

FORUM:	Environment Commission
ISSUE:	Measures to Address the Environmental Impact of Lithium Mining in Chile
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Introduction

Global demand for lithium is rising as lithium mining can support electric vehicles, battery storage for renewable energy, and, most importantly, the transition to clean energy. However, at the same time, lithium extraction can cause water depletion, damage to fragile desert ecosystems, and biodiversity loss. This reveals how lithium is necessary for decarbonization, but its extraction is not automatically environmentally sustainable and can even cause further environmental consequences if not managed properly. Chile, a country rich in lithium, especially in the Atacama Desert, a 1,600km stretch of arid land covering more than 100,000km² where Chile, Bolivia, and Argentina meet, lies the so-called lithium triangle (SQM). It is estimated that over 60 percent of the world's lithium reserves are stored in this region, in

enriched and highly concentrated brines (SQM). According to USGS (United States Geological Survey) estimates, 23 percent of the lithium produced worldwide in 2019 originated from the Salar de Atacama (SQM). Therefore, Chile is a critical actor in the global lithium industry as well as the environment. SQM is a global mining company based in northern Chile and operates in strategic industries for sustainable development.



Figure 1 Chile's Atacama Desert

Background

In Salar de Atacama, SQM has been investing in its world-class lithium operations for more than 25 years. In 1979, Chile declared lithium a strategic, non-concessionable mineral, reserving ownership and control primarily to the State (Jobet, Juan Carlos, et al.). As a non-concessionable resource, lithium cannot generally be exploited through ordinary private mining concessions, and its exploitation is reserved for the Chilean State. Mining rights granted before 1979, however, were allowed to continue, enabling companies such as SQM to retain access to major lithium deposits (Chan, Justin, and Erica Martienelli). Throughout the 1990s and until now, commercial lithium extraction has expanded rapidly in the Salar de Atacama due to the increase in global demand for electric cars, batteries, and transitioning into clean energy. Extraction in the Salar de Atacama relies primarily on pumping the lithium-rich brine from underground

aquifers into large evaporation ponds, where water naturally evaporates to store the lithium. This

evaporation method typically requires 18

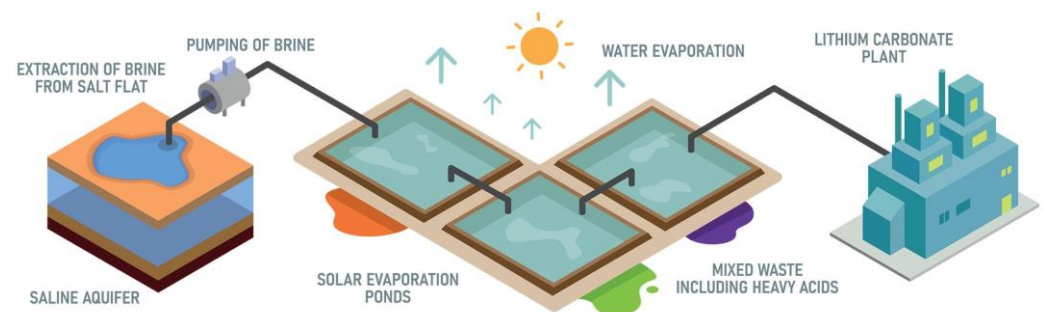


Figure 2 Brine extraction method used in Salar de Atacama

months for the sunlight to evaporate the pool and leave behind lithium salts, and 85 to 95 percent of the water is lost during the process (Livingstone). As the Atacama Desert receives extremely little rainfall, both freshwater and underground brine systems are naturally limited and slow to replenish. Thus, scientists and environmental organizations began raising concerns that large-scale brine extraction could alter groundwater flows, reduce wetland water availability, and disturb the desert's fragile hydrological balance (Peñaloza-Pacheco et al.). Scientists have already found that the groundwater levels declined by up to 15% around the Salar de Atacama between 2010 and 2019 (Peñaloza-Pacheco et al.). Furthermore, vegetation decreased by about 0.4% in areas exposed to lithium extraction. Indigenous communities living around the Salar de Atacama also expressed concerns over declining water resources, impacts on traditional livelihoods, and insufficient participation in mining decisions, which led approximately 1.5% of human settlements to outmigrate to other areas (Peñaloza-Pacheco et al.). This created a paradox: lithium is essential for reducing global greenhouse gas emissions, yet its extraction may generate significant local environmental impacts. Mining companies, including SQM, continued expanding operations while obtaining environmental permits through Chile's Environmental Impact Assessment system. SQM Salar has received 20 permits from the environmental authority after submitting environmental impact statements and assessments since 1996 (Chan and Martinelli). However,



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environmental groups questioned whether these assessments adequately accounted for cumulative and long-term impacts on water resources and biodiversity. In response, the Chilean government strengthened environmental monitoring and began developing policies aimed at improving oversight of the lithium industry. In 2023, Chile introduced its National Lithium Strategy, seeking to balance economic development, environmental protection, greater state participation, and technological innovation in lithium extraction (International Energy Agency). Despite these efforts to protect the environment, concerns remain regarding the long-term sustainability of lithium mining, particularly its effects on water resources, biodiversity, and indigenous rights. Today, the central challenge for humans is how Chile can continue supplying a mineral that is essential for the global clean energy transition while minimizing environmental degradation and ensuring that local communities and ecosystems are adequately protected.

Problems Raised

Water depletion and disruption of the hydrological system

Most lithium in Chile is extracted using the brine method beneath the Salar de Atacama. Mining companies such as SQM pump large volumes of lithium from 1.5 to 150 meters below the surface into the large evaporation ponds (SQM). Natural solar evaporation typically takes about 13 to 16 months to evaporate water and leave lithium behind (SQM). The



Figure 3 Dried desert due to Chile's water crisis

concentrated lithium is then transported to the Salar del Carmen processing plant, where it is refined into lithium carbonate and lithium hydroxide (SQM). Although this method is effective for extracting lithium, it requires the removal of massive amounts of brine and freshwater—approximately 180 million liters per day—raising concerns about long-term water availability (Chan, Justin, and Erica Martinelli). This extensive water usage leads to water diversion of the San Pedro River as well as drying of brines, deterioration of watersheds, and ultimately depletion of water resources that disrupts the hydrological system. This significantly affects the nearby protected wetland ecosystems negatively, which could lead to environmental degradation because of its strong negative correlations with vegetation cover and soil moisture.



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Biodiversity loss and ecosystem degradation

The extraction of lithium in Chile not only influences the water resources but further impacts the biodiversity in the Salar de Atacama. Especially, the Maricunga salt flat is recognized as a biodiversity hotspot, supporting 53 animal species, endemic microorganisms, and threatened species such as the Andean flamingo (Livingstone).



Figure 4 Flamingoes in the Atacama desert

Scientists have revealed that lithium mining in the Atacama has been directly linked to a 10 to 12 percent decrease in James' and Andean flamingo populations, likely due to habitat disturbance and expansion of evaporation ponds. During the extraction process, the reinjected brine could have traces of chemical compounds that could affect the whole ecosystem (Livingstone). Disruption caused by mining activities would most likely force the flamingoes to abandon the lake and find a new habitat. Scientists have cautioned that alterations to the salt flat's hydrology could affect the entire interconnected ecosystem. Furthermore, the extensive extraction of lithium not only influences the ecosystems, but also the indigenous communities such as the Collar and Lickan Antay who live near the Salar de Atacama (Meckievi, Sol, et al.).

International Actions

European Union-Chile Advanced Framework Agreement (2023)

In 2023, the European Union and Chile signed the Advanced Framework Agreement (AFA), which strengthens cooperation on critical raw materials including lithium. From the Preamble, the Agreement reaffirms the EU and Chile's commitment to ensuring that trade and investment contribute to sustainable development across economic, social, and environmental dimensions for lithium resources. Furthermore, the Agreement 1.2 (6) emphasizes the parties' support for the United Nations Declaration on the Rights of Indigenous Peoples, which could include the Atacameño (Lickanantay), Colla, and other indigenous communities near the Atacama Desert. Although the Agreement establishes a strong framework for sustainable cooperation, it does not contain legally binding environmental standards

specifically governing lithium mining. Instead, this framework provides broad principles that encourage Chile and the EU to pursue more sustainable management of critical resources.

OECD Due Diligence Guidance for Responsible Mineral Supply Chains (2016)

Chile is a member of the Organization for Economic Cooperation and Development, and OECD's due diligence guidance for responsible mineral supply chains is applicable for lithium in Chile. The OECD introduced a Five-Step Due Diligence Framework that requires companies to identify environmental risks, implement mitigation strategies, undergo independent audits, and publicly report their responsible sourcing practices (OECD). Although this guidance was not specific to lithium, the framework has increasingly been applied to critical minerals such as lithium used in electric vehicle batteries. Although the OECD provides general guidance for responsible mineral supply chains, it is mainly focused on minerals such as tin, tantalum, tungsten, and gold extracted from conflict-affected regions rather than environmentally critical areas.

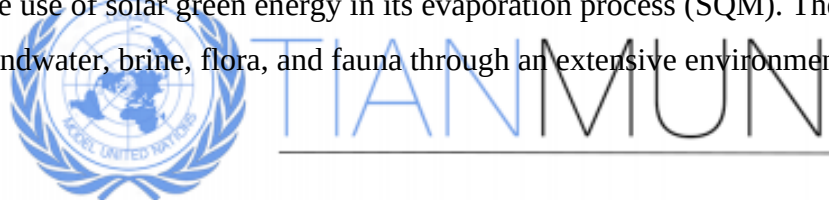
Key Players

Chile

Chile is the world's second largest lithium producer and possesses the world's largest lithium reserves, especially at the Salar de Atacama. Unlike most minerals, lithium is legally classified as a strategic, non-concessionable resource under Chilean law, meaning it can only be exploited by the State, state-owned enterprises, or through Special Lithium Operation Contracts (CEOLs), authorized by the President (Guajardo, B.J.C.). Through the National Lithium Strategy, Chile aims to increase lithium production while promoting downstream processing, sustainable development, and greater state participation in the industry (Guajardo, B.J.C.). At the same time, the government faces challenges in balancing economic growth with environmental protection and meaningful consultation with Indigenous communities (Guajardo, B.J.C.).

SQM (Sociedad Química y Minera de Chile)

SQM is one of Chile's largest lithium producers and operates major extraction facilities in the Salar de Atacama. However, its operations are central to debates surrounding groundwater depletion, ecosystem degradation, and Indigenous rights. SQM argues that its brine-based lithium extraction is more environmentally sustainable than hard-rock mining, pointing out lower carbon emissions, lower water consumption, and the use of solar green energy in its evaporation process (SQM). The company states that it monitors groundwater, brine, flora, and fauna through an extensive environmental monitoring



system and has committed to reducing freshwater consumption by 50 percent and achieving carbon-neutral lithium production by 2030 (SQM). SQM also emphasizes financial contributions to local governments and Indigenous communities through royalties, community investment, and social development programs (SQM).

Possible Solutions

Transition to Direct Lithium Extraction (DLE)

Direct Lithium Extraction (DLE) is an emerging technology that extracts lithium directly from brine using selective absorption, ion exchange, or solvent extraction, rather than relying on large evaporation ponds. Compared to conventional brine extraction, DLE has the potential to reduce land use, shorten production times, improve lithium recovery rates, and lower freshwater consumption by reinjecting processed brine into underground reservoirs (Razmjou). The extraction method is known to maximize the recovery of lithium with the lowest environmental footprint (Livingstone). However, the technology remains relatively new, requiring further commercial development and assessment of its long-term environmental impacts before widespread implementation.

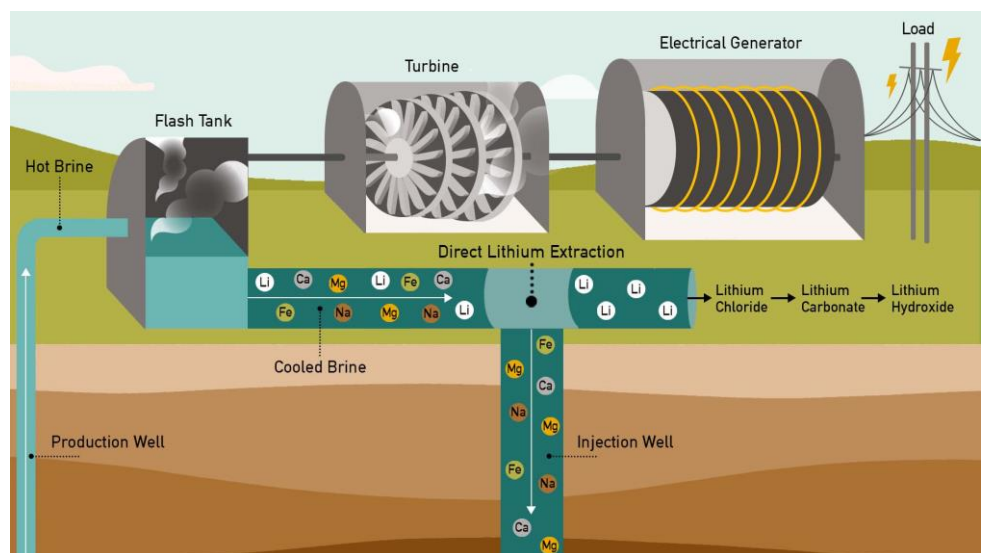


Figure 5 Direct lithium extraction method

Strengthening Environmental Regulation and Indigenous Consultation

As the current solution that the Chilean government is following is nationally based, meaning that the assessments of tracking the environmental impacts may not be fully objective or transparent. Thus, strengthening environmental regulations through third-party organizations such as the United Nations or International Lithium Association could ensure comprehensive environmental impact assessments, transparent monitoring of water resources, and regular reporting of ecological data throughout a project's lifetime. In addition, ensuring meaningful consultation and participation of Indigenous communities

before approving lithium projects can help reduce conflicts, improve accountability, and protect culturally and environmentally significant areas. Establishing clear legal frameworks, independent oversight, and benefit-sharing mechanisms with Indigenous communities can encourage more sustainable lithium production in Chile while balancing economic development with environmental protection and community rights.

Recycle and reduce water waste

Since water waste is a significant factor in environmental impact, one solution to reduce the environmental impact of lithium mining is to improve water efficiency through water recycling and the use of alternative water sources. The International Energy Agency (IEA) explains that mining operations can reduce their water consumption by controlling water losses and using recycled process water, treated wastewater, or desalinated seawater instead of relying heavily on freshwater (Bredariol). By recycling water used during the extraction and processing stages, mining companies could reduce their freshwater consumption and limit pressure on surrounding groundwater resources. In addition, companies could use treated wastewater or desalinated seawater for industrial processes, allowing freshwater resources to remain available for local communities and ecosystems (Bredariol). The effectiveness of water recycling is demonstrated by other mining operations; for example, Anglo American has implemented measures that allow its Los Bronces mine to recycle more than 78% of the water it uses (Bredariol).

Glossary

Brine Extraction

The conventional method of extracting lithium by pumping underground brine into evaporation ponds. This method is used mainly in Chile, which possesses potential environmental issues such as water depletion.

Salar de Atacama

Chile's largest salt flat and one of the world's richest lithium deposits, located in the Atacama Desert.

Direct Lithium Extraction (DLE)

A newer technology that extracts lithium directly from brine using chemical or physical separation techniques, reducing land use and water consumption compared with evaporation ponds. This method is typically regarded as a more environmentally friendly method for lithium extraction than evaporation ponds.

Hydrological system



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The interconnected movement and storage of water, including groundwater, rivers, wetlands, and rainfall within an ecosystem.

Hydrological balance

The natural balance between water entering, leaving, and being stored within an ecosystem or water system.

Aquifer

An underground layer of rock or sediment that stores and allows groundwater to move through it.

Desalinated Seawater

Seawater that has undergone a process to remove most of its dissolved salts so that it can be used for other purposes.

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