Imperial College London

Natural Environment Research Council

2024_84_MechEng_JE: Evaluating the ecological impact of mining for electric vehicle and stationary storage battery minerals

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Lithium-ion batteries are key for eliminating global fossil fuel consumption, as they are a core technology powering electric vehicles and can be used to balance intermittent renewable energy sources, such as wind and solar. However, lithium-ion batteries are comprised of numerous critical minerals (ex. lithium, nickel, cobalt, graphite) that are obtained through mining projects, often causing land use change and habitat destruction which threatens local ecosystems and biodiversity. Given the scale at which demand for batteries is expected to explode in the coming decades as the transportation sector electrifies, it is critical that battery raw materials be sourced with the lowest possible ecological impact.

Prior work analysing the land use and ecological impact of mineral extraction for lithium-ion batteries is very limited. Land use change, biodiversity, and other key ecological impact metrics are notoriously difficult to assess, with no universally accepted method established. Sonter et al. have studied the impact of mining on areas of high biodiversity broadly, finding that over 50 million km2 globally have the potential to be affected, with over 80 % of mines being for minerals required for the clean energy transition.1 Specific studies for the lithium-ion battery supply chain are virtually non-existent in the literature.

This PhD would consist of two phases, with the aim of answering the following research questions: 1) How can the ecological impact of battery mineral mine sites be assessed? and 2) What is the potential environmental benefit of next-generation technologies and alternative mining practices from an ecological impact perspective? The first phase would involve designing a framework for identifying and assessing the ecological impacts of battery mineral extraction, relying on the development of both quantitative and qualitative metrics. Topics could include land use change, pollution, and biodiversity impact. The aim of this framework would be to offer a means to holistically assess the ecological risks associated with an existing or planned battery mineral mine. The second phase of work would be to utilize the developed framework to assess the potential ecological benefits of alternative practices and next-generation technologies compared to the current state-of-the-art. This body of work would both bridge a significant gap in the literature and provide practical insights to electric vehicle & battery manufacturers, policymakers, and conservation planners. Furthermore, this work would offer an interdisciplinary perspective on designing a battery lifecycle that is truly sustainable and offers the maximum possible environmental benefit.

1. Sonter, L.J., Dade, M.C., Watson, J.E.M and Valenta, R.K. Renewable energy production will exacerbate mining threats to biodiversity. Nature Communications, 11 (2020).