PC6: LCA-SUB

Environmental assessment and Life Cycle thinking for A sustainable use of the SUBsurface
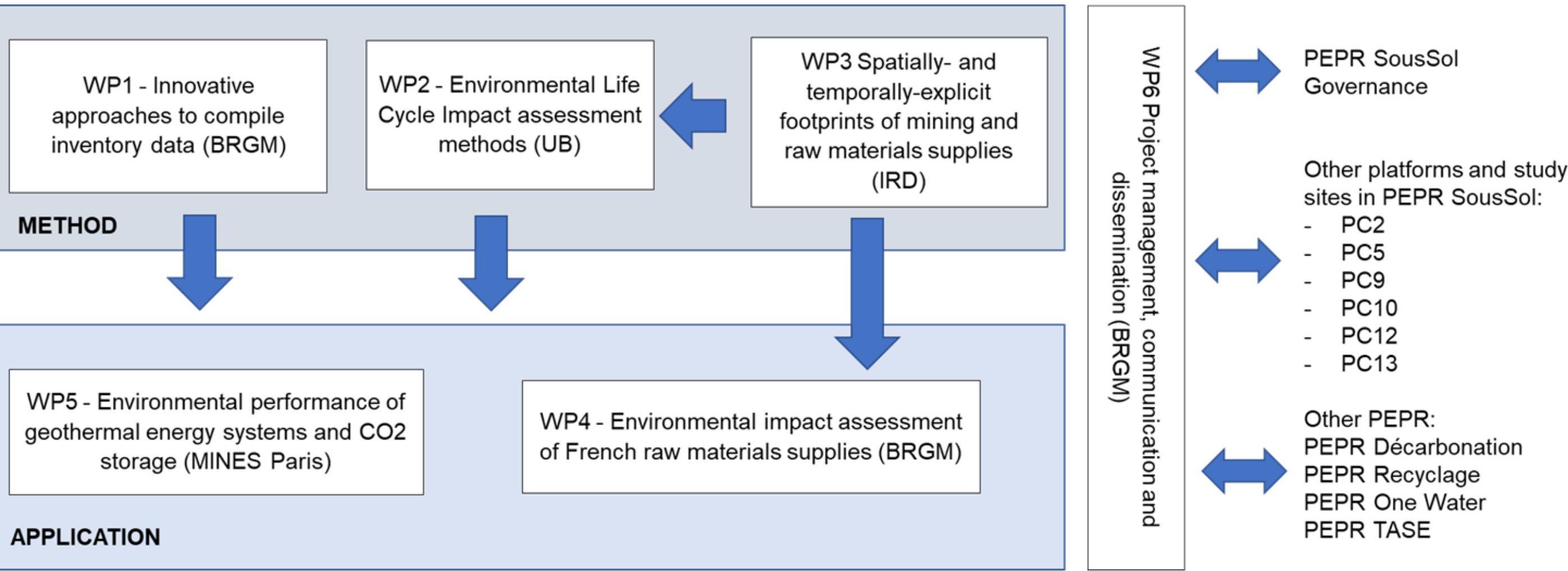
FRANCE 2030 — PROGRAMME DE RECHERCHE — SOUS-SOL

Auteurs

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LCA-SUB will significantly advance Life Cycle Thinking methods for environmental assessment, thanks to an innovative combination of approaches and tools. It will provide an environmental assessment of the perspectives offered by the potential future exploitation of the French subsurface. It will consider, and discuss, threats and opportunities with respect to both local and global environmental challenges
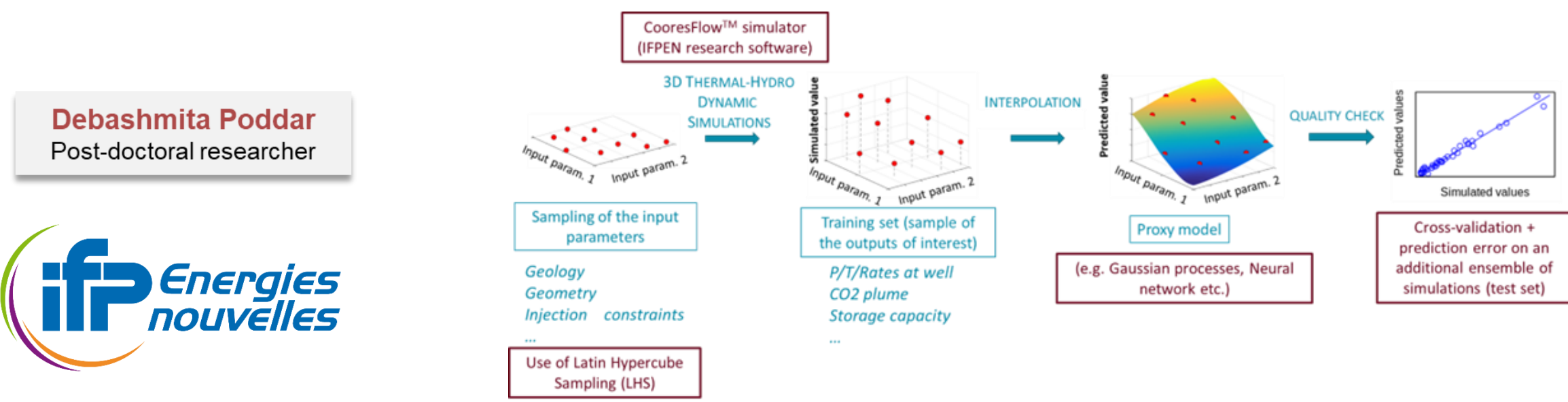
Project outline

Life Cycle Assessment of CO₂ geological storage

Development of Life Cycle Inventories (LCI) and Life Cycle Assessment (LCA) models specific to CO_2 geological storage sites, taking into account leakage risks
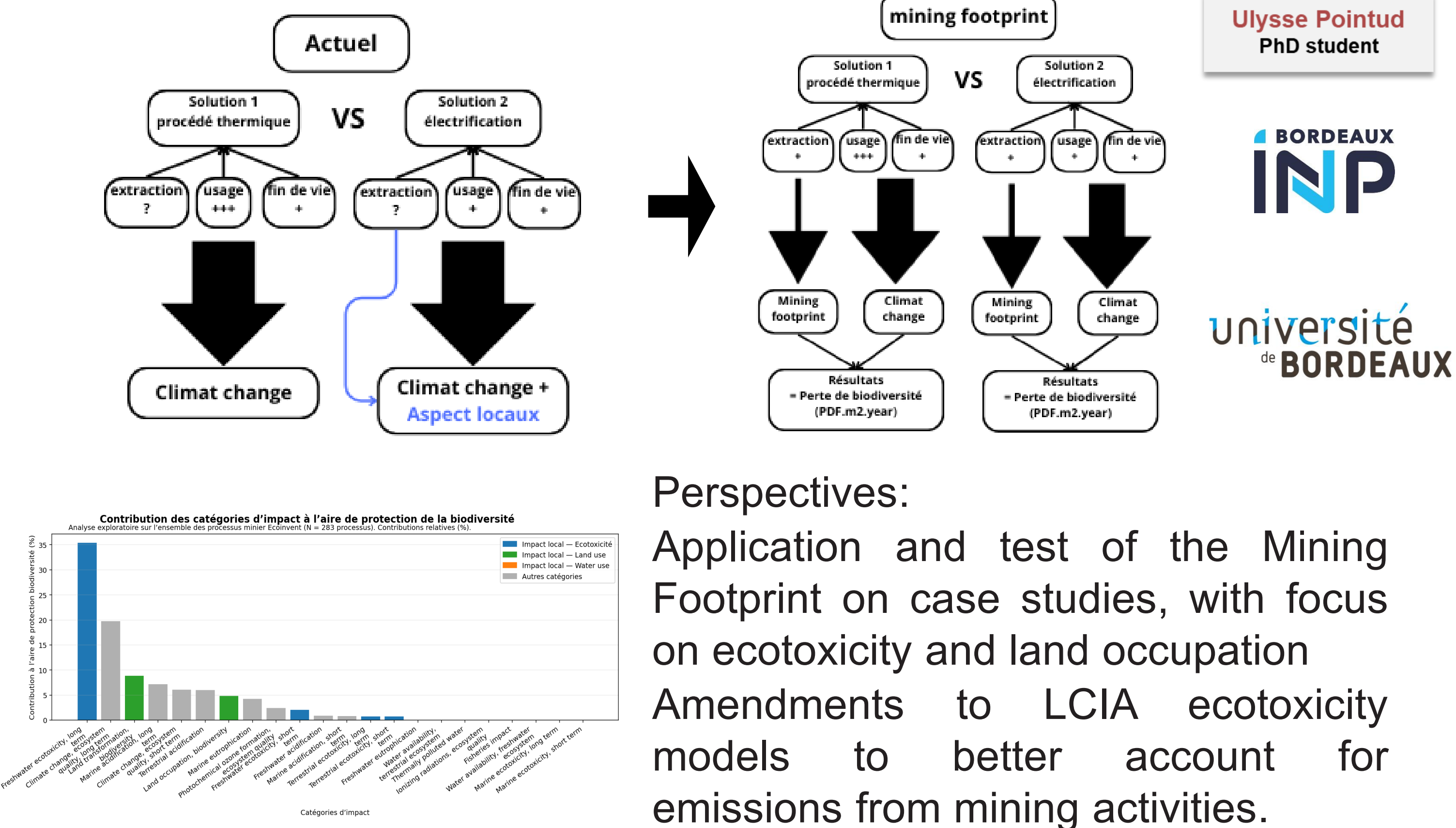
- Building and training of fast meta-models to replace the physical simulations in the risk estimation process considering machine learning-based approaches
- A set of a few representative reservoir models with associated uncertainties will be built, considering different types (e.g. depleted gas field, saline aquifers), typologies (sandstones, carbonates etc.), and leakage scenarios (damaged well, fault reactivation).

Debashmita Poddar — Post-doctoral researcher — IFP Energies nouvelles

Scientific Valorization supported by LCA-SUB

- Lagae Capelle, E., **Beylot, A.**, Coudert, L., Demers,I., Neculita, C. N., Noirant, G., Pépin, G., **Muller, S**. *Comparative life cycle assessment of scenarios of low sulfide tailings management: identification of hotspots towards eco-design*. Submitted to IJLCA (2025)
- Sakatadi, G., **Beylot, A., Lai, F.**, Hippmann, S., Pavón, S., Blengini, G. A. *How can prospective life cycle assessment support the eco-design of an innovative battery-grade lithium carbonate production process?* Submitted to RCR (2026)
- Istrate, R., Schenker, V., **Beylot, A., Collignon, V.,** Pfister, S., Steubing, B. *Future environmental performance of lithium from brines shaped by energy and reagent decarbonization and technology optimization*. Submitted to ES&T (2026)
- **Mas-Fons, A**., Freboeuf, L., **Beylot, A., Pino Herrera, D.,** Loubet, P., **Sonnemann, G.,** Reuter, M. *Use of process simulation in LCA of mineral raw materials production: a critical review*. Submitted to Sustainable Metallurgy (2026)
- Husmann, J., Northey, S., **Beylot, A.** et al. *Inconsistencies in handling of multifunctionality in the environmental footprint of electric vehicle batteries: a cross-industry analysis.* Int J Life Cycle Assess 30, 1560–1578 (2025). https://doi.org/10.1007/s11367-025-02506-y
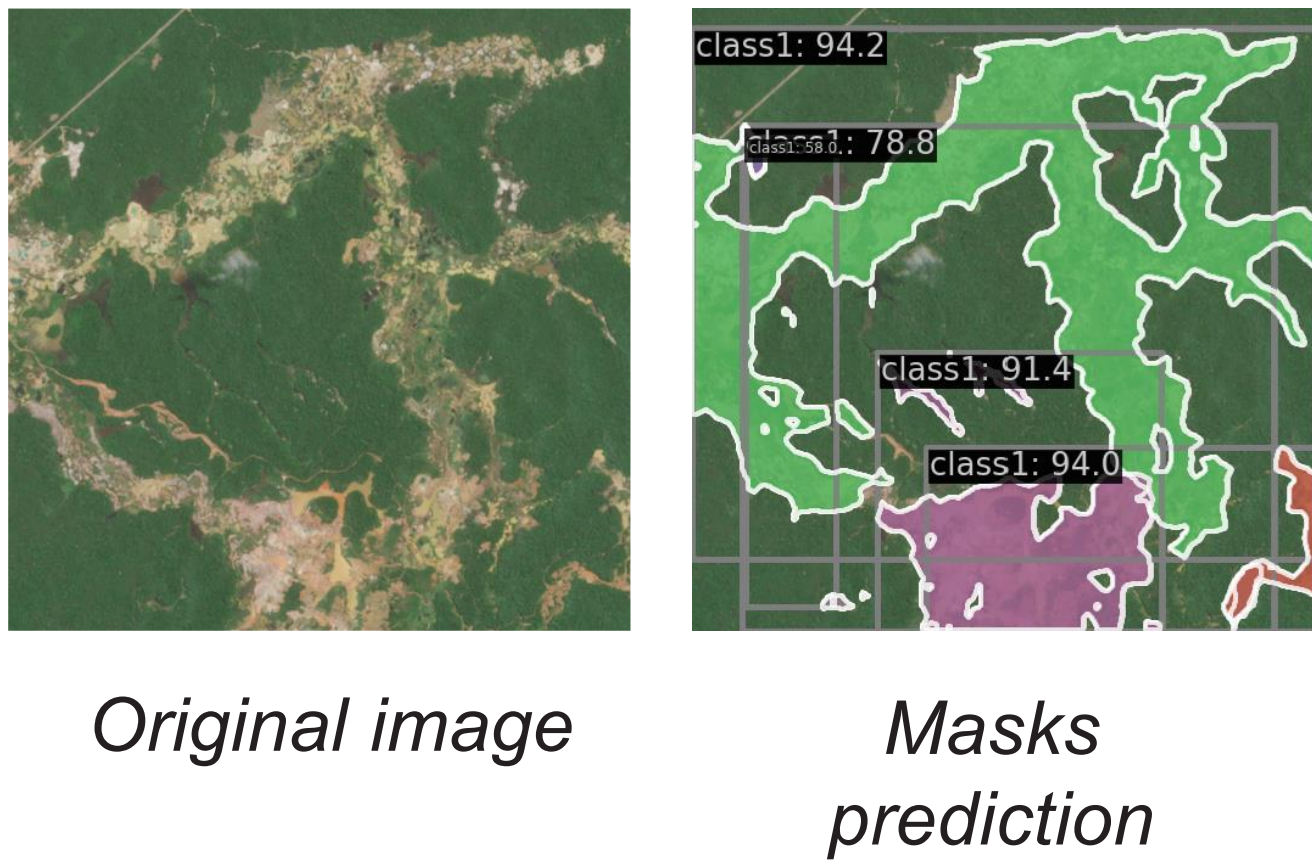
Mining Footprint: a methodological framework

Ulysse Pointud — PhD student — BORDEAUX INP — université de BORDEAUX

Perspectives:
Application and test of the Mining Footprint on case studies, with focus on ecotoxicity and land occupation
Amendments to LCIA ecotoxicity models to better account for emissions from mining activities.

Land and temporal footprint of mining activities through satellite images

- Key results so far: creation of a database annotated and focused at gold panning, first model of image segmentation
- Future work:
- Field missions to the Ivory Coast (to facilitate image tagging) and to Peru (interdisciplinary approach from the perspective of political geology)
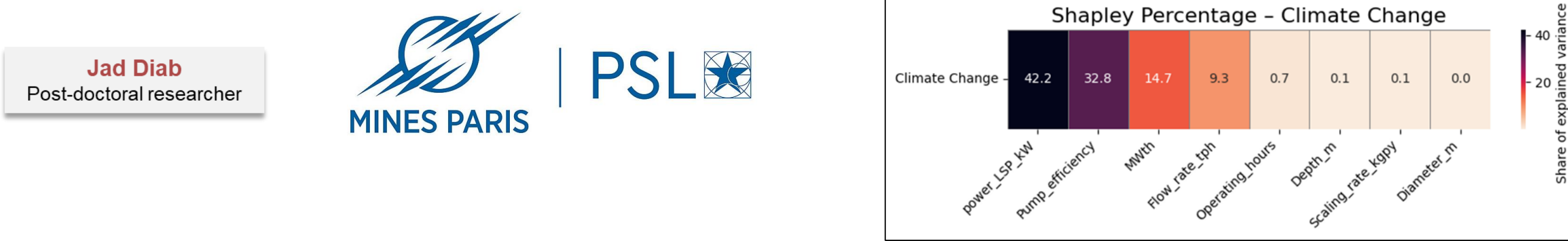- Expansion of the database and evaluation of different models, analysis of results

Original image — *Masks prediction*

Florent Feriol — Post-doctoral researcher — IRD Institut de Recherche pour le Développement FRANCE

Life Cycle Assessment of geothermal energy production systems

Environmental assessment of geothermal energy production systems – parameterization and case studies
Key results so far:
- Update of the Rittershofen case
- Development of a dependency model via Shapley
Perspectives: on-going synergy with BRGM, and planned engagement with operators of the Paris Basin

Jad Diab — Post-doctoral researcher — MINES PARIS | PSL

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