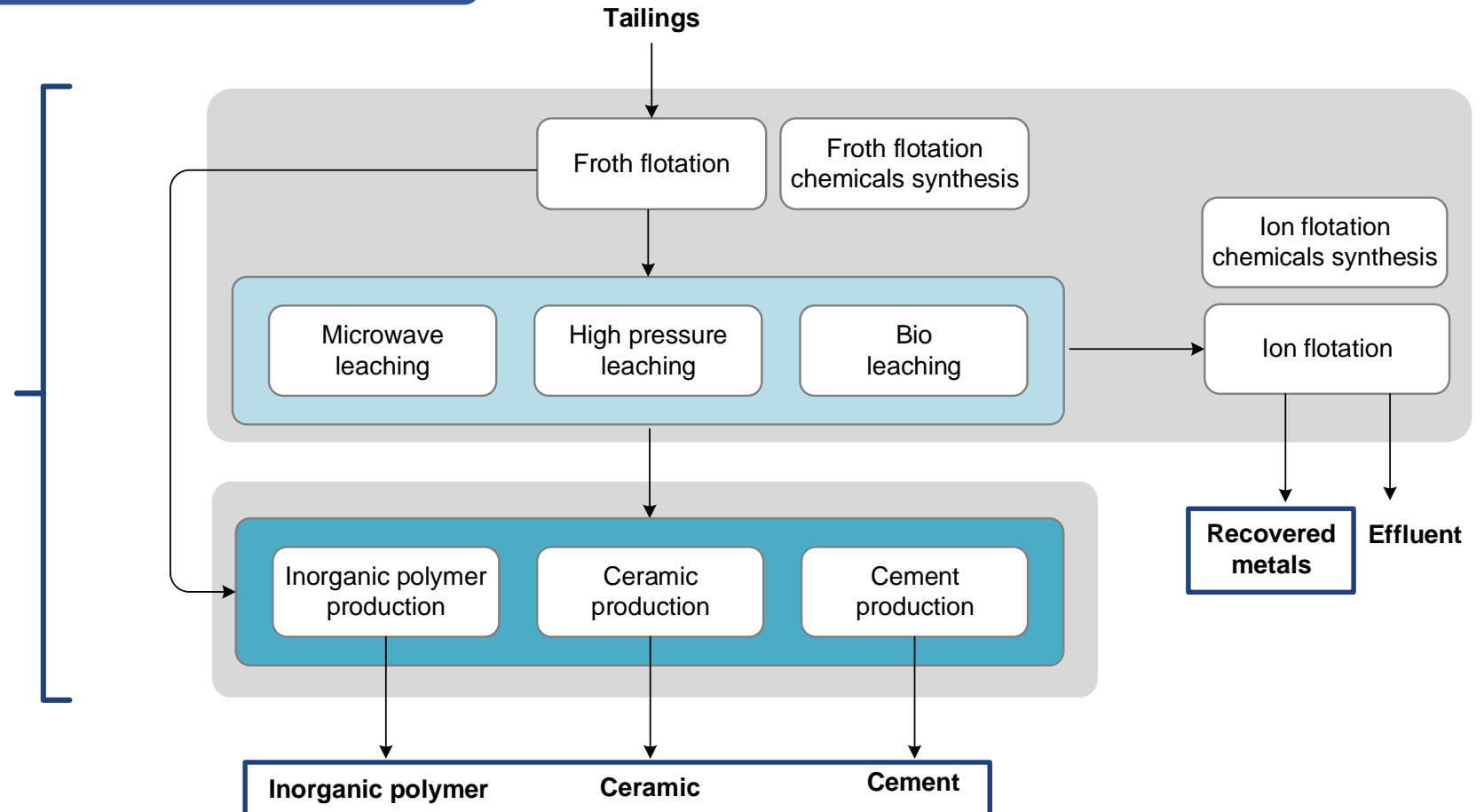
Part 2 – Prospective LCA of emerging processes



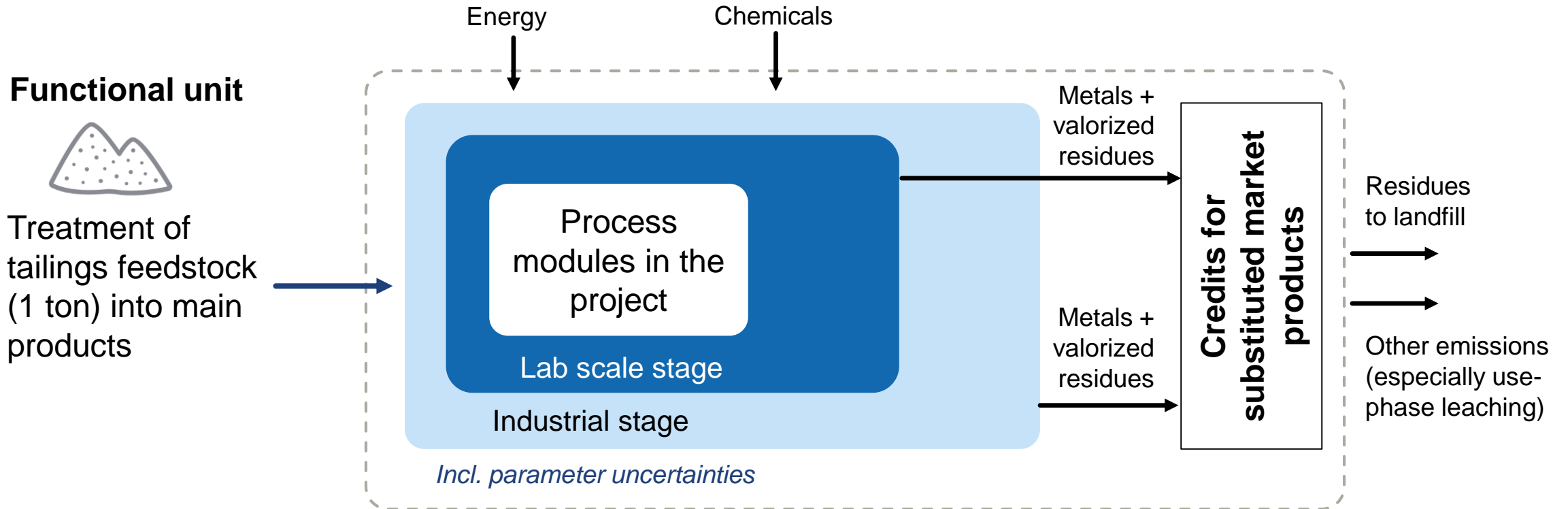
Part 2 – Prospective LCA of emerging processes

Aim: Identify hotspots at early stage

- Inventory collection of 10 process modules
(This study)
- Design feedback based on LCA interpretation
(This study)



Part 2 – Prospective LCA of emerging processes



Approach

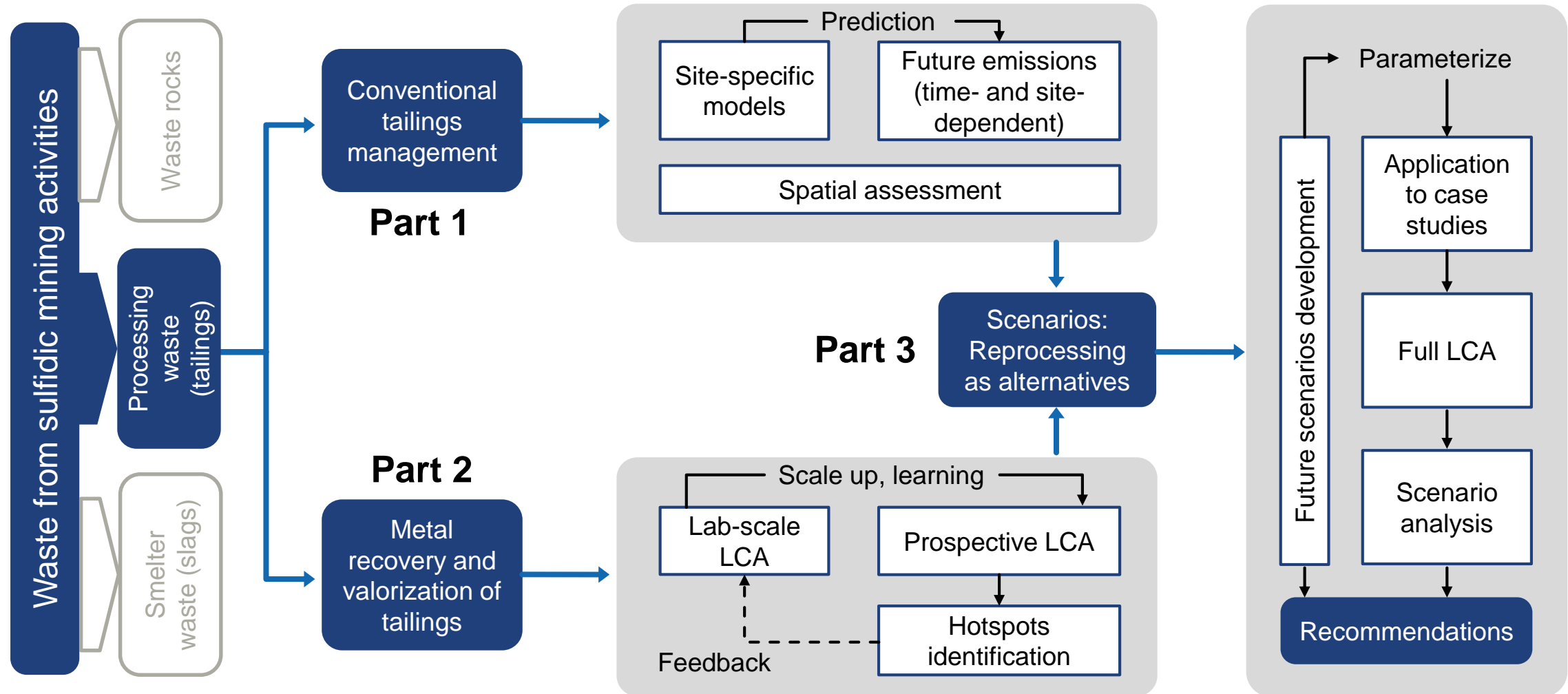
Useful frameworks (foreground inventories)

- Technology upscaling and learning
- Process-oriented model, metallurgical simulation

Analysis

- Contribution analysis
- Sensitivity

Part 3 – Scenarios: Reprocessing of tailings as alternatives



Part 3 – Scenarios: Reprocessing of tailings as alternatives

Aim: Environmental consequences of materials use


Resource recovery from inactive stocks (i.e. tailings)

Additional Impacts

- Metal recovery processes
- Mineral residue valorization processes

Environmental benefits

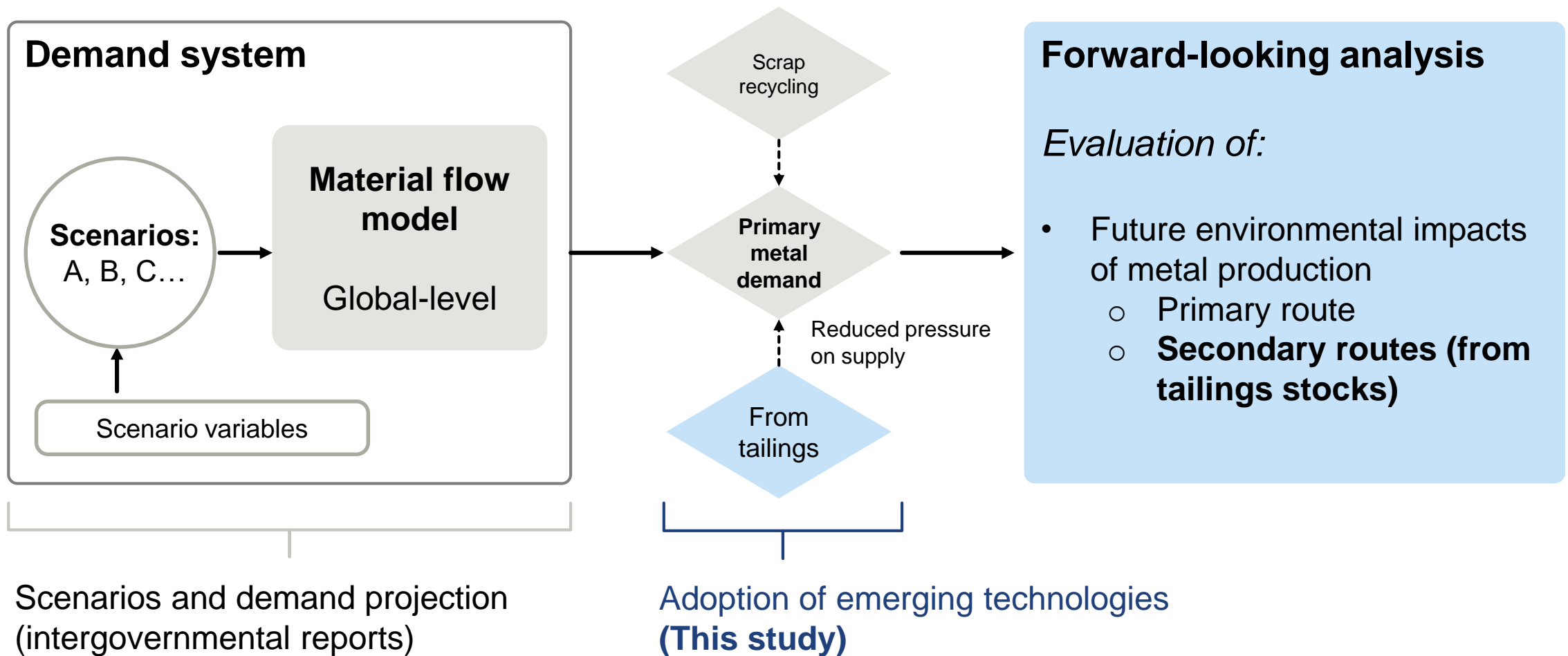
- Less 'landfilling'
- **Avoid** primary metal production
- **Substitute** of building materials



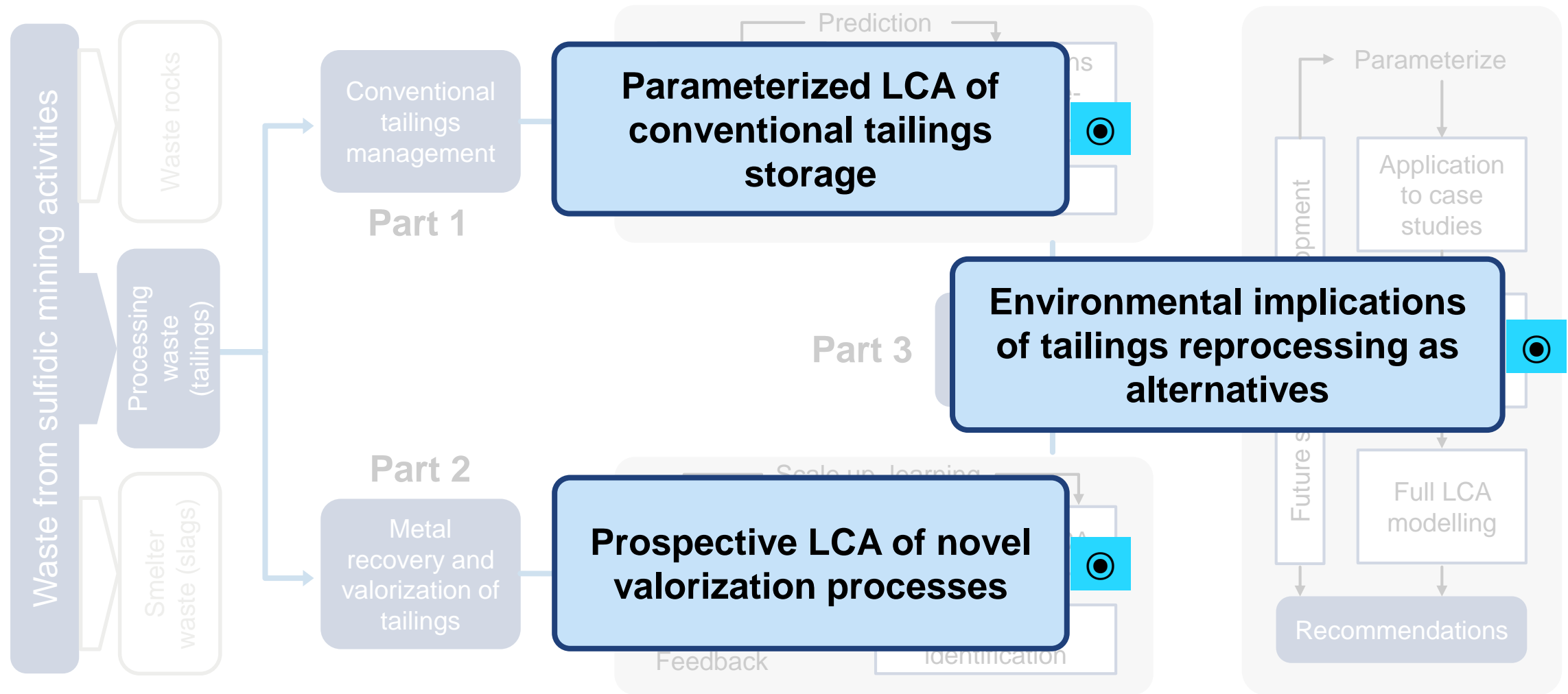
Environmental implications of reprocessing tailings

(This study)

Part 3 – Scenarios: Reprocessing of tailings as alternatives



Research parts as planned publications



Relevance for science and economy



Parameterized LCA of
conventional tailings
storage

- Global environmental assessment
by means of site-specific factors



Prospective LCA of novel
valorization processes

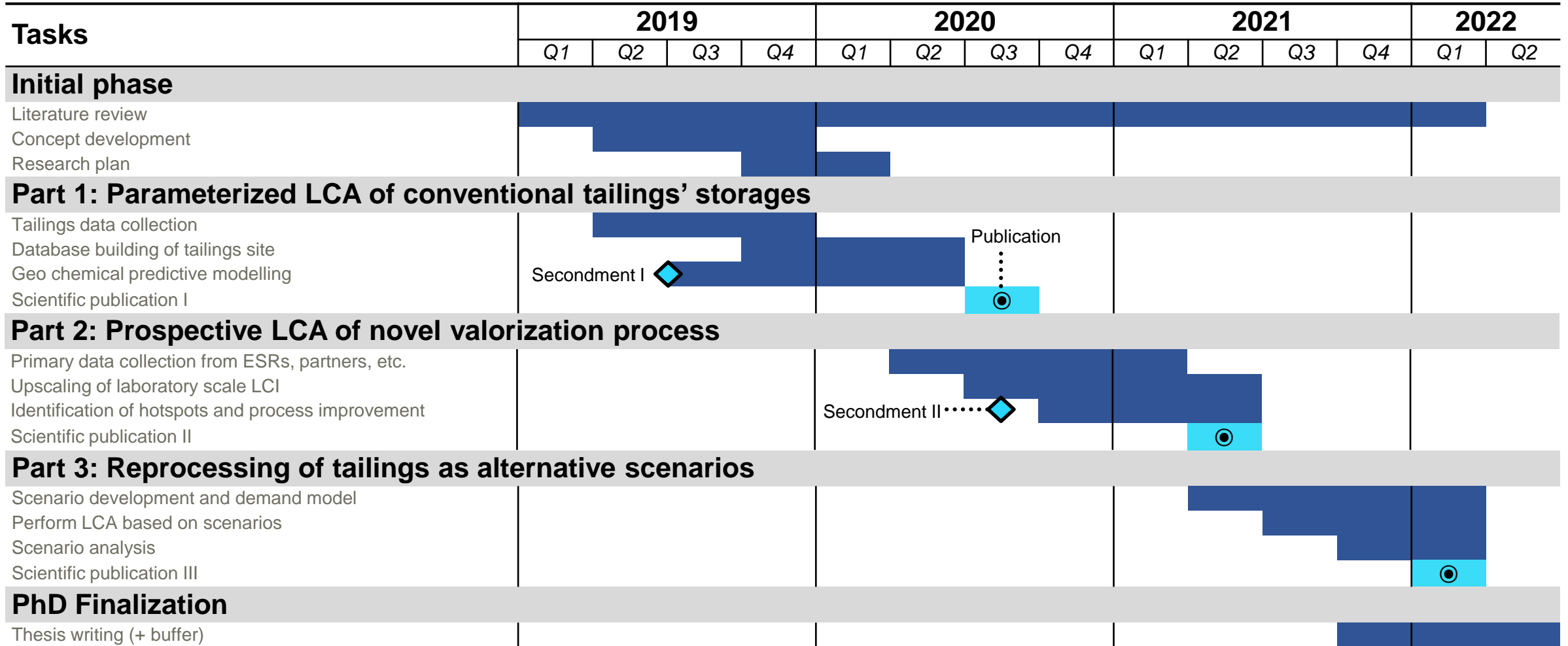
- Structured methods to assess environmental
performance of emerging technologies



Environmental implications
of tailings reprocessing as
alternatives

Scientific contribution

Time schedule



Today →



Thank you!
Any questions?



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