Imperial College London

Natural Environment Research Council

2023_01_BGS_Hughes: Assessing the sustainability of lithium brine extraction in high Andean salars

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Lithium-rich brines from the lithium triangle countries (Argentina, Bolivia, Chile), comprise over 50% of the global lithium resources and are critical for decarbonisation technologies. Future projections suggest high demand for lithium for use in lithium – ion batteries (LIBs), which will require significant upscaling of lithium mining. Doing so in a responsible and sustainable manner is a significant challenge.

There is a challenge in understanding the environmental effects of brine extraction and its potential impact on ecology and groundwater systems where abstraction for fresh water may occur, which is of concern to local stakeholders. Our work has identified the lack of understanding of the lithium system and mass balance at the watershed scale to the salar to the wellfield. The latter is critical for ensuring environmental sustainability, considering the rapid upscaling requirement and the fragile ecosystems in which these brines exist.

Given the lack of data and understanding of high Andean salars systems, sustainability impact assessment and the development of sustainability indicators could prove a useful way of determining whether adverse impacts are occurring. Building on existing techniques, such as DRASTIC and those for saline Intrusion (doi.org/10.1007/s11269-018-1952-2), this PhD would develop sustainability indicators, based on systemic understanding of the mass transport of brine from the basin to the salar. Data based on open sources, such as topography, rainfall, groundwater head, brine distribution will be used in their development. Using a complex, well understood example, i.e. Salar de Atacama, a quantified conceptual model (water and mass balance) will be developed and based on its systemic understanding sustainability indices will subsequently be produced. Their purpose will be to quantify environmental impacts using 'simplified' but representative analogues to the system. Life cycle scenario analysis will be used to evaluate the non-linear effects of Li production scale up (doi.org/10.1016/j.jclepro.2020.120067; doi.org/10.1016/j.jclepro.2022.133636). The 'simplified' sustainability indices approach can then be applied to other salars where the understanding is less well developed. They will provide powerful tools for decision makers and industry in the lithium triangle countries and desired evidence for important global initiatives, such as the Sustainable Development Goals (e.g. SDG 12 on sustainable production and consumption) and the Extractive Industry Transparency Initiative.

Field visits to Salar de Atacama and other salar(s) will be required to collect data.

The research methods to be used include:

Geological investigations; Mass balance quantification; Life cycle analysis; Expert elicitation