

E&T confirms that major companies 'mining' brine for lithium in Chile's Atacama salt flats are reducing water levels in an already dry region, with detrimental consequences for local communities and the environment. By **Ben Heubl**

LITHIUM AT ANY PRICE?



GLOBAL LITHIUM DEMAND is soaring, as climate pressures drive a switch to electric vehicles that use the metal in their batteries. Therein lies a conflict: supply needs to increase for environmental reasons but lithium mining harms the environment.

Much of the world's lithium (over 30 per cent) comes from Chile, but an *E&T* investigation reveals new evidence that its extraction without adequate regulatory control is harming communities and damaging fragile ecosystems.

Since the lithium rush began, companies like Sociedad Química y Minera de Chile (SQM), a multibillion-dollar Chilean chemical business, and US-headquartered Albemarle Corporation have invested fortunes to exploit brine in the Atacama salt

flat, one of the most arid spots on Earth. Brine mining is a basic but effective method of extracting lithium, in use since the 1950s.

The way lithium is 'water-mined' is a problem, says Ingrid Garcés, a researcher from Chile's University of Antofagasta and a chemical civil engineer. Saline water pumped from the subsurface can affect freshwater levels in places nearby. The result: ongoing outcry among local communities. But so far, quantitative evidence has been scarce.

Cristina Dorador, a Chilean biologist who studies microbial life in the Atacama desert, says San Pedro de Atacama, Peine and other small towns are drying out. "It is a paradox in Chile. On one side we are talking about decarbonisation, [to mitigate] climate change and the loss of biodiversity and on

the other side we exploit the environment for resources to power the electric mobility revolution, [and] that supports climate change," she says.

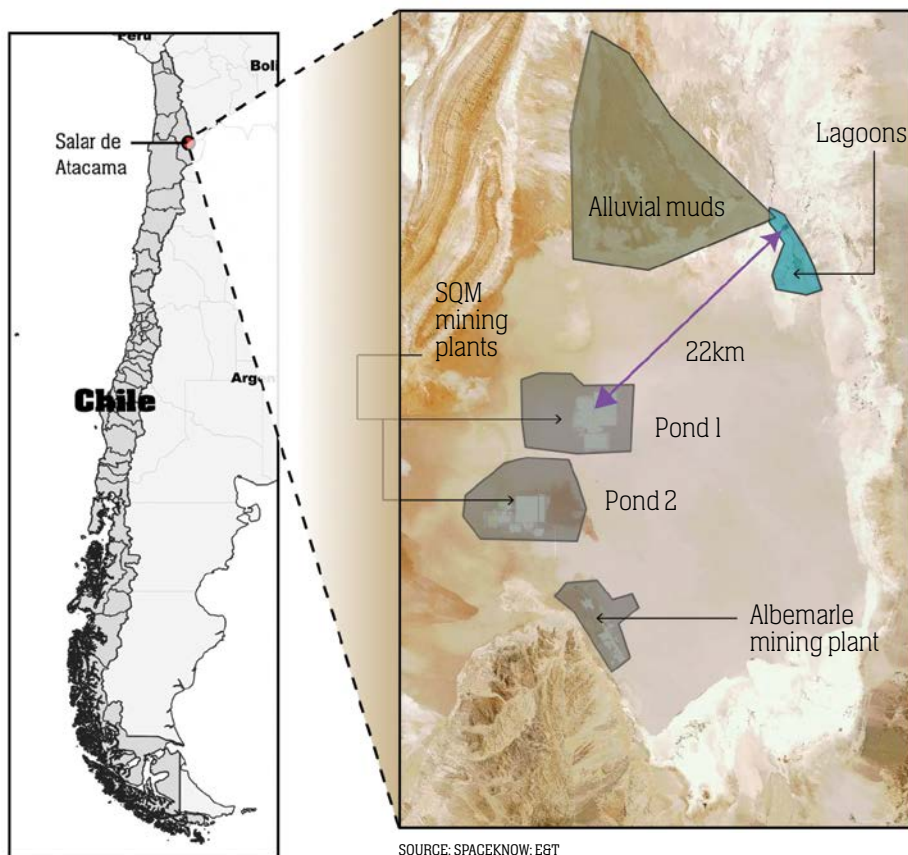
A collaboration between SpaceKnow and *E&T* has found strong inverse relationships between water reservoir levels at SQM's ponds and the lagoons. As water levels in SQM's ponds increased, those in lagoons would drop. SQM's first pond links to the fragile protected lagoons of the Soncor area, part of the Los Flamencos National Reserve – an important nesting ground for Andean flamingos. Its second pond correlated with water reservoirs in alluvial muds.

The statistical analysis confirms that as brine extraction operation expanded, nearby areas suffered environmental degradation.

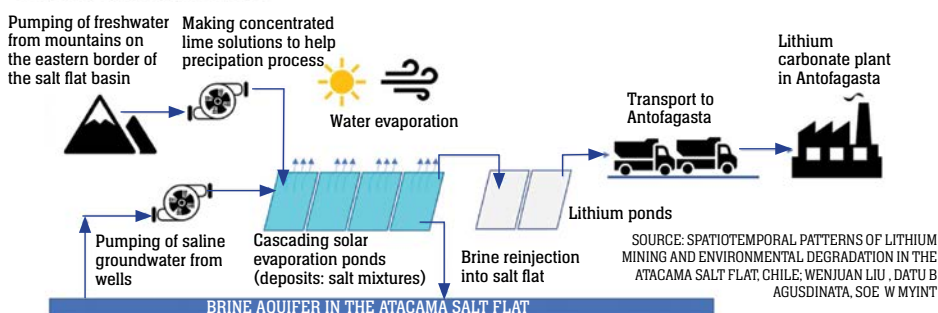
Chile's salt plains are a source of lithium-rich brine, but its extraction is endangering freshwater supplies

Study area: Salar de Atacama, Chile

The analysis compared the lithium production areas with nearby lagoons and alluvial muds



Lithium extraction process



Schematic representation of lithium extraction process. The brine is concentrated through chemical additives and evaporation by wind and solar energy. Lithium-concentrated salt is then transported to Antofagasta for further purification and production of lithium carbonate

It is an issue for both flamingos and microorganisms. Dorador says: "There is no recharge of the water in the Atacama salt flat. This isn't sustainable."

San Pedro-based Ramón Morales Balcázar from the Plurinational Observatory of Andean Salt Flats – a network of people from the communities, NGOs and universities in the region – says the only way to address the loss of water is by drastically cutting water extraction by the firms operating there.

Government figures issued by the Nonmetallic Mining Committee confirm that current extractive development in the basin of the Atacama salt flat creates hydrological imbalances. With a brine output of $8.8\text{m}^3/\text{s}$, and a recharge capacity of $6.8\text{m}^3/\text{s}$, it is $2.0\text{m}^3/\text{s}$ above the rechargeable threshold.

Adding to the concerns is the ambition by Chile's government to open up more land to brine mining, says Balcázar. "There are actually 59 salt flats in Chile, and the Ministry of Mining is now calling for their exploitation, as soon as possible."

Recently, Chile's environmental assessment service permitted Wealth Minerals Chile – a natural resources company concentrating on developing lithium brine property packages – to explore the northern part of Salar de Atacama. It is near a Ramsar site – a wetland site designated to be of international importance under the Ramsar Convention – as well as close to tourist attractions.

In August, state-owned Codelco (National Copper Corporation of Chile) and mining

company Minera Salar Blanco announced an agreement to explore the possibility of developing a lithium project at the Maricunga Salt Flat. *E&T* was told that this happened without any consultation with the indigenous Qulla communities. The corporations were also granted access to a national park area, the Nevado Tres Cruces and a Ramsar site – the Laguna Negro Francisco and Laguna Santa Rosa.

Scientific researchers at Arizona State University found that lithium mining in the area bore strong negative correlations with environmental degradation. Allowing for a booming tourism industry and a slight population increase, lithium brine-mining activity was still found to be a major environmental stressor. >

< There is also a link to climate change. Findings by the IPCC suggest that current levels of global warming are associated with moderate risks from increased dryland water scarcity, soil erosion, vegetation loss and wildlife damage. Some of these match the symptoms spotted in the Atacama salt flat study.

Despite watertight water-pumping rights, the corporations' alibi for causing damage with brine has flaws. Brine water consists of 70 per cent water and 30 per cent salt. Nonetheless, the Law of Mining still defines it as a mineral. The presence of bacteria and other living organisms in the brine sustaining life would also add weight to the scientific argument that salty water should be considered as water, activists argue.

SQM and Albemarle have held extraction rights for a long time. SQM's were given during a period of dictatorship more than four decades ago, and not under the current environmental law, Balcázar argues. He also laments that the members of the local community were not consulted about the rights to operate near their territories.

SQM is known to have great influence in government circles, but Chilean newspaper *La Nación* has reported several cases where people associated with the company have faced investigation or trial on matters such as tax evasion and bribery.

There is also a question of whether SQM knew about the damage its brine pumping operation had on freshwater reserves before independent studies reviewed it. The firm claimed in earlier reports that the lakes and salt flats were separate, isolated water systems and that brine and freshwater would not blend. Without an independent report, this was accepted until recently, when SQM acknowledged that there was some interaction between the systems.

The truth, that the two water systems do mix, jeopardising nearby freshwater reservoirs, came to light only after independent scientific studies began to publish their own results. However, Garcés says it is possible that SQM could have been aware of the fact earlier, given that the company had studied the area in detail.

Also, water scarcity problems in the Atacama salt flat should have been obvious to SQM six years ago, in 2013, when 32.4 per cent of the native Algarrobo trees on the company's property were found to be dying due to the effects of water shortages.

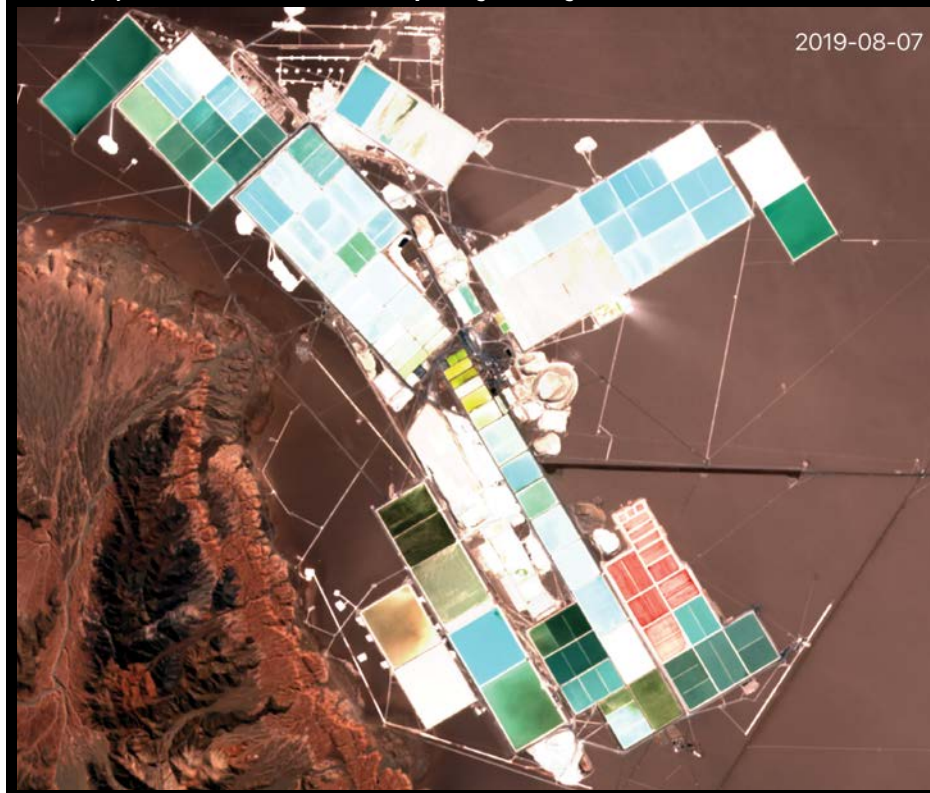
Now adding to the pressure on SQM is a new letter to the Chilean ministry of mining warning of staggering inefficiencies in the firm's lithium-mining process. The letter sent by a chemical engineer and seen by *E&T* cautions authorities that SQM's records for production do not correspond to the actual quantities delivered. Figures for the raw mineral and the final product simply do not add up, with the value of the difference amounting to several billion dollars. At the time of writing, the ministry has not responded to the letter, *E&T*'s source claims.

Garcés finds this worrying, and thinks exploitative pumping practices should be subject to sanctions, prosecutions and



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E&T worked with geospatial analytics firm SpaceKnow to investigate the effects of lithium brine mining in the Atacama salt flats. These satellite images, taken in 2015 and 2019, show the increase in activity by Albemarle, one of the two firms operating in the region.



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exemplary penalties – but she doesn't expect it to happen.

The strategy adopted by the other company in the region, Albemarle, is to hand out money to municipalities, local universities and communities, say people familiar with the topic.

"Albemarle gives money to all these communities in the Atacama salt flat, so they can solve basic problems inherited from centuries of systematic abandonment and discrimination by the state," according to Balcázar.

Garcés accuses the Chilean state of failing in its duty to oversee and protect assets that belong to all Chileans. "How is it possible that we have a General Water Directorate in

the region with one inspector?" she asks – though *E&T* has been told the directorate has subsequently added two more inspectors.

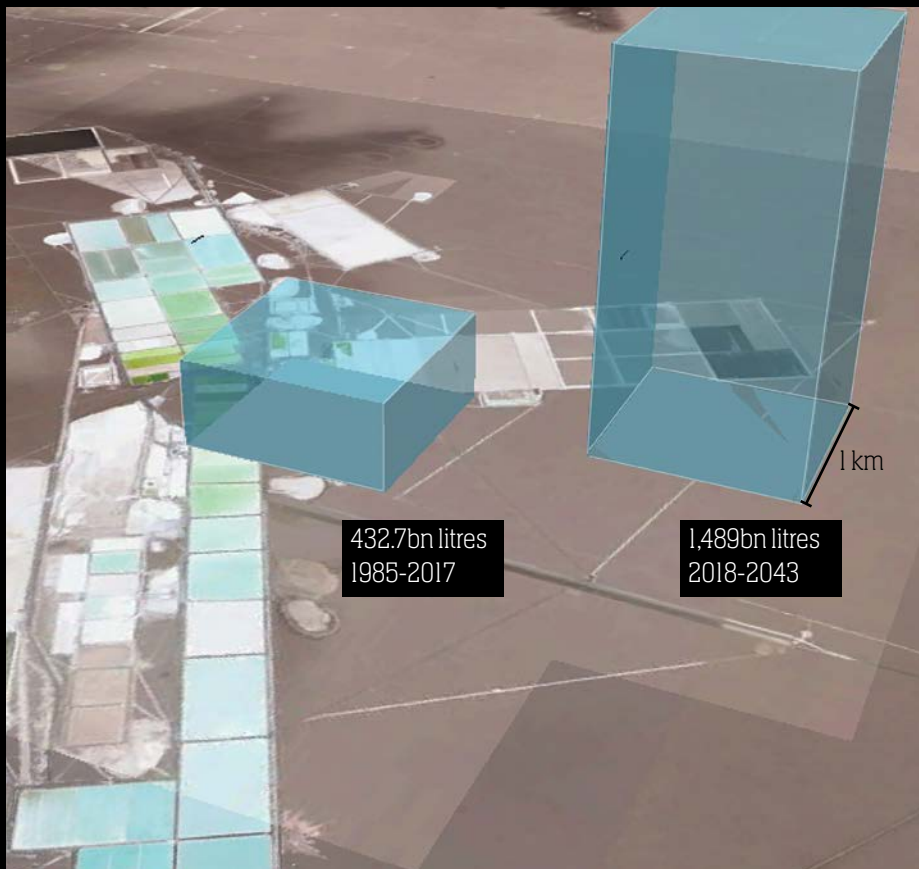
Market risk

As well as the risk of environmental degradation, brine-mining also carries a financial risk. Dr Rich Crane, a lecturer in sustainable mining at the University of Exeter's Camborne School of Mines, points out that the pools may require operation over several years, making them susceptible to the inherent boom-and-bust nature of the mining industry. "If the lithium price were to undergo a significant downturn then there could be a major problem," he says.

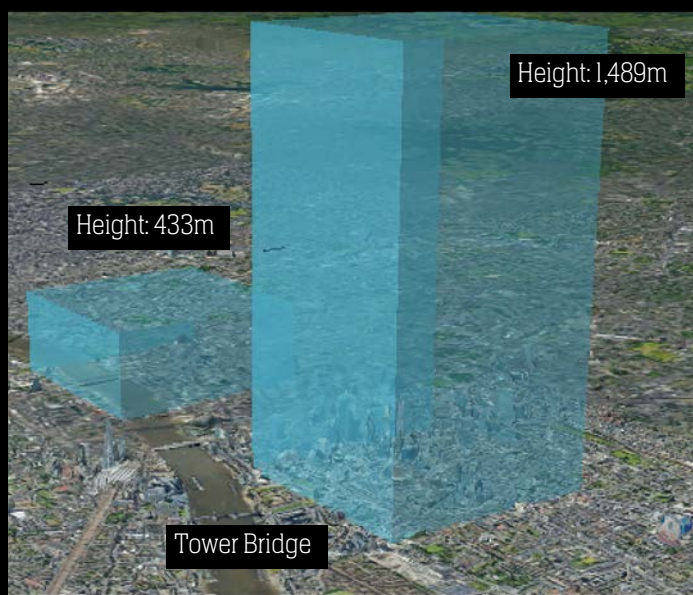
A recent backlash against extending

Comparison: water lost to the Sun

Comparison of how much water was and could be lost to evaporation in the process of lithium production by Albemarle Corporation* in the Atacama salt flat



Comparison: same water volumes when placed into geometry of London. The water block for future mining exploration is almost 1.5km in height



*ALBEMARLE'S EXTRACTION CONTRACTS PREVIOUSLY BELONGED TO SOCIEDAD CHILENA DEL LITIO. BEN HEUBL FOR E&T MAGAZINE; GOOGLE EARTH. CALCULATIONS BY E&T

companies' brine-mining production in 2016 and 2017 by Chilean regulators did sent ripple effects through financial markets, says Andrew Miller, head of price assessments at Benchmark Mineral Intelligence.

Albemarle is aiming to defend itself against commercial risk by diversifying its portfolio, such as through a joint venture with a lithium rock-mining operation in Australia. To convince regulators of its good intentions, Albemarle has also pledged to increase lithium mining efficiency.

Garcés remains highly sceptical of the latter. The lithium yield from brine-mining remains "brutally low to the present day", but this is hard to judge, as "they keep it a state secret". This ambiguity raises

questions about how much lithium is really lost to inefficient practice by operators. "Why so much secrecy if it is so easy to calculate it? It is not a matter of secret patented process," she adds.

In the case of Albemarle, *E&T* has been able to piece together an estimate that 433 billion litres of water has been removed from the environment over the course of the past three decades. This is based on the assumption that two million litres of water are lost for each tonne of lithium extracted.

If that volume of water was laid out with a kilometre-square footprint across the City of London, the block would be nearly half a kilometre tall (see graphic). The amount would also rival the annual freshwater

withdrawal rates of small countries like Papua New Guinea.

Applying the same method of calculation to projections for Albemarle's lithium extraction between 2018 and 2043, 1.5 trillion litres of water may be at stake within the Atacama salt flat over that period. With SQM pumping nearly four times as much brine as Albemarle, it is not unreasonable to assume that rates could be much higher.

Both companies were invited to comment on *E&T*'s findings. Albemarle responded on several points, but SQM has yet to reply.

Albemarle told us that it updated its hydrogeological model of the Salar de Atacama in March with the measurements of the last few years, making it the most up-to-date tool, and that it "serves as a basis for authorities, communities and other companies with operations in the area".

While it did not mention monetary payments in its statement, the company confirms it has established a "series of voluntary commitments with the authority to ensure the proper care of the Salar ecosystem", entailing "a monitoring system of 150 wells in the Salar basin and a permanent plan for water and lake level monitoring, flamingo monitoring and an Early Warning Plan". All of this would be "always available to the authority and the communities", Albemarle said, adding: "We all benefit from sustainable management of the Salar de Atacama."

Cleaner processes needed urgently

Chile's aspiration to toughen regulation is high but action remains scarce. In January, after an investigation found SQM overdraw lithium-rich brine, the environmental regulator accepted a compliance plan featuring an online system to monitor SQM's extraction rates as well as its use of fresh water alongside its industrial process. Many people doubt that this is enough.

Access to unbiased information is another concern. "The state doesn't have its own models," says Balcázar. "If you don't know the real damage, you cannot regulate it."

But there is still hope. In May, the Atacama People's Council built a monitoring station in a lagoon on the salt flat – the first in a series to continuously monitor water levels, as opposed to the monthly measurements overseen by mining companies.

Garcés argues that instead of increasing their brine-pumping quotas, companies must replace the current evaporation process in the pools with a truly sustainable one.

Cleaner lithium-mining processes are being developed, as Dr Crane explains: "Solutions include electrodialysis, nanofiltration and adsorption, and graphene-based filtration approaches."

From a market perspective, new technical developments are urgently needed, says analyst Miller. Even if expected investments are fulfilled, he thinks a lithium deficit is likely for 2023. Processes in development that may not be commercial today could add that "critical extra bit to the lithium supply balance in the next couple of years" when electric vehicle penetration really kicks off. *