POLICY PAPER

LITHIUM: RECOMMENDATIONS FOR SALT FLAT GOVERNANCE IN CHILE

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ESPACIO PÚBLICO

This version has been prepared based on the information available until November 24th, 2023. Regarding the first published version, it includes technical clarifications regarding the water balance of the Atacama salt flat and other formal changes.

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ABOUT THIS DOCUMENT

This document aims to promote the governance of salt flats, based on the principles of just social-ecological transition, through the development of public policy recommendations for the sustainable exploitation of lithium in Chile. This report was prepared by Rodrigo Guerrero and Matias Piña, researchers at Espacio Público, with the collaboration of Annie Dufey and Marcela Angulo, board members of Espacio Público. It was supported by the Open Society Foundations.

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1. INTRODUCTION

Addressing climate change stands as one of the primary challenges our societies are currently grappling with. From the point of view of mitigation, climate multilateral organizations have decided to reduce global greenhouse gas (GHG) emissions by decarbonizing energy matrices, a strategy known as the "global energy transition". A direct consequence of this agreement is that, in recent years, global investment in low GHG-emission energy technologies has boosted demand for critical minerals. Among these critical minerals is lithium, which stands out due to its importance for the manufacture of rechargeable batteries, electronic goods and, in particular, for the boost it gives to electromobility.

After Australia, which today leads lithium production worldwide with 43% market share, our country is positioned as the second largest producer of the mineral, with 34%. A share that, however, has gradually decreased, as Chile was considered in 2016 the largest producer country in the world by reaching 41% of the world rate[1]. However, during 2022 the mineral experienced a superlative increase in its demand, increasing lithium physical sales from Chile to foreign countries by 777% compared to 2021.

Our country extracts lithium from the high Andean wetlands of the Atacama Desert, among which the Atacama salt flat stands out, as it is home to one of the largest reserves of this mineral in the world. The salt flats are ecosystems recognized both for their biodiversity value, and their socio-environmental fragility as well as for their fundamental role in the hydrological basins to which they belong. Specifically, this salt flat is essential for the town of San Pedro de Atacama, not only from the hydric point of view, but also for the activities it sustains, such as tourism and cattle raising. Likewise, the Atacama salt flat has historically been linked to the way of life and worldview of the Lickan Antay communities that live nearby. For these reasons, lithium exploitation is highly sensitive from an ecological and social point of view.

Beyond mitigation, climate change requires adaptation to the impacts already being felt in the territories, including drought and the loss of ecosystem biodiversity. This dimension demands the development of economic activities that respect local ecosystem limits and, at the same time, governance that integrates regional and national governmental actors and civil society, basing public and private decisions on scientific evidence.

In order to respond to these challenges, in early 2023 Chile presented the National Lithium Strategy, which seeks to take advantage of the productive potential of lithium, through public-private partnerships, new technologies and productive chains, while seeking to ensure socio-environmental sustainability conditions. It is a proposal to articulate and project the sustainable development of the sector, in a period in which the State has not been able to update its guidelines or the respective legal framework.

[1] In 2016, Chile produced 82 kt of Lithium Carbonate Equivalent, out of a world total of 195 kt.

Although the definitions of this policy are still awaiting the results of citizen participation processes, it is aligned with previous instruments, such as the Long-Term Climate Strategy, in which the country proposed lithium management as one of its "cornerstones" to achieve carbon neutrality. Along the same vein, the Chilean State has promoted the concept of Socioecological Just Transition to coordinate its climate action (see box 1), so it is to be expected that the development of an economic activity as relevant as lithium exploitation will be able to incorporate these principles in its planning and execution of its operations.

Based on these elements, **crucial governance challenges[2] arise for the development of the lithium industry in Chile**. To address them, this paper takes the salt flat of Atacama as a case study. In this sense, chapter two proposes a description of the lithium value chain, its national institutional framework and its production process; the third chapter describes the Atacama salt flat, emphasizing the water balance and the interethnic governance system of the basin; finally, an assessment of the governance of the Atacama salt flat is made and recommendations for the implementation of public policies are proposed, aiming at safeguarding the fairness of lithium exploitation in Chile.

BOX 1:
CHILE AND THE SOCIO-ECOLOGICAL JUST TRANSITION

The current boom cycle of critical minerals, most notably lithium, is due to the world's efforts to drive the global worldwide efforts to drive the global energy transition to decarbonized societies. As part of this trend, in 2022 -and under the framework of the COP 27 of the United Nations Framework Convention on Climate Change, Chile presented its most recent update of its Nationally Determined Contributions (NDCs), which incorporated the notion of Socio-Ecological Just Transition as one of its central concepts.

This was defined as the pursuit of societal transformation to a resilient and equitable model that can cope with the social, ecological and climate crisis, by three main axes:

- The transition requires that in the territories the productive sectors are innovative and sustainable.
- The transition must be carried out by ensuring decent work, gender equality, and territorial and intergenerational equity, climate resilience, and social and environmental justice.
- The goal of the transition is ecological balance and the physical, mental and social well-being of people.

[2] We define governance as the subsystem that includes the political, economic and social institutions, formal and informal, through which social actors negotiate access to and use of social and natural resources. The importance of this subsystem lies in its capacity to describe the "way in which society organizes itself to solve its dilemmas and create new opportunities" and, therefore, it aims to strengthen the capacities for anticipation and adaptive response of ecosystem management based on the human factor.

2. LITHIUM AND ITS EXPLOITATION IN CHILE

A. GLOBAL VALUE CHAIN

In the global energy transition scenario, the main source of lithium demand comes from so-called energy storage applications in lithium-ion batteries, as opposed to industrial applications. In fact, the lithium demanded in 2015 was distributed 65% for industrial applications and 35% for batteries. But in 2019, 57% of the lithium was for battery applications and only 43% for industrial applications. Thus, it can be seen that in recent years, global demand for lithium has been driven by the battery market, especially by the electromobility industry (electric vehicles, buses, electric bicycles, etc.).

In 2010, the demand for lithium associated with electromobility was 5.1 kt of lithium carbonate equivalent (LCE), experiencing steady growth to 42.6 kt in 2016 and, later on, to 304 kt in 2021. From there, its demand is estimated to approach 3,177 kt by 2035. If we take into account that in the same year the overall demand for lithium is projected at 3,828 kt, we can confirm how the development of the lithium industry is conditioned by this sector.

Globally, the demand for raw materials such as lithium has led to international competition for control of the supply chain. In fact, in 2022, the *Mineral Security Partnership* was created between the governments of Australia, Canada, Finland, France, Germany, Japan, Korea, Sweden, the United States, Great Britain and the European Union (represented by the European Commission). This alliance seeks to strengthen the supply chains of critical minerals[3] especially those linked to advanced batteries and electromobility.

However, China is the world leader, accounting for 55% of global lithium demand in 2022, followed by the European Union (21%) and North America (14%). In turn, China accounted for 77% of battery manufacturing capacity. Following the same trend, the Asian country was the main buyer of lithium from Chile during the last year: 76% of lithium carbonate exports went to China, 11% to South Korea and 7% to Japan. Consequently, China's supremacy in the battery industry is viewed with caution by countries interested in competing in the electromobility and renewable energy market, as well as by those that depend on it as the main buyer of strategic resources.

Lithium is an abundant material in the world, extracted from rocks and brine from salt flats. In the case of Chile, lithium products are made from brine extracted from the Atacama salt flat, with value-added products accounting for the largest proportion of exports, such as battery grade lithium carbonate and

[3] "Critical" has been defined as those mineral resources for which demand is increasing - in the context of the global energy transition - due to their use in clean energy technology and, at the same time, whose supply may be conditioned by factors such as limited availability, number of producers or supply bottlenecks in supply chains.

lithium hydroxide, which are mainly used as an input in the production of battery cathodes. Countries such as Australia, on the other hand, export lithium as spodumene concentrate, which must then be processed in the destination countries for the production of lithium carbonate or hydroxide. In this regard, it should be noted that China also controls 55-60% of spodumene/brine[4] processing and refining worldwide.

From the point of view of lithium extraction, international production has historically been concentrated in the hands of a few companies, most notably the US companies Livent and Albemarle[5], as well as the Chilean company SQM[6]. In 2009, the production capacity of this triad represented 80% of the world market. However, in 2017 this figure fell to 43%, as a result of the irruption in the Chinese capital market through Tianqi Lithium and Gangfeng Lithium[7]. This is in line with the Chinese investment strategy, by investing in key resources for the renewable energy industry.

The increase in demand has been accompanied by a significant rise in prices, through a jump from $7,950 USD/t in December 2020 to $62,000 USD/t in December 2022 for LCE (+680%), and from $10,075 to $62,000 USD/t for hydroxide over the same period (+515%). However, current mineral demand and prices respond to a cyclical and transitory character, as already happened in 2003-2014. Thus, the new lithium super cycle brings with it already known economic dynamics: **the bonanza in sales prices drives governments' interest in maximizing tax revenues, since economic rents are amplified during periods of high prices, but -since the price increase is in response to expected excess demand - it also imposes pressures on the industry by investors and related companies, to speed up the availability of exploitable resources.** Taken together, these interests result in a structural tension between the impact on local ecosystems, the enhancement of global climate action, and the interest of states in maximizing the capture of ricardian rents.

Although there are developments of batteries with alternative inputs, such as sodium batteries, these have a much higher energy density, which in the short and medium term hinders their use in electromobility at least. On the other hand, the recycling of lithium batteries will increase the supply in the medium term. Therefore, new projects are being developed to respond to the projected increase in demand: it is estimated that in the next decade, prices will tend to the long-term marginal cost of marginal producers to meet demand, which should not exceed USD 20 thousand per ton of LCE. In fact, it is estimated that the battery market will reach a value of USD 300 billion by 2030, while the demand for lithium hydroxide

[4] he energy requirements for the refining of spodumene concentrate are particularly high, as coal is used for heat generation. In turn, the Chinese energy matrix is largely supplied by GHG-intensive sources, such as coal. For example, the production of one ton of lithium hydroxide -from spodumene concentrate in China- emits three times more CO_2 (15 $tCO_2/tLiOH$) than that emitted in Chile from brine processing (5 $tCO_2/tLiOH$).

[5] Albemarle Ltda. is a company of U.S. origin, which is jointly owned by Foote Minera e Inversiones Ltda. (45%) and Albemarle US Inc. (55%), the latter being the world's largest lithium producer, with operations in Australia, China and Chile. It acquired its name in 2015, after its acquisition from Rockwood Holdings, but its origins date back to 1984 when Corfo and Foote Minera promoted the exploitation of lithium in the La Negra industrial park.

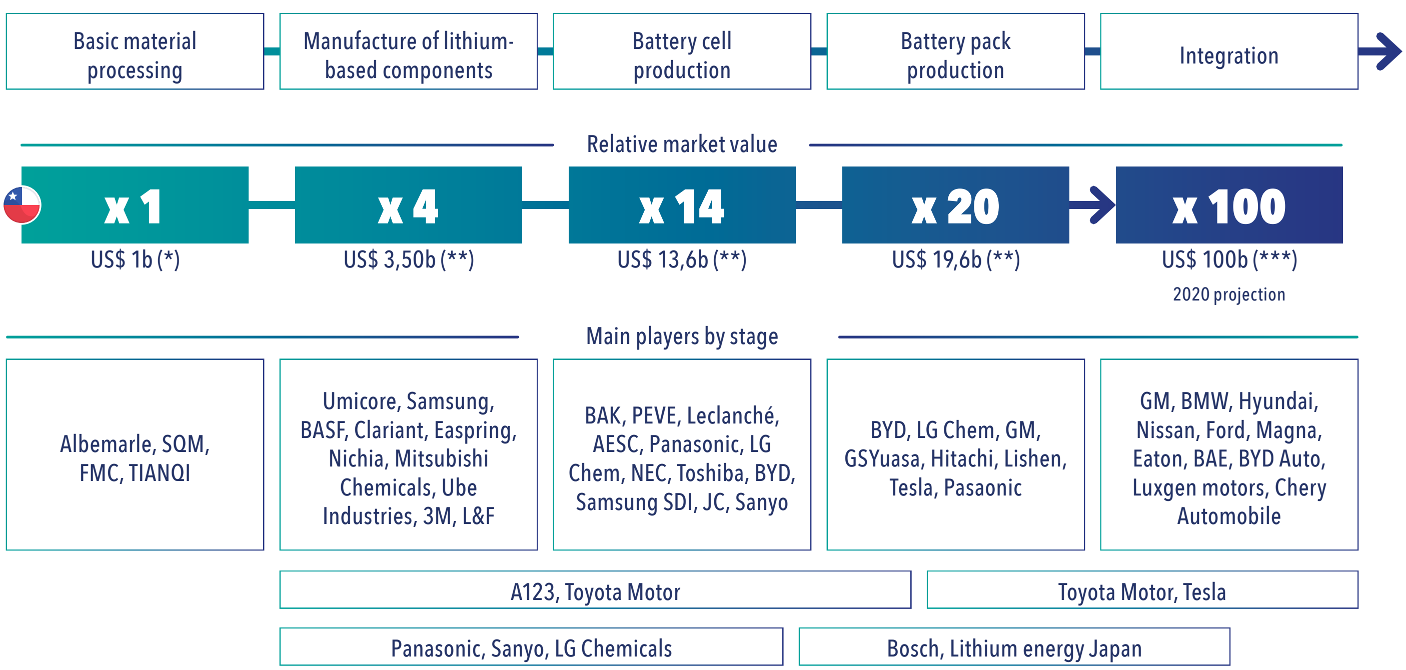
[6] SQM (Sociedad Química y Minera de Chile S.A.) is a company of Chilean origin, dedicated to specialized plant nutrition, iodine and derivatives, lithium and derivatives, potassium and industrial chemicals, operating in 20 countries. Its origin dates back to 1968, when it was founded with mixed capital between the State of Chile and the company Anglo Lautaro S.A., to reorganize the remnants of the saltpeter industry in the Atacama Desert. In 1971 it was nationalized, maintaining this condition until 1983, when it was finally privatized.

[7] It is worth noting that in 2018 Tianqi Lithium, of Chinese capital, acquired a 24% stake in SQM, which led the National Economic Prosecutor's Office to impose restrictions, considering that the structural relationships between Tianqi, SQM and Albemarle "would create risks of a coordinated nature in the lithium carbonate and lithium hydroxide markets", measures that remain in place since 2018 until today.

and lithium carbonate will increase more than 15 and 3 times, respectively, by 2030. This boom seems to benefit Chile and the other countries of the so-called "lithium triangle", completed by Argentina and Bolivia, as they have a comparative advantage in lithium extraction due to the high concentration levels of the mineral in brines from the Atacama puna and relatively low refining costs (see box 2).

However, lithium only represents between 4% and 7% of the total value of a lithium battery (see figure 1). This implies a lower share of lithium exporting countries in the value added in the entire battery production value chain. Similarly, despite the demand boom, it is considered that one of the main risks facing the electric vehicle market, and which will have a knock-on effect on lithium values, is a decline in prices in the medium term.

Figure 1. Chain diagram and magnitude of lithium value as of 2016.



Source: Prepared based on information published by Corfo (2016).

BOX 2:
GLOBAL SUPPLY CHAIN FOR LITHIUM-ION BATTERIES

Chile is integrated into the global supply chain as a supplier of raw materials for batteries through lithium and its derivatives (mainly lithium carbonate and lithium hydroxide). The country has a competitive advantage in this market because the costs of brine operations are less intensive in capital and work. The production of lithium carbonate from brines has a cost that varies between USD 3,600-5,000, while the costs of producing it from rock ore range from US$4,200-5,200/tonne. In particular, the Atacama salt flat has high lithium concentrations in its brines and good climatic conditions (high radiation and low precipitation) for the evaporitic process.

The commercial flow of battery manufacturing corresponds to a globalized process, with a significant global exchange of raw materials, where lithium stands out, but it also requires other raw materials such as nickel, cobalt and manganese. While the process of extracting these raw materials is geographically dispersed, the centers of demand for lithium-ion batteries are highly regionalized, with China, Korea, Japan, Europe and the United States standing out. This process consists of four main stages: preparation of precursors, cathode sintering, cell manufacturing and battery packaging assembly.

Each of the four stages is clearly differentiated; however, in recent years there has been a trend towards vertical integration of the different processes in the chain by the large manufacturers, with the aim of reducing costs and generating a productive industry that is geographically close to the final consumers of batteries. Thus, the value chain, once the raw materials have been secured, tends to become more regionalized and complex, adding greater value at each of its subsequent stages (see Figure 1).

B. MARCO INSTITUCIONAL

The exploitation of lithium in Chile can be arranged in four historical periods, linked to institutional and administrative milestones:

- **Period 1970-1983:** In the framework of the Cold War, lithium was classified as a "strategic resource", given the nuclear race that was underway. Since 1979, lithium acquires a reserved status, not concessionable and excluded from the mining property regime in force in the country, which is still in force today.

- **Period 1984-2004:** The privatization of lithium exploitation coincided with the increase in international demand, first from the United States and Europe, and then from China, which positioned the country as the world's leading producer in 1997.

• **Period 2005-2013:** During these years, lithium acquired a new momentum, gaining relevance within the political agenda, in order to establish a planning for the growing world demand and to achieve environmental sustainability in its exploitation. However, this process failed to materialize in any concrete policy and a concentrated and limited structure of private lithium exploitation was maintained, with little state participation.

• **2014 onwards:** during the last decade, the commercial boom of lithium has been consolidated, pushed by global decarbonization goals. Within this time, the main milestones have been the creation of the Comisión Nacional del Litio; the renegotiation of contracts between Corfo and the companies Albemarle and SQM; the failed drive to tender new exploitation contracts; and the publication of the bases of the National Lithium Strategy. Throughout this period, the different governments have not been able to promote a State policy on lithium, and there are great differences, especially in the role of the State in its exploitation.

These periods are characterized by processes of greater scale and scope that defined, at a structural level, the institutional framework and economic geography of the country. Thus, during the dictatorial period (1973-1990), the 1981 Water Code, which privatized water management, and the 1983 Mining Code, which promoted foreign investment, precisely in territories such as the arid north, stand out. Thus, since the end of the last century, the interest of capital in resources such as copper and lithium has spread, with prominent investors being the Australian mining company BHP Billiton through Minera Escondida, and the Chilean company Antofagasta Minerals through Compañía Minera Zaldívar.

Over the last four decades, the regulatory instruments on lithium have remained unchanged. Its current administration is considered to be an exception within the mining regulations, as it is defined by two milestones that explain its management up to date: First, in 1976 and marked by the Cold War context, when the Organic Law of the Chilean Nuclear Energy Commission (CCHEN) was modified through Decree Law No. 1557 to declare lithium a material of "nuclear interest"; and second, in 1979, when it was decided to reserve this resource for the State through Decree Law No. 2886, granting CCHEN the power to authorize the exploitation of lithium and declaring it as a non-concessionable mineral. A third milestone can be added, in 1982, when the Organic Constitutional Law on Mining Concessions was approved, ratifying the non-concessionability of lithium for mining[8]. Since then, it can only be exploited directly by the State and its companies, or through administrative concessions and special operation contracts (Contratos Especiales de Operación, CEOL).

Despite the public policy recommendations made in 2014 by the Comisión Nacional del Litio[9], the different governments have not been able to give continuity to the respective guidelines, nor to update their legal framework, evidencing a lack of State vision on how to exploit this mineral. **With a historical perspective, the renegotiation of contracts between Corfo and the companies Albemarle and SQM in 2016 and 2018 has laid the foundations of contemporary governance in the Atacama salt flat** (see box 3).

[8] However, based on the principle of legal stability, it excludes mining titles granted before January 1, 1979, an exception that excludes lithium mining titles granted by Corfo and that would later be ratified by the Mining Code in 1983.

[9] The commission was created in 2014 as a high-level technical body, aiming to generate guidelines for a National Lithium Policy. Among its main proposals were the maintenance of the non-concessional nature of lithium and its elevation to constitutional status; the strengthening of the role of the State as owner of the resources, through greater participation in the exploitation and capture of mineral revenues; the creation of a company controlled by the State, favoring a public-private associative business model; and the strengthening of the institutional framework linked to the governance of the salt flats. In the short term, one of the main recommendations that was effectively carried out was the review of the lithium exploitation contracts of SQM and Rockwood (now Albemarle).

BOX 3:
RENEGOTIATION OF CONTRACTS BETWEEN CORFO, ALBEMARLE AND SQM

During 2016 and 2018, the State negotiated the update of the operation contracts of the companies Albemarle and SQM, respectively. These contracts have laid the foundations for the current governance of the territory and the lithium management model in Chile, through the incorporation of new provisions regarding the redistribution of mineral rents and improving the conditions of its use for the State:

- Within the new conditions of the Basic Agreement signed by **Rockwood Lithium Inc. (currently Albemarle)** and Corfo, a fixed term of up to 27 years was established for terminating the exploitation rights (from January 1, 2017 to January 1, 2044); a new lithium metal equivalent quota of up to 262. 132 tons; the payment of progressive, variable and incremental fees depending on the lithium price of 6.8% up to 40%; permanent financial contributions for R&D; preferential lithium prices for producers located in national territory of up to 25% of the annual production capacity; and the contribution to the Consejo de Pueblos Atacameños for 3.5% of annual sales. In addition, the importance of the previously signed agreements with local stakeholders in the basin: i) Cooperation, sustainability and benefit agreement with the Consejo de Pueblos Atacameños, the Comunidad Atacameña Río Grande and Others; ii) Cooperation, sustainability and mutual benefit agreement with the indigenous community of Peine; and iii) Framework Cooperation Agreement with the Illustrious Municipality of San Pedro de Atacama.

- In 2018, after an extensive process of legal disputes and arbitration, the modification of the two lease and project agreements between Corfo and **SQM**[10] [11] was signed, having as background the agreements reached with Rockwood. Among the conditions set are to maintain the operation term until Decezmber 31, 2030; a new lithium metal equivalent quota of up to 349,553 tons; the payment of progressive, variable and incremental commissions depending on the price of lithium from 6.8% to 40%; permanent financial contributions for R&D; annual contributions to the Regional Government of Antofagasta and the municipalities of Antofagasta, San Pedro de Atacama and María Elena; and fixed contributions to the communities.

[10] During the last decades, SQM has been involved in several controversies, among which stands out its link to the so-called "Penta case", accused by the Public Prosecutor's Office for crimes ranging from tax fraud to bribery. At the same time, since 2010, the company has been facing litigation due to possible anomalies in the calculation of income payments to Corfo for its lithium operations. These tensions led to the renegotiation in 2018. It should be noted that, because of these disputes, the legitimacy of this company to negotiate with the State has been questioned by various stakeholders.

[11] Although this negotiation did not modify the brine extraction authorizations in any way, Corfo became part of the accusations of a very serious environmental infraction against SQM, before which the compliance plan implied a commitment to reduce SQM's brine extraction from 1700 l/s authorized in its RCA to 820 l/s by 2028. In addition, the creation of the Corfo Salt Flat Governance Committee made it possible to conduct the first hydrological study of the entire basin. The Lithium Technological Institute was also created, financed by SQM royalties, to evaluate new production technologies with less water use.

The modification of Corfo's respective lease contracts with these companies has allowed the State of Chile to obtain higher revenues by leveraging the current lithium super cycle, reaching an extraordinary peak of around USD 5.5 billion in 2022 in tax revenues[12] and leasing to private companies, which corresponds to 1.9% of GDP and 7.2% of total fiscal revenues for that year. However, the economic contributions to the communities have also led to conflicts between and within them.

On the other hand, the lithium fiscal regime has been questioned for its opacity, since -despite it being possible to know the gross figures of its operation- the State is prevented from disclosing individualized information on the profits, losses and expenses of the companies linked to the exploitation of lithium, which extends to the taxes paid[13]. This information has been protected on grounds of "tax secrecy", hindering the conditions for an informed public discussion, based on the rule of reserve contained in the Tax Code.

This renegotiation consolidates a model to seek the "social license" of communities and local governments with respect to the development of investment projects, establishing commitments that, although fundamentally economic, are presented as links of partnership and participation. This model, although it still entails governance challenges and development benefits for the communities, has been presented as a shared value paradigm, as it seeks to accommodate the autonomous development of the partners. This was, in fact, promoted by the Comisión Nacional del Litio, which sought to recognize the right of communities not only to receive benefits for the use of public goods, but also to be compensated for damages received.

To date, it has not yet been possible to consolidate a State policy regarding lithium. This has become evident after the failed efforts to promote several exploitation initiatives, such as the tender awarded by SQM in 2012, invalidated due to the existence of vices in the process; or the 2022 tender to exploit and commercialize this mineral, denied to the companies BYD Chile SpA and Servicios y Operaciones Mineras del Norte SA, for not including a prior indigenous consultation. Similarly, Corfo's efforts to bid for the Clean Technologies Institute also faced difficulties, as it described a failed first bidding process and was only awarded in 2023 to the consortium Asociación para el Desarrollo del Instituto Tecnológico (ASDIT)[14]. It should be noted that the Circular Economy Research Center was awarded in 2019 and has been under execution since 2021.

Finally, during the year 2023, the bases of the National Lithium Strategy were published, which offered guidelines for a State policy on the matter, organized on the basis of five strategic definitions:

- ***Empresa Nacional del Litio* and State involvement in the entire industrial cycle:** The aim is for the State to play a more active role in the entire lithium production cycle (exploration, exploitation and manufacturing). Thus, it is proposed that the preferred vehicle for state participation in projects considered "strategic" will be the

[12] Currently, the lithium tax regime is broken down into the following instruments: Profits Tax (ISU, by its Spanish acronym); lease rent (or *ad valorem* royalty); Specific Tax on Mining Activity (IEAM by its Spanish acronym); mining patents; contribution for regional development, although this is frozen as an economic reactivation measure; and contributions for R&D, as well as direct contributions to communities, which were incorporated after the renegotiation of contracts with Albemarle and SQM.

[13] Although the creation of the IEAM established the obligation for taxable companies to present their financial statements, this obligation is only for companies that signed tax invariability contracts, which is why companies such as Albemarle are exempt from this responsibility.

[14] Its development includes financing of USD 125 million, coming from the contract between SQM and Corfo. Over the next decade, the institute will focus on the innovation and development of clean energy, such as solar and green hydrogen, and sustainable mining. Its headquarters will be in Antofagasta and will have a strong regional development component.

Empresa Nacional del Litio. However, until this is created, the state-owned companies Codelco and Enami will be responsible for creating subsidiaries for this purpose. At the same time, it is proposed to promote a Lithium and Salt Flats Committee, under the authority of Corfo, in charge of preparing and implementing scientific-technological and industrial development policies.

• **Capacity building:** Currently there are several information gaps regarding the exploitation of lithium and salt flats, therefore the strategy seeks to create a Lithium and Salt Flats Public Technological and Research Institute for the generation of knowledge and information on lithium, salt flats and the value chain associated with the mineral. This institute will be responsible for centralizing the cadasters of each salt flat, with which the Corfo Committee will determine whether a salt flat will be considered industrially strategic or whether it will be preserved.

• **Public-private partnership:** Through joint ventures, majority controlled by the State, the partnership between the State and the private sector is considered fundamental for the management of current and future operations. Thus, new special lithium operating contracts (CEOL) will be opened.

• **Institutional framework:** An update of the current institutional framework will be promoted to close gaps in regulations, oversight bodies and relations between the central government and regional/communal governments, which will allow the development and growth of the industry with a minimum impact on the salt flats ecosystems and on the communities and indigenous peoples.

• **Social and territorial sustainability:** Dialogue and participation processes will be initiated with the different actors involved in the lithium industry, including indigenous communities. The processes will be carried out under the framework of international agreements such as ILO Convention 169 and the Escazú Agreement. The strategy also contemplates the creation of a Network of Protected Salt Flats to protect at least 30% of these ecosystems by 2030, as established in the most recent Framework Convention on Biodiversity.

Thus, the strategy places three public bodies at the center of governance: Corfo, as administrator of the contracts and promoter of the Lithium and Salt Flats Committee for interministerial coordination; the Technological and Public Research Institute for Lithium and Salt Flats, as a transversal scientific platform; and the public companies CODELCO and ENAMI, as well as the potential *Empresa Nacional del Litio*. Regarding the latter, it should be noted that the government has emphasized that it will respect the terms established in the contracts with Albemarle and SQM, using them as references for new joint ventures that consider a majority state participation (under the formula 50%+1, in the salt flats that it defines as strategic).

Despite the need to project an industrial strategy for the sector in the long term, these guidelines do not seem to reach consensus. Differences persist among the different political actors, especially with respect to the role of the State in the exploitation of lithium and, in particular, with respect to the relevance of State companies or subsidiaries to exploit the so-called "strategic salt flats". The lack of involvement of subnational governments in the design of the strategy, as well as the lack of early citizen participation, are also among the questions raised. In this scenario, it is worth highlighting three public policy objectives that should be considered for the evaluation of the different management models:

1. Appropriation and participation of rents in a timely manner: The boost to new exploitation projects must be in accordance with the temporality of the demand cycle and international prices, in order to take advantage of their benefits within the horizon defined until 2030. Regarding strategic salt flats, the Atacama salt flat concentrates the greatest interest in exploitation.

2. Environmental sustainability and community participation: Following the Global Biodiversity Framework, in order to promote new projects, specific criteria must be defined to preserve or restore the integrity, connectivity and resilience of the salt flats, as well as justice with the communities, not only from an economic point of view, but also safeguarding the principle of justice between generations. This requires agility in the promotion of the Comisión del Litio y Salares, as well as the Instituto Tecnológico Público, in order to complete the conservation objectives of 30% of these ecosystems.

3. Integration in the value chains: That is, to promote the insertion in more advanced links of the battery industry, aiming at higher levels of refining and complexity to generate regionalized linkages.

Promoting joint ventures in strategic salt flats would hypothetically allow higher capture percentages but would increase the investment risk for the private sector, given the influence of political cycles and the governance difficulties associated with the management of the company. Strategic salt flats other than the salt flat of Atacama become relevant in the medium term, to the extent that their exploitation is promoted. If the State maintains a dominant role, the tension described above will increase in these territories.

It should be noted that the formulation of the bases of the present strategy did not consider consultations with the indigenous communities or with the sub-national levels of government in advance, and for this reason it has been questioned. Although this process will begin this year, it is still pending that the various stakeholders can participate and refer to both the relevance of each mining project and its characteristics, making transparent the level of incidence and the stages of participation.

At the same time, it should be noted that state-owned companies, not only private ones, also encounter resistance in the territories, as their historical performance has caused significant environmental damage, such as the contamination of the Loa River in 1997. Therefore, public leadership must push for the development of more efficient technologies, applying the best environmental, social and corporate governance practices.

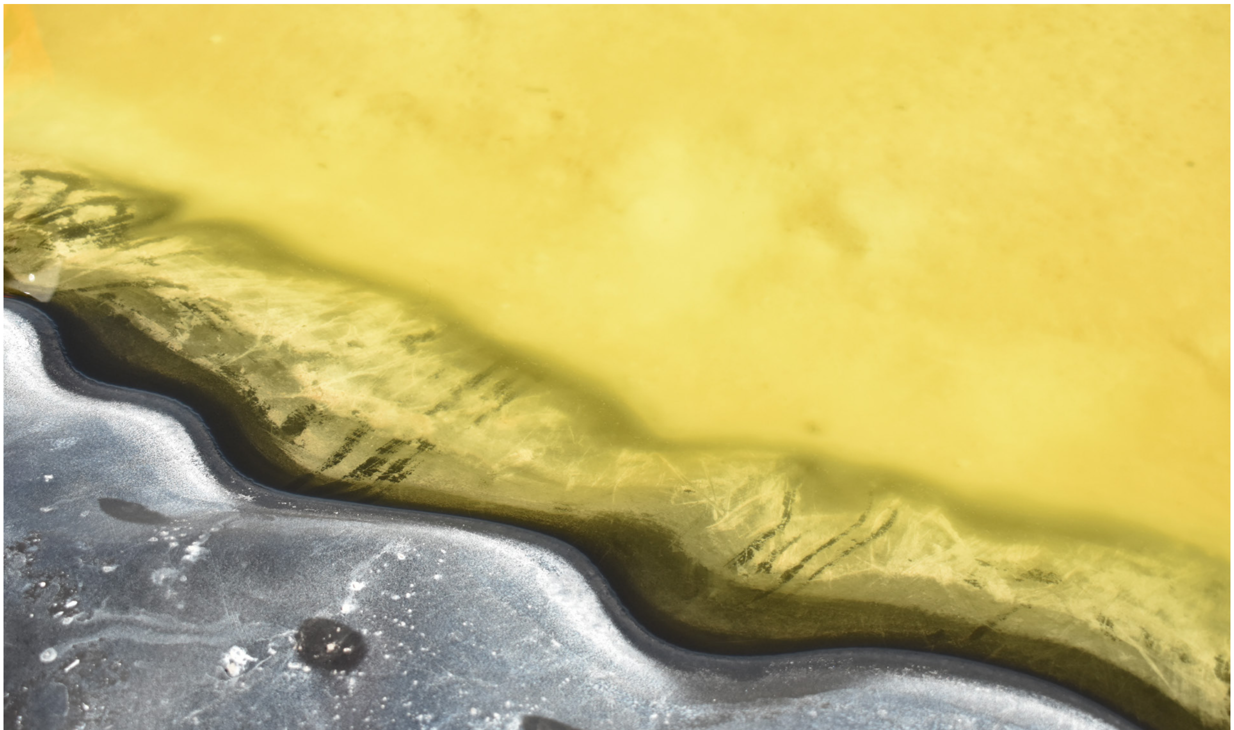
C. EXTRACTION PROCESS

Lithium is a non-metallic mineral that can be found in various sources: clays, rocks, brines and seawater; this makes the mineral an abundant resource in nature. However, the technological feasibility of its extraction considers only the commercial relevance of lithium, which is obtained from pegmatite rocks and granites (26% of the world's total) or from salt flats in endorheic basins (58%). The rest is obtained from clays and geothermal or hydrocarbon brines, representing approximately 13% of total world reserves.

Chile participates with 36% of the world's lithium reserves, concentrating 9.3 million tons. Until 2022, it was estimated that the Atacama salt flat, the main national supply, holds 42% of the world's lithium reserves from brines. However, the availability of the resource has doubled between 2010 and 2023, according to the United States Geological Survey (USGS), figures that are updated year by year.

The national reserves currently under installation are extracted from brines found at the bottom of the salt flats of the Puna Atacameña (see box 4), being extracted by SQM and Albemarle. Lithium production from this source has the advantage of being less expensive than other sources, since it requires fewer inputs as it is produced by evaporation and precipitation. In this sense, the energy requirements of the process are covered by solar energy, which is why it is considered a "clean" production, as it has a low carbon footprint, in relation to lithium processing from lithium processing from spodumene[15]. In 2021, 49% of the world's lithium was obtained from brines and 51% from pegmatites. Chile contributed 71% of production from brines and Argentina 12%, while Australia was responsible for 84% of lithium production from spodumene and other pegmatites.

[15] Different life cycle analyzes of lithium carbonate and hydroxide production (see Kelly et al., 2021 and Chordia et al., 2022) have demonstrated the highest energy requirement from spodumene regarding brines, in the extraction, concentration and production processes of these elements. Only for the initial process of lithium concentration from brine and spodumene concentration, from rock extraction, Kelly et al. (2021) estimate a GHG emission of 0.08-0.18 g CO2e/ton of lithium concentrate versus ~0.42-ton CO2e/tonne of spodumene.



BOX 4:
LITHIUM EXTRACTION PROCESS FROM BRINES

Brines correspond to accumulations of saline water with high concentrations of dissolved solid elements, such as lithium, potassium, magnesium, boron and others. Consequently, describes a salinity 70 times higher than fresh water and 10 times higher than seawater, so its direct use is not possible for human consumption or agriculture.

Currently, brines are extracted from the core of the Atacama salt flat through hydraulic pumping, and are deposited in solar evaporation ponds for a period of between 12to 24 months. Thanks to solar radiation and the aridity of the desert, the brines evaporate, thus concentrating the dissolved salts and ions. During the process, the brines pass into different evaporation pools, depending on the concentration level of salts and ions. Once the evaporation time has ended, the final brine has a concentration between 4% and 6% lithium, which is then transported to the refinement plants, where it is processed into final products such as lithium carbonate or hydroxide.

Chilean legislation differentiates between water and brine: while the former is regulated by the General Directorate of Water, through Water Use Rights (DAA by its Spanish acronym), the Brine is considered a mining resource, so it depends on the mining institutions of the country (Ministry of Mining and Chilean Nuclear Energy Commission). Each one requires the formulation and approval of their respective Environmental Qualification Resolution (RCA, by its Spanish acronym) for its mining use. In fact, brine is not regulated by Water Use Rights (DAA by its Spanish acronym), so the General Directorate of Water (DGA) has limited powers to decree restriction areas or prohibition zones in areas of mining concessions like those of lithium.

3. THE ATACAMA SALT FLAT

A. BASIN DESCRIPTION

The Atacama salt flat is located in the municipality of San Pedro de Atacama, in the Antofagasta Region, describing an average elevation of 2,300 meters above sea level. and a saline system surface of 3,500 km2 (see figure 2). The basin, which bears the same name, is endorheic in nature[16] and has an area of 17,020 km2. Its rainfall ranges between 0 and 200 mm per year, while, for the salt flat floor, this value averages between 2 and 15 mm per year. It has a saline core and a surface crust, which was formed due to evaporation, condensation of evaporites and crystallization of salts throughout a process of thousands of years, giving the system's lagoons a brackish character.

The basin has three protection figures: the Los Flamencos National Reserve; the Soncor Hydrogeological System Ramsar Site; and the Laguna Tebenquiche Nature Sanctuary. These protected wild areas present fauna relevant to conservation such as the Chilean flamingo, James's flamingo and Andean flamingo[17]. There are also reptiles such as the Fabián lizard and mammals such as the culpeo fox and vicuñas. For their part, the salt flats present flora such as salt grass, tar, cachiyuyo, reed and pingo-pongo. This exemplifies the diversity of flora and fauna found in the saline system, however, its value is not exhausted in these kingdoms, since the presence of hundreds of species of "extremophilic" microorganisms that inhabit the brine areas of the flat and whose importance is still unknown.

Según el Censo de 2017, la comuna de San Pedro de Atacama presenta una población de 10.996 habitantes, lo que la convierte en una comuna de baja densidad poblacional debido a su extensión territorial (0,47 hab/Km2). Cabe resaltar que, para el año 2017, la tasa de pobreza por ingresos fue de 4,04%, mientras que la tasa de pobreza multidimensional alcanzó un 22,05%. Por otro lado, 50,2% del total de sus habitantes se ha radicado en áreas urbanas, mientras que 49,8% lo hace en áreas rurales.

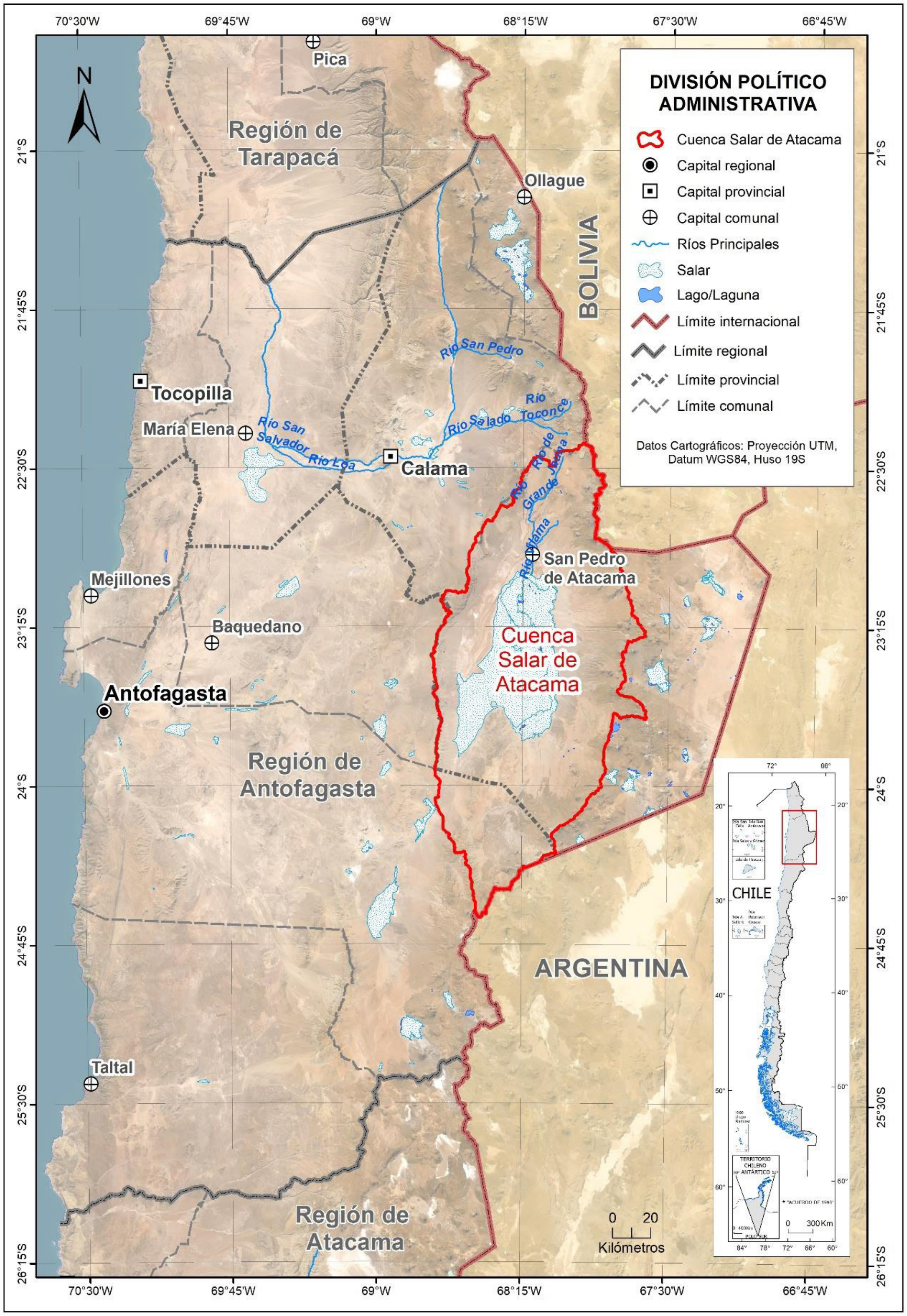
De la población comunal, 52% se reconoce como indígena, destacando la pertenencia al pueblo Atacameño o Lickan Antay (73,3%), quienes han habitado el desierto por miles de años. Así, su historia se ha construido en torno al oasis como al salar de Atacama, siendo éste fundamental para prácticas de relevancia cultural como la extracción de sal y la "limpia de canales". Estas prácticas se mantienen en la actualidad, si bien en menor medida, y se complementan con otras como la recolección de vainas de tamarugo y la agricultura familiar campesina, definiendo un modo de habitar complejo y actual en relación a los salares y el desierto.

Según el Censo de 2017, la comuna de San Pedro de Atacama presenta una población de 10.996 habitantes, lo que la convierte en una comuna de baja densidad poblacional debido a su extensión territorial (0,47 hab/Km2).

[16] It corresponds to an aquifer whose waters have no outlet to the ocean.

[17] The last two are endemic to the region and have an almost threatened and vulnerable level of conservation, respectively. The three species are essential for maintaining the balance of the ecosystems where they live.

Figure 2. Location of the Atacama salt flat, political-administrative division.



Source: General Directorate of Water (20121).

According to the 2017 Census, the municipality of San Pedro de Atacama has a population of 10,996 inhabitants, which makes it a municipality with low population density due to its territorial extension (0.47 inhabitants/Km2). It should be noted that, for the year 2017, the income poverty rate was 4.04%, while the multidimensional poverty rate reached 22.05%. On the other hand, 50.2% of its total inhabitants have settled in urban areas, while 49.8% do so in rural areas.

Of the communal population, 52% recognize themselves as indigenous, highlighting their belonging to the Atacameño or Lickan Antay people (73.3%), who have inhabited the desert for thousands of years. Thus, its history has been built around the oasis such as the salt flat of Atacama, this being fundamental for culturally relevant practices such as salt extraction and "canal cleaning." These practices are maintained today, although to a lesser extent, and are complemented by others such as the collection of tamarugo pods and peasant family agriculture, defining a complex and current way of living in relation to the salt flats and the desert.

On the other hand, since the beginning of the 20th century the area has been characterized by the development of the mining industry. Although the lithium deposits were discovered in 1962 by the American miner Anaconda Mining Company, it was not until the 1980s when exploitation began in the salt flat. The historical presence of mining industries in the basin has triggered multiple tensions over water, such as the 2007 conflict in Pampa Colorada, between the Consejo de Pueblos Atacameños[18] (CPA) and the copper mining company Minera Escondida (controlled by the Australian BHP Billiton).

In parallel to this industry, tourism has developed strongly in the municipality of San Pedro de Atacama, which has the Atacama salt flat as one of its main attractions. In this way, during the last 20 years the municipality has shown significant growth, but without a territorial approach that integrates social and economic development.

B. HYDRIC BALANCE

The Atacama salt flat is fed by two main rivers: the San Pedro River and the Vilama River, which constitute one of the main water inputs to the basin, identified as direct precipitation and runoff. However, due to their characteristics, these waters evaporate quickly or do not become groundwater recharge. In turn, the system has two additional inputs: (a) deep, regional groundwater, which constitutes the majority of the total flow into the basin and has very long residence times (greater than 65 years), being little affected by modern climatic variations; and (b) local and intermediate groundwater, whose transit times are average (1-10 years) and come from local recharge of alluvial aquifers.

The tributaries that reach the salt flat core are mainly subsurface flows, with the San Pedro River being one of the only major surface runoffs that reach it. Surface water consumption is mainly used for agricultural irrigation, while subsurface water is used for human consumption and for industrial mining consumption; on the other

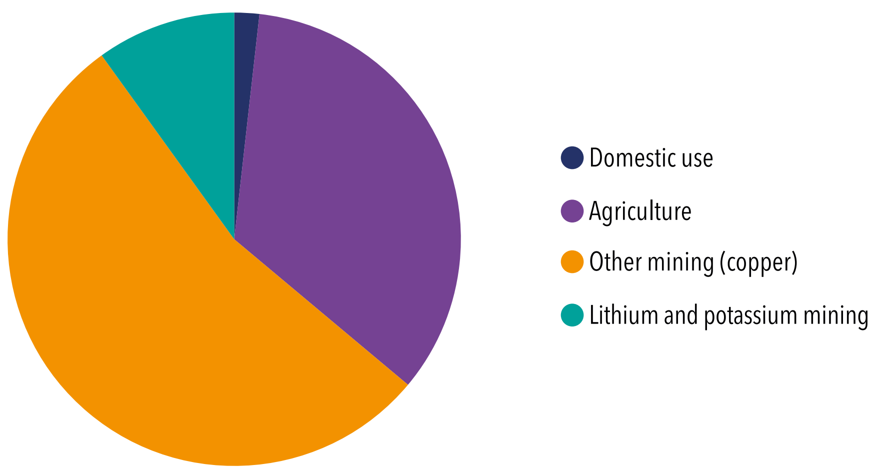
[18] The Atacama indigenous community or Lickan Antay lives in different locations around the saline system. Since 1992, it has been grouped around the Consejo de Pueblos Atacameños, which brings together 18 Atacama communities from the Atacama La Grande Indigenous Development Area. Currently, the Lickan Antay territory is divided into "Atacama La Alta", whose center is the town of San Pedro de Atacama, and "Atacama La Baja", with its center in the town of San Francisco de Chiu Chiu. Specifically, around the Atacama salt flat basin the communities of Río Grande, Machuca, Catarpe, Quitor, San Pedro de Atacama, Sequitor, Larache, Yaye, Solor, Coyo, Cucuter, Tulor, Toconao, Talabre, Camar, Socaire and Peine are recognized.

hand, brines are extracted from the salt flat core aquifer for lithium, potassium and bischofite production. Thus, the basin is pressured by different actors with a variety of uses.

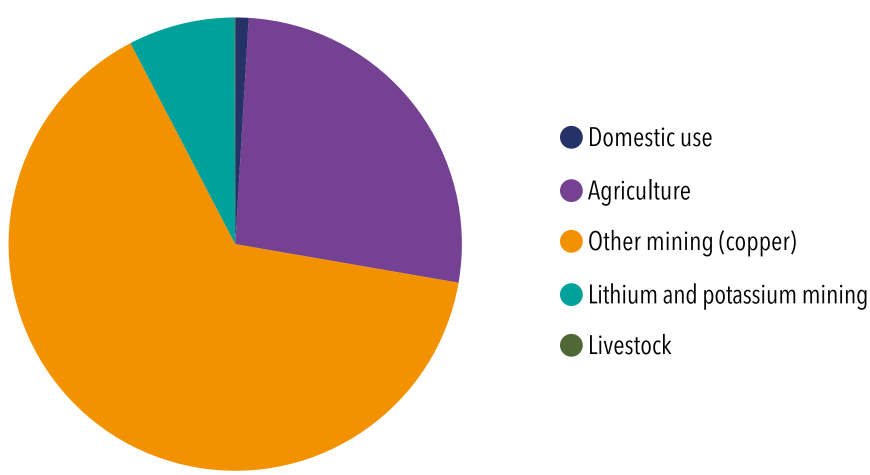
By 2019, the distribution of water rights (see Figure 3) was concentrated in mining, registering 3625 l/s, equivalent to 63.9% of the total rights in the basin. It was followed by agriculture, with 1946.6 l/s registered (34.3%), while human consumption (including tourism) only registered 101 l/s (1.8%).

Figure 3. Water use rights (left) and estimated freshwater use (right) in the salt flat of Atacama, as of 2019.

Distribution of water use rights in the Salar de Atacama as of 2019



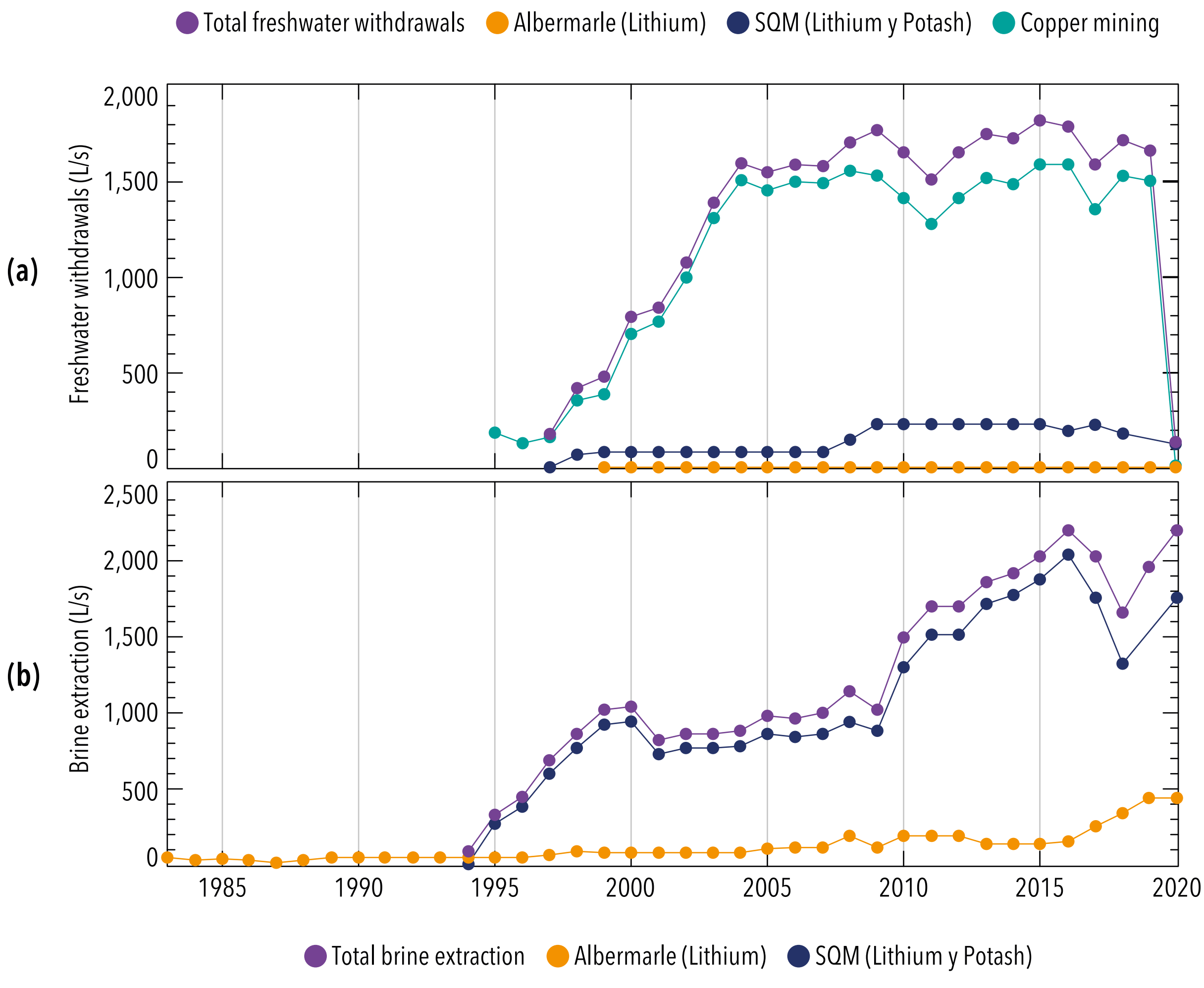
Raw water use in the Salar de Atacama basin as of 2019



Source: Own elaboration based on DGA (2021).

From the point of view of the effective use of raw water in the Atacama salt flat basin (see Figure 3), during the period 2000-2020, water demand for human consumption averaged only 22.4 l/s; while the agricultural sector averaged an annual consumption equivalent to 634 l/s during the period 1986-2018. In 2019, the net freshwater demand of the mining sector was 1,709.9 l/s, rising to 3,201 l/s if the brine extraction flow is included (see Figure 4b). SQM extracted 172.9 l/s of water, out of 549 registered, and 1,049.6 l/s of brine; while Albemarle extracted 7.1 l/s of water, out of 15 registered, and 332 l/s of brine. The rest of the freshwater flow (1,529.9 l/s, out of 3,061 registered) was demanded by the Escondida and Zaldívar mines[19] (see Figure 4a).

Figure 4. Annual extraction of (a) raw water and (b) brine in the Atacama salt flat by company.



Source: Moran et al. (2022).

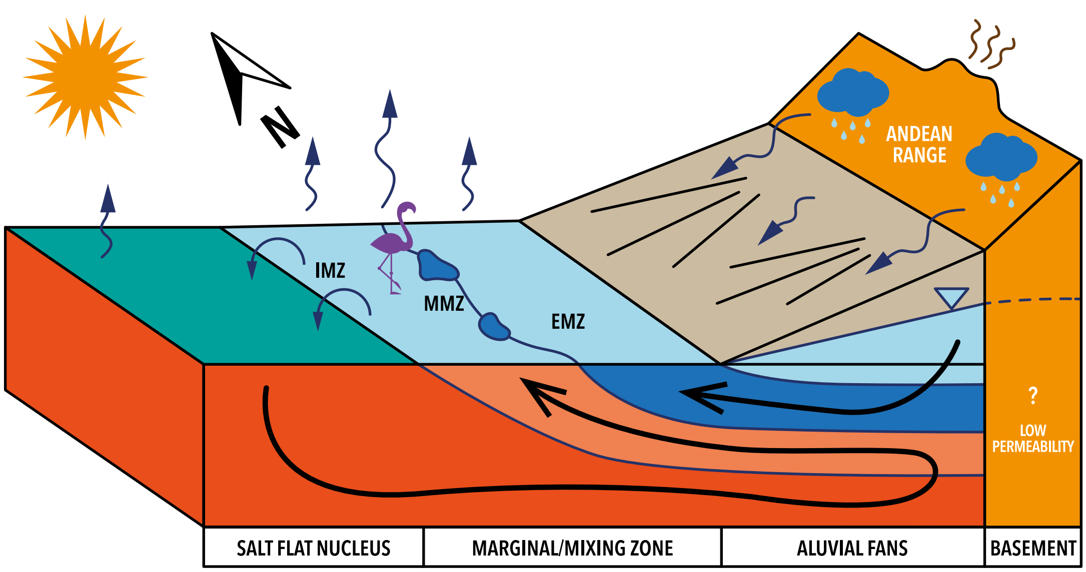
[19] Although not located within the boundaries of the Atacama salt flat, there are two copper mining operations that have extracted water resources from the southern sector of the basin: Compañía Minera Zaldívar (part of the Antofagasta Minerals mining group), which began operations in 1995 and is located 175 km southeast of the regional capital; and Minera Escondida (owned by BHP Billiton), which began operations in 1990 and is located 170 km southeast of Antofagasta. In 2021, Zaldívar produced 88.0 kMT of copper, while Escondida produced 1,011.4 kMT. The companies had water use rights with authorized flows of 200 l/s and 1,400 l/s, respectively, from the Monturaqui-Negrillar-Tilpozo aquifer, located 50 km southeast of the salar. In 2019, Escondida stopped its water extraction and in 2020, the mining company abandoned the processing of a new Environmental Impact Study in the Monturaqui aquifer for new water rights to extract 428 l/s, after the Environmental Superintendence sanction -equivalent to $6,600 million- for the irreparable environmental damage generated in the Vegas de Tilopozo. Zaldívar has water use rights for extraction until 2024 and recently submitted an Environmental Impact Study for extending its operation until 2051, which considers to continue using its water rights for extraction from the Negrillar sector until June 2028, and then replacing it with desalinated water.

It is worth noting that the scientific community is not yet in consensus regarding the impacts of brine extraction on the aquifer (see box 4 and appendix 1). Although we know that there is a difference in densities and salt composition between the brines in the core of the salt flat and the freshwater flows from the Cordillera, with a salinity 70 times higher, measuring the behavior of the saltwater intrusion or interface and quantifying the impacts of brine extraction on the aquifer in general, requires new studies.

On the one hand, the studies highlight that brine and raw water are of a different geochemical nature and temporal scale, pointing to the impact of copper and agricultural activities, as well as drought and rainfall events, to explain the environmental impacts on the salar flat. On the other hand, research has shown that the behavior of the salt water intrusion requires understanding the aquifer as an integrated system (see Figure 5). Meanwhile, brine extraction does cause a drop in the level at the core zone of the salt flat.

It should be noted that none of the studies reviewed here rule out the medium- to long-term impact of brine extraction on the salar flat; on the contrary, they relativize its relevance. **Even so, two cones of depression have been observed as a result of brine pumping in the sectors where the SQM and Albemarle brine extraction wells are located. Likewise, the investigations warn of the need to update the distribution of water use rights and effective extraction, according to relevant balances with the current and future water availability, as all projection scenarios show a general decrease in the aquifer balance.** To this is added the requirement to consider with greater relevance periods of drought and other effects of climate change, not only because they affect water availability in the aquifer, but also because they hinder the possibility of attributing specific impacts to human activities.

Figure 5. Conceptual scheme of the mixing zone in the Atacama salt flat basin.



Note: Black lines represent flow lines. IMZ: Internal mixing zone (towards the core sector); MMZ: Middle mixing zone; EMZ: External mixing zone (towards the Eastern edge).
Source: General Directorate of Water (2021).

It is alarming that -as a result of anthropic and vegetational extractions and the sustained evaporation regime during the period 2000-2018- the basin has yielded a negative balance of 1,236 l/s. In other words, for the period in question, the basin had greater outflows than inflows, so water and brine extractions during this period have been provided from pre-modern sources of water whose recharge time is longer than the rate of consumption and recharge. Consequently, the projections for the period 2020-2060 warn of a water gap associated with drinking water for human use that ranges between 17.44 and 27.74 l/s. To this must be added an ecological flow of 1,610 l/s, thus expressing a critical scenario for the coming decades.

In fact, the General Directorate of Water (DGA) has issued Declarations of Surface Water Depletion for both, San Pedro River and its tributaries, since 2016 (DGA N° 449); and Vilama River and its tributaries, since 2017 (DGA N° 03). This confirms a scenario of water scarcity in the salt flat de Atacama basin, configured by the decrease of its tributaries and a sustained water demand, despite reduction efforts, coming from mining and agriculture.

For its part, large industry has already begun to react. Minera Escondida put an end to its extraction in 2019 and Minera Zaldívar proposes to migrate its extraction to seawater of the municipality of Antofagasta from 2028. Meanwhile, to improve its water management efficiency, SQM announced the "Proyecto Salar Futuro", which expects to reduce inland water consumption to 80 l/s of raw water by 2030; while Albemarle announced the "New Lithium Era", where it committed to voluntarily waive its water rights in Tilopozo, Tutúcaro and Peine, leaving them for environmental conservation (the company is requesting the same amount of water in a new area, Tilocalar) to obtain desalinated water starting in 2027, through the company CRAMSA. In addition, both companies propose to promote Direct Lithium Extraction mechanisms (see box 4).

Despite these efforts, projections to 2040 -which incorporate the reduction of mining water extraction- indicate that in all the simulated scenarios there are water table decreases in the core and in the marginal zone of the salt flat, as well as displacements in the saline interface. These impacts are described considering the effects of climate change and variations in the intensity of the brine extraction regime.

BOX 5: DIRECT LITHIUM EXTRACTION

Direct Lithium Extraction (DLE) refers to a variety of technologies such as thermal or electrochemical processes, which allow to obtain lithium from brines in a shorter time than the current evaporite process. Companies are proposing this technology as a more sustainable alternative, as it would produce more lithium from less raw material, and the brine with no lithium would be re-injected into the salar flat. It is estimated that new technologies can recover up to 90% of the lithium in the brine. 1.5 to 3 times the current rate (30%-60%). This increase in efficiency would allow production flexibility in the face of short-term changes in demand.

However, questions arise about the economic viability compared to the current evaporite system and the environmental impacts of the reinjection process. Studies show that DLE does not always generate brines with the right lithium concentration, which would imply adding thermal processes that would increase the cost of implementation. Thus, the estimated cost[20] of applying DLE technologies is close to USD 6,700/t LCE while, in the Atacama salt flat, a total current cost of USD 3,650/t LCE is estimated through the use of evaporation technologies.

[20] Taking Goldman Sachs (2023) data as a starting point and calculating a discount rate of 10% over 20 years, it is estimated that the initial capital expenditure (CAPEX) for a lithium mine with DLE technology is USD 3,523/t LCE, while its operating cost (OPEX) amounts to USD 3,200/t LCE. On the other hand, in the Atacama salt flat, the current CAPEX cost for a mine based on evaporation is USD 1,750/t LCE, while the OPEX is USD 1,900/t LCE.

In turn, some technologies require fresh water for their operation. This is a major challenge, as the current process only uses between 22.5 and 50 m^3 of fresh water per ton of lithium carbonate produced in the salar flat, and the requirements of some technologies can be up to 10 times higher (500 m3 per ton of lithium carbonate). Finally, there is uncertainty about the effects of brine reinjection, which may contain exogenous chemical materials to the salar flat. To have scientific knowledge about these possible impacts is essential, as salt flats are complex and sensitive ecosystems.

C. RESOURCES AND ACTIVITIES IN THE BASIN

The companies operating in the Atacama salt flat, in addition to lithium and copper, also produce by-products derived from **potassium salts**, which are obtained after processing the salts collected from the evaporation ponds. In the case of SQM, the company started the production of potassium chloride in the salt flat in 1995, with the objective of supplying raw material for its potassium nitrate production, to later develop other products such as potassium sulfate. Thus, the company produces three potassium by-products. In 2022, SQM produced 984 kt of potassium chloride and potassium sulfate, 30% less than that produced in 2021 (1,407.5 thousand tons), which are processed at the SOP and MOP plants in the salt flat. Albemarle also produces potassium chloride as a byproduct of the salts precipitated at its Salar Plant.

On the other hand, **salt** is a fundamental resource in the Atacama Puna, since its abundance and availability has been used by its inhabitants for several centuries. Thus, it has progressively developed a technical knowledge (regarding their ways of collection and use) and a symbolic value that is part of the cultural identity of the Atacameño people. Of great commercial value since pre-Hispanic times, its importance is so great that it is part of the contemporary claims because it is considered of identity value for the salt communities. Several salt collection sites coincide with mining sites. For this reason, it was included in past negotiations between companies and communities, as in the case of the agreement signed between the Consejo de Pueblos Atacameños and Rockwood Lithium S.A. (now Albemarle) in 2012.

In turn, **tourism** is one of the main economic activities developed around the Atacama salt flat, thanks to the landscapes offered by the flora and fauna of the high Andean salt flat. Due to the diverse natural and cultural points of interest, the municipality of San Pedro de Atacama receives a steady influx of national and international tourists, who contribute to the economic dynamism of this sector, but also generate pressures and negative impacts on the landscape. Its development over the last 20 years has boosted a whole chain of adventure tourism, transport, gastronomy, and lodging companies that benefit from this influx of visitors, as well as allowing indigenous communities to receive benefits from tourism (for example, through the co-administration of the Los Flamencos National Reserve between communities and CONAF).

The tourism offer is very varied and does not have a defined target public, which is one of the challenges for its sustainable development. There are no official statistics or tourism observatories that gather complete information on the formal and informal tourism sector in the municipality; however, according to data from the INE Tourist Lodging Survey, between the months of August 2018 to July 2019, there were 211,128 tourists staying in formal establishments. Finally, it is important to mention that mass tourism puts pressure on the area's natural resources (water demand, overloading of visitor sites, among others), in addition to causing tensions with indigenous communities.

Finally, it is worth noting that in the municipality of San Pedro and in the towns surrounding the salt flat, **agriculture and livestock farming** are subsistence or self-consumption activities. These activities are deeply rooted in the culture of the inhabitants of the territory, although traditional agriculture has decreased its surface area in recent years due to the decrease in the flow of the San Pedro and Vilama rivers. For example, in the locality of Socaire, the ancestral system of cultivation in terraces of species such as potato, corn and quinoa is still in practice. According to the last Agricultural Census of 2021, in the municipality of San Pedro de Atacama there are 326 silvo-agricultural production units (UPA, by its Spanish acronym) with a total area of 196,897 hectares; 10 UPAs are managed by legal entities for a total of 195,943 hectares, while 316 UPAs are managed by individuals for a total of 955 hectares. On the other hand, there is competition for the use of agricultural land due to the increasing change of urban land use, in an area where there is a shortage of land with agricultural capacity.

D. INTERETHNIC SYSTEM

Around the salt flat of Atacama there are traditional practices such as the "canal cleaning" or *Talatur*, rooted in the communities of the Atacameño people. Rituals related to water confer a sense of territorial belonging, while at the same time they refer to a greater cosmological order, sustained by the presence and reciprocity with mother earth. Thus, water has a symbolic connotation for Atacameño communities that endows the salt flat of Atacama with cultural relevance. In the same way, the salt historically exploited in the salt flat has a fundamental place in their identity, as there are communities that recognize themselves to this day as salt producers; the hills - as divine entities - are linked to the origin of the rains and snows that allow the economic and vital reproduction of the communities. In short, the salt flat and the elements that make up its natural landscape are relevant to the cosmovision of the Lickan Antay communities. The socio-environmental tensions unleashed by mining have connotations that go beyond the distributive, acquiring cultural and historical depth.

Beyond lithium, a **history of socio-environmental conflicts between the mining sector and local communities has been described in the Atacama territory**. Examples include the loss of the Ojos de San Pedro lagoon in the 1960s, due to the Chuquicamata mining; the appropriation of the Toconce community's water by Empresa de Servicios Sanitarios de Antofagasta; the use of groundwater by Compañía Minera Cerro Colorado (a subsidiary of BHP Billiton), which resulted in the drying up of meadows and wetlands of Pampa Lagunillas; and more recently, the negative impacts of Minera Escondida on the Punta Negra and Pampa Colorada salt flats, due to water extraction, among others. At the same time, historical claims for the restitution of indigenous territories before the State of Chile persist, which increases tension between private, public and indigenous actors present in the territory.

In this way, **the historical privatization process promoted by the State in San Pedro de Atacama -since the last decades of the 20th century- triggered very significant changes in Atacama society**. Firstly, this process brought with it the settlement of large mining industries in the region; secondly, communities were deprived of access to essential resources, such as water and land, to which they used to have collective and historical access; and thirdly, it pushed communities to move from an agro-pastoral economy to work in subsidiary tasks of mining, either as workers or offering services and products. In short, this process has caused profound transformations in local identities and economies.

Within the salt flat of Atacama, the above elements have configured an interethnic system in which the State, mining companies and the Lickan Antay people stand out, the latter grouped mainly in the Consejo de Pueblos Atacameños. However, the governance of this system was defined, in the first instance, on the basis of direct agreements between the mining companies and the indigenous communities, which proposed reparation and benefit schemes for the communities, within the framework of the copper and lithium exploitation projects; later, this scheme was updated during the renegotiation of contracts between Corfo and the lithium companies, which once again placed the State at the center of governance.

In this way, a hierarchical institutional scenario was configured, pushed by the State, to define the rules for mineral exploitation in an attempt to resolve the territorial tensions caused by mining projects and to increase the capture of rents. Although this model has allowed the State and the communities to capture rents, it has also caused tensions within the local social fabric, due to the actions of the mining companies. For example, SQM has been accused of co-opting leaders and intervening within the communities to cause internal divisions. Thus, the model of profit retribution has enforced a transactional governance that reduces territorial dialogue to a negotiation of benefits or the filing of appeals for protection, based on ILO Convention 169. In fact, this has been the case for the judicialization of the 2018 agreement between SQM and Corfo, which maintains to this day USD 29 million unable to be delivered to the communities, and of the bidding for new lithium deposits in 2022.

In this context, the new cycle boom experienced by lithium has come to update mining exploitation in the salt flat of Atacama, through contracts that incorporate criteria of redistributive justice of economic benefits to seek the "social license" of the Atacama communities; the same strategy replicated with local governments. However, this governance model has neglected key aspects for the justice of the global energy transition, preserving conditions of unfair distribution in terms of environmental costs and the lack of restoration of historical damages to local communities. In the current scenario, it has been argued that lithium mining reproduces the historical inequalities between local territories and international production centers.

Consequently, in order to advance in key aspects for the justice of the global energy transition, it is necessary **to have a governance that allows indigenous communities and citizens in general to participate in strategic decision making, to build long-term territorial investment criteria, incorporating the diversity of visions and cosmovision.** In this sense, it is worth highlighting the growing efforts to promote governance at the basin scale in the salt flat of Atacama. Among them, the Ministry of Environment's impulse to promote a Pilot basin council, in coordination with the Regional Government, from the perspective of the Just Water Transition, stands out. In a similar vein, the German Society for International Cooperation (GIZ) has promoted for two years the Multi-stakeholder Roundtable, which has worked to resolve the information gaps in water management in the basin.

4. CONCLUSIONS AND GOVERNANCE RECOMMENDATIONS

A. GOVERNANCE RECOMMENDATIONS FOR MAXIMIZING REVENUES, VALUE ADDED AND TRANSPARENCY

The international lithium market is currently projecting a price boom cycle that will last at least a decade. From the international point of view, there is a race among exporting countries, such as Australia and Argentina, to lead the market; at the same time, importing players are disputing the dominance of the supply, with China being the main one, over others such as the European Union and the United States. This context imposes pressure on the Chilean State to promote the exploitation of the mineral in order to increase the income received by the country. From the international point of view, the State policy should push the following axes:

• It should be considered that the temporality of the lithium price super cycle imposes on the State the need to negotiate with the current controllers of the operations in the salt flat of Atacama, to extend the terms and quotas of extraction. This new renegotiation **must maintain or raise the standards defined by the contracts currently signed by Corfo, to ensure favorable conditions for capturing rent**.

• It is essential **to include the transitory nature of lithium tax revenues in the country's finances**, in order to avoid committing permanent expenditures charged to revenues that may have a transitory component due to variations in mineral prices.

• Chile should aim to diversify lithium buyers and investors, with the objective of distributing risks and giving viability to public-private alliances, following criteria of geopolitical balance in the incorporation of commercial partners. In this aspect, the **Comité de Litio y Salares can play a fundamental role: promoting mechanisms or regulations to align foreign direct investment with national interests and counterbalance pressures for the supply of lithium, considering the high concentration of its demand.**

• In order to maximize the fiscal capture of rents, the current National Lithium Strategy has defined to increase the exploitation of the mineral towards new salt flats. To this end, the State must accelerate the action of its mining companies, especially in the Atacama and Maricunga salt flats, where the largest reserves are concentrated. Although significant steps are being taken in the salt flats that will be defined as strategic, it is urgent to advance in the definition of criteria for new joint ventures; while in smaller salt flats new CEOLs can be promoted.

• It is necessary to continue[21] with the **promotion of the development of a cluster with a technological focus regarding the lithium industry, with the objective of increasing the added value**, thus increasing the productive efficiency and increasing the extensive margin of its commercialization.

[21] Currently, two Chinese companies -BYD Company Limited and Yongqing Technology Co. Ltd- have been selected by Corfo to access lithium products at a Preferential Price (as stipulated in the contracts with SQM and Albemarle), in order to develop cathode material in the country, thus advancing in the value chain; both operations contemplate investments that, added together, exceed USD 500 million.

Lithium management in Chile is characterized by a strong State control, which has leased the exploitation of the mineral to private companies. This model has imposed environmental performance and economic compensation requirements on local communities and subnational governments, framing the social dimension, i.e., the relationships between the actors in the territory, to the latter aspect. After the unsuccessful efforts of various governments, the main milestone to update this governance took place during the renegotiation of administrative contracts between Corfo, Albemarle and SQM during 2016 and 2018; an event that updated the regulatory framework set during the 1980s, by incorporating better conditions for rent collection for the State. Despite these advances, this regulatory framework now needs to be deepened:

• State policy must **project the industry's development beyond political cycles**, leveraging the current boom and increasing production capacity and market share. In this sense, it is worth highlighting the need to open the discussion on the strategic nature[22] of lithium for the State of Chile, evaluating the need to update the legal framework for its exploitation, incorporating not only management and technology measures, but also regulation and distribution of its income. More generally, it is urgent to move forward in transversal agreements on the development of this industry, particularly regarding the public role, so that it becomes a State policy.

• The conditions established in the renegotiated contracts with Albemarle and SQM in the Atacama salt flat should serve as a basis for new public-private partnerships, replicating aspects such as **contributions for R&D, subnational governments and communities**. These mechanisms should be formalized and structured, according to the strategic nature of the mineral, to ensure its long-term social and environmental sustainability.

• Likewise, disputes such as the one raised by SQM regarding the difference in amounts with the SII in the payment of the IEAM[23], which went to the Court of Appeals, should serve to **strengthen the tax regime**. Currently in Chile, tax revenues are not published individually in official statistics: doing so is essential to strengthen the commitments signed, such as the Escazú Agreement, and international standards, such as the Extractive Industries Transparency Initiative (EITI).

• The creation of skilled labor must be promoted, in accordance with the conditions of technification and innovation that the country and the regions that will host the new industries need to promote. It is imperative **to strengthen human capital among the surrounding communities, so that the population can access higher-skilled jobs**; this should be done with greater emphasis on the female population to address labor participation gaps in traditionally male-dominated sectors.

[22] The term "critical minerals" should be distinguished: an international concept that refers to the importance of certain resources for the development of clean energy technologies. Strategic" minerals are those defined as relevant by countries for their own development experience.

[23] In this regard, Jorratt (2022) states that "The IEAM applies to concessionable minerals. However, Article 7 of the Mining Code declares lithium as a non-concessionable mineral, which may raise doubts as to whether companies exploiting lithium are subject to this tax. The IRS has construed that if the companies that exploit lithium do so under the protection of the mining claims, whose survey certificates of measures were registered prior to the declaration of non-concessionable mineral, they are subject to the tax. This is the case of the two companies currently operating in the salt flat of Atacama".

B. GOVERNANCE RECOMMENDATIONS FOR ENVIRONMENTAL SUSTAINABILITY

It is relevant to highlight how the urgency of agile state action to promote the exploitation of new lithium quotas or operations contrasts with the need to make environmental decisions that are both scientifically based and guided by citizen and indigenous participatory processes. Understanding that -by definition- the nature of scientific and social cycles is prolonged, in order for the lithium industry to promote a just transition, the State's action must aim at repairing the impacts that have accumulated in the mining territories.

Historically, lithium mining in Chile has been developed in the Atacama salt flat, the main reservoir in our country. There, they coincide with copper companies and farmers who, together, create a scenario of (negative) water imbalance in the basin, due to water and brine extractions. In addition, Atacameño communities and Protected Wildlife Areas coexist in the territory, making for a complex local governance scenario.

In order to advance in this process, essential considerations for the sustainability of the industry in the basin must be taken into account:

• To meet the objectives of industry sustainability and ecosystem conservation, **the Comité Corfo de Litio y Salares must promptly define measurable and transparent criteria, informed by science, to create the Protected Salt Flats Network**. They should consider aspects allowing for the preservation and restoration of the integrity, connectivity and resilience of these ecosystems, in accordance with the Framework Convention on Biodiversity. Similarly, the **Instituto Tecnológico y de Investigación Pública en Litio y Salares will be fundamental in addressing information gaps regarding the socio-environmental impacts of the industry**, contributing to the transparency of the industry's processes while promoting the effective conservation of the salt flats. In a more structural sense, the institute can contribute to the sustainability of activities, through rigorous scientific information that allows setting limits to industrial pressures.

• The promotion of new projects should **consider the current imbalance between water supply and demand in the Atacama salt flat, both from the point of view of the water use rights granted, as well as the effective extraction of raw water and brine**. It should be noted that the current regulatory instruments available to oversight agencies -such as the General Directorate of Water or the Superintendence of the Environment- do not allow limiting the exploitation quotas of resources already allocated. Therefore, there is a need for a regulatory strengthening oriented, according to specific and territorially relevant thresholds, to regulate each particular operation.

• **It is essential to reduce the extraction of brine and eliminate the extraction of fresh water from the Atacama salt flat.** To the extent that environmental sustainability is ensured, this objective can be achieved through the promotion of new technologies. Specifically, in order to bring water sustainability to the system, the promotion of integrated projects at the basin scale is essential, where the installation of desalination plants is aligned with public and private interests, placing emphasis on the consumption needs of the communities and their economic activities, promoting the public good and generating economies of scale around water. To this end, caution is recommended when promoting new desalination technologies or direct extraction of lithium, in order to consider the feasibility and relevance of their implementation, avoiding impacts that are not yet scientifically known.

C. RECOMMENDATIONS FOR SOCIAL AND LOCAL GOVERNANCE

The general objective of the lithium policy should be to harmonize the fragmented governance that has operated in Chile for the last decades, promoting a balance between productive activities, the sustainability of ecosystems and the impact on the communities surrounding lithium operations. To this end, it is key to clearly establish which institutions will be in charge of implementing governance and what will be its guiding framework to harmonize the three previously mentioned aspects:

• Administrative and political coordination with the regional governments where the new operations will be developed must be safeguarded. Specifically, and to this end, **management at the basin scale must be strengthened, as it faces the challenge of promoting a participatory management model in a complex territory**, characterized by its cultural diversity, multiple historical tensions and, it should be noted, over-intervened by various actors and initiatives. Therefore, in order to promote basin management in the salt flat of Atacama, it is essential to coordinate existing efforts in terms of territorial management and planning; to recognize and balance leadership, creating spaces for dialogue regarding the various interests in the basin; to broaden the range of stakeholders beyond the Water User Organizations and reach out to indigenous peoples, civil society, the private sector and representatives of State services.

• From the social point of view, lithium governance **should consider a framework of transparency that promotes best industry practices: technological, on the one hand, but also with respect to the economic resources allocated to local stakeholders, on the other**. This framework should strengthen the role of regional and local governments, with a sense of accountability and including mechanisms of transfer to the communities that promote investments with a sense of collective action and relevance to indigenous worldviews. In this sense, a public discussion should be held on the formulas that ensure the participation of the parties in decision making, not only in the task of revenues, but also in terms of improving the mechanisms through which financial contributions are delivered to communities, municipalities and regional governments.

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APPENDIX 1:
Main studies since 2020 on water extraction impacts in the Atacama salt flat.

STUDY	OUTCOMES
Desarrollo de Herramientas para el análisis de salares y cuencas costeras y su aplicación para el desarrollo del Plan Estratégico de Gestión Hídrica en la cuenca del salar de Atacama (DGA, 2021)	The study suggests that the groundwater system must be approached in an integrated manner, as brine and raw water are closely related, forming a saline interface. During the period 1986-2018, the study describes multiple level drops in the water and brine extraction areas, mainly in the southern sector (between 24 and 8 m), where the companies Minera Zaldívar and Minera Escondida Limitada operate; but also, in the eastern sector (between 3 and 8 m), where the companies SQM and Albemarle operate. This decrease is emphasized since 1995, when the magnitude of extraction increases, observing a sustained emptying of the water system.
Modelo hidrogeológico de la cuenca del salt flat de Atacama. Informes modelo hidrogeológico conceptual y numérico (Amphos, 2021)	The first report notes two cones of depression as a result of brine pumping, identifying a maximum drop of 9.8 m in the sector where the SQM wells are located (between 1996 and 2019) and a drop of 4 m in the sector corresponding to Albemarle. However, regarding the impact of brine extraction, it states: "The difference in salinity and density between freshwater and brine, in addition to a lower permeability in sectors of the marginal zone, allow for a differentiated evaluation of the availability of these resources, as well as their changes over time due to extractions. However, the existence of a mixing zone where both fluids interact, in addition to the surface environmental protection objects related to its operation, determine that the system needs to be treated as a whole and not independently. Indeed, any modification in the functioning of the saline interface, resulting from water stress in the brine or freshwater domain, could have an effect on the environment of the environmental protected objects, which should continue to be the subject of specific studies and permanent monitoring".

Hydrogeologic and Geochemical Distinctions in Freshwater-Brine Systems of an Andean Salt flat (Munk et al, 2021)	Using long-term remote sensing methods, it is observed that extreme precipitation events are the main driver of changes in the extent of surficial aquifers. However, it is the subsurface geology and the development of the freshwater-brine interface that defines the formation of these aquifers. It is concluded that the subsurface brines of the transition zone and the halite core are geochemically distinct compared to groundwater discharge.
Relic Groundwater and Prolonged Drought Confound Interpretations of Water Sustainability and Lithium Extractions in Arid Lands (Moran et al, 2022)	Groundwater extraction has coincided with periods of drought, which makes it difficult to specifically attribute environmental impacts to anthropogenic activities. However, the study concludes that the water "budget" of the Salt Flat de Atacama basin has been sustained on the basis of relict water, questioning the sustainability of the current regime of distribution of water use rights. It details that the extraction of fresh water - by copper mining and agriculture - has greater impacts than brine extraction on wetlands, lagoons and groundwater storage. Finally, the study concludes that brines are extracted from aquifers that are disconnected (on the human time scale) from the surface water and wetland system.
Roadmap: Estrategia tecnológica del litio en Chile (Alta Ley, 2022)	It states that brine and fresh water, although part of the same system, are physically separated due to the contrast in density. However, at the same time, it points out that "regarding environmental management in relation to water sustainability, there is no consensus, partly because of the independent treatment given to brine and fresh water, but also because of the separate formulation and approval of the Environmental Qualification Resolutions (RCA, by its Spanish acronym) of the mining operations in the salt flats".

Source: Own elaboration.

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