PhD Position on
advancing Life Cycle Impact Assessment methods of toxicity, water and land use towards a general mining footprint approach for mining case in a French context

Profile

The Life Cycle Group 'CyVi' at the Institute of Molecular Sciences (ISM), University of Bordeaux (UB), and the French Geological Survey (BRGM) are looking for a PhD candidate to work on advancing Life Cycle Impact Assessment methods of toxicity, water and land use towards a general mining footprint approach for the mining case in a French context.

Since its creation in 2012 the CyVi Group has got an inter- and transdisciplinary orientation and has been specialized in life cycle approaches for chemical products. Key issues thereby are the application and methodological advancement of life cycle assessment (LCA) in the areas of chemical products and materials, with a strong focus on the natural resources and raw materials needed.

The BRGM has a strong team to measure the environmental impacts linked to the supply of mineral raw materials. In this respect, through a better understanding of the flow of materials along value chains, BRGM helps economic players to reduce environmental impacts. Moreover, BRGM has got a strong expertise on evaluating the so-called criticality of raw materials and has contributed to the development of the critical and strategic raw materials list at national and EU level.

The primary workplace will be the Bordeaux campus, with the candidate spending approximately two-thirds of their time at the ISM in the CyVi group, University of Bordeaux, and the remaining one-third at the BRGM in Orléans and other offices of collaboration partners. Option of exchanges might come up with collaboration partners such as the Technical University of Denmark in Copenhagen and the interdisciplinary research center on the life cycle assessment of product, processes and services CIRAIG in Montreal. The Bordeaux campus in Talence and the BRGM offices are easily accessible with public transportation.

Starting date: 1 October 2024 or later, mandatory start before the end of 2024

Requirements

- Should hold a master's degree in chemistry, toxicology, environmental or material sciences, chemical, environmental or process engineering, mining, metallurgy, sustainable resource management or related fields.
- Experience in, life cycle assessment, material flow analysis, toxicology, sustainable water and land management.
- Interest in ***interdisciplinary high-level research,*** advanced research focusing on toxicity, land and water use as part of the environmental impacts evaluated in life cycle assessment, with a focus on mining and the challenges of the energy transition
- Enthusiasm for collaborating within research groups on sustainability assessment of the energy transition using life cycle, risk assessment and other system analytical approaches for evaluating mining in particular and metals life cycles in general, including the possibility to contribute to the supervision of Master and Bachelor students.
- Willingness to contribute to the management tasks of the project funding the PhD thesis, and general duties within the research groups.
- Knowledge of or interest in learning programming languages such as Python and other IT skills is an advantage

- Strong interest in mining activities and the raw materials sector, in particular where metals are relevant, is important.
- Excellent knowledge of both ***English and French*** are required.

Project context and description of the PhD thesis

The proposed thesis project, co-supervised by the CyVi group at UB and the BRGM, will focus on advancing Life Cycle Impact Assessment (LCIA) methods of toxicity, water and land use towards a general mining footprint approach for the mining case in a French context. This work is done as part of the France 2030 funded project LCA-SUB (for *Environmental assessment and Life Cycle thinking for A sustainable use of the SUBsurface*) that aims at significantly advancing LCA for mining thanks to an innovative combination of approaches and tools. This is done to address key challenges ahead identified for the LCA of metals production[1]. A particular objective is to develop a general mining footprint approach. The methods developed in LCA-SUB will be applied to case studies of the use of the French subsurface. Moreover, the project LCA-SUB will bring together, structure and strengthen the LCA research community in France. The project LCA-SUB will thus provide an environmental assessment of the perspectives offered by the potential future exploitation of the French subsurface as part of the energy transition. The project LCA-SUB is part the Priority Research and Equipment Programme (PEPR) SousSol.

The PhD student hired by UB will do a review of existing toxicity and ecotoxicity impact assessment methods, including USEtox®[2], for metals with regard to four questions: a) adequateness for assessing metals and coverage of which metals, b) which key specificities reported in scientific literature, like the existence of a background concentration, essentiality of some metals for life, complex dynamic speciation, are addressed or not, c) possibility to extend to site-dependent archetypes-based characterisation factors, d) integrability into the general mining footprint approach foreseen.

Based on this review the most promising methods, including USEtox®, will be used in at least one case study from mine to metals from those available in the LCA-SUB project. This test in one or more case studies will allow UB and BRGM to come up with recommendations on which method to use in which situation in LCA applied to metal mining and refinery activities. Once the initial review has been carried out, potential regional impact assessments for the PEPR SousSol "study sites" Massif Central, Rhine Graben or French Guiana will be carried out, or site-generic characterisation factors for metals not yet well covered and of relevance particularly for batteries or other applications for the energy transition will be developed. In the first case, a critical analysis will be conducted on French site-dependent archetypes of USEtox® based characterisation factors for metals and the toxicological and ecotoxicological impact assessment methods identified in the initial review by UB. In the second case, missing site-generic characterisation factors of metals will be identified and conditions for improvement will be determined. Other basic documents will be considered such as guidance documents and data developed and used for the evaluation of metals in the context of the European regulation on chemicals and related information systems. This task will closely interconnect with other tasks in the LCA-SUB project in order to support the development of improved models useful for tailing management, and outcomes from these two tasks will feed the case studies "from mine to metals".

In addition to this focus on toxicity the PhD will also have to work on water and land use relevant impact categories in LCA. The level of maturity and overall acceptability of related LCIA methods are, like for the case of water[3] and land use[4,5], lower in comparison to e.g. Global Warming Potential. Therefore, the PhD student will do a review of existing methods with regard to three questions: a) adequateness for assessing mining and refinery activities, b) alignment with the biodiversity and ecosystem services methodology developed in the LCA-TASE project (for *Life Cycle Assessment of Technologies related to Advanced energy systems to contribute to Sustainability and Energy sovereignty* part of the PEPR TASE on renewable energies), c) integrability into the land footprint and water footprint approaches foreseen to be advanced as part of the overall mining footprint to be developed in the LCA-SUB project. Based on this review the most promising methods will be tested by BRGM jointly with the land footprint and water footprint approaches in at least one case study from mine to metals from those available in the LCA-SUB project. This test in one or more

case studies will allow UB and BRGM to come up with recommendations on which method to use in which situation in LCA applied to metal mining and refinery activities.

Funding: LCA-SUB project funded by France 2030 and operated by the French National Research Agency (ANR) under the Priority Research and Equipment Programme (PEPR) SousSol "Subsoil – Common property".

Duration of the thesis: 3 years
Length of employment: max. until the end of 2027

PhD Thesis director: Prof. G. Sonnemann, Univ. Bordeaux
PhD Thesis advisors: Dr. A. Beylot, BRGM, Dr. T. Chitaka and Dr. E. Mignard, Univ. Bordeaux

Application

Deadline for application: ***21 June 2024*** at noon

Interested and highly motivated applicants should provide their application files (Motivation letter, CV, publication list and up to 3 potential referees with address, phone number and email) in electronic form in one pdf file), if possible, by the end of the deadline to:

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For any questions, please contact: Prof. Guido Sonnemann, Dr. T. Chitaka and Dr. Antoine Beylot at the indicated email addresses.

References:

[1]Beylot, A. 2021. LCA of metals production: key challenges ahead and potential way forward. PROMETIA Life Cycle Analysis Webinar. 31st August 2021.
[2]Rosenbaum, R.K., Bachmann, T.M., Gold, L.S., Huijbregts, M.A.J., Jolliet, O., Juraske, R., Koehler, A., Larsen, H.F., MacLeod, M., Margni, M., McKone, T.E., Payet, J., Schuhmacher, M., Van De Meent, D., Hauschild, M.Z., 2008. USEtox - The UNEP-SETAC toxicity model: Recommended characterisation factors for human toxicity and freshwater ecotoxicity in life cycle impact assessment. Int. J. Life Cycle Assess. 13, 532–546. https://doi.org/10.1007/s11367-008-0038-4
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[5]Vidal-Legaz, B., Sala, S., Antón, A., Maia De Souza, D., Nocita, M., Putman, B., Teixeira, R.F.M. 2016. Land-use related environmental indicators for Life Cycle Assessment. JRC Technical report. Luxembourg: Publications Office of the European Union, pp.44 doi: 10.2788/905478