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Water or mineral resource? Legal interpretations and hydrosocial configurations of lithium mining in Chile

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The advance of electromobility has boosted global demand and interest in lithium. The consequent expansion of lithium mining puts the sustainability of Chile's Andean salt flats at risk. In these unique ecosystems, lithium is abstracted from mineralized groundwaters, referred to also as brines. This article analyses the legal treatment of brines and its implications in assessing the socioecological impacts of lithium mining projects. For our analysis, we draw from scholarship at the intersection between hydrosocial research and critical legal geography. Methodologically, our study is based on interviews and the analysis of legal texts and judicial and administrative claims, including the environmental impact assessment studies of the three single lithium mining projects approved in the country. We show that the interpretation of brines as mining resources supported by mining companies and endorsed by environmental State agencies is based on a legal loophole. We document how such interpretation is operationalized and contested in the environmental impact assessments of three mining projects and other instances. We explore how the same legal loophole could lead to alternative interpretations and relatedly regulatory proposals and discuss their implication for the assessment of socioecological impacts of mining projects. These include first an understanding of brines as hybrids minerals/waters put forward in a recent report commissioned by State agencies, and second an interpretation of brines as a type of water. The latter is in line with the position of some indigenous groups and academics. We conclude with reflections on the implications of our analysis for lithium mining in Chile and beyond.

KEYWORDS

brine, mineralized groundwaters, salt flats, Andean wetlands, indigenous territories, water justice, environmental impact assessment, critical legal geographies

1. Introduction

In the last decade, lithium has become an object of desire of major economies and manufacturers of batteries and electric vehicles across the world, particularly in the context of the energy transition (World Bank, 2020; IEA, 2022; EC, 2023; USGS, 2023). Chile is currently the second largest lithium world producer—surpassed only by Australia—and it has the largest exploitable reserves of this mineral (USGS, 2023). Unlike in Australia, which produces lithium mainly from pegmatite rock, in Chile, it is obtained from the extraction and evaporation of mineralized groundwaters—also referred to as brines—from the aquifers of the Andean salt flats (or "salares"). Brines are pumped with extraction wells from saline aquifers and subsequently diverted to a system of evaporation ponds where lithium salts

are concentrated through solar evaporation for 9–14 months (Flexer et al., 2018; Bustos-Gallardo et al., 2021). The amounts of brines required to produce one ton of lithium vary from one salt flat to another (and even within them) depending on the concentration of lithium minerals dissolved and the efficiency of the process used (Flexer et al., 2018). As part of this process, freshwater is also abstracted and used in smaller quantities as input for industrial activities, such as removing mineral salts.

Lithium extraction in Chile is currently carried out only in the Atacama salt flat. In 2020 new mining projects were approved in the Salar of Maricunga. In addition, several projects are in the preliminary stages of prospecting or exploration in 28 salt flats and saline lagoons in the country. Salt flats are fragile ecosystems characterized by unique biodiversity, including birds in the conservation category, such as flamingos, and benthonic microorganisms fundamental to the tropic chains. In these environments, aquifers of varying salinity are hydrodynamically interrelated, sustaining systems of lagoons, meadows and peatlands (high Andean wetlands), some of which have been recognized as national parks, reserves and Ramsar sites (Dorador et al., 2009, 2018; Thiel et al., 2010; Cubillos et al., 2019; Marazuela et al., 2019). In these terms, the salt flats constitute integrated salt flat-wetland ecosystems. Many salt flats are part of the ancestral territories of indigenous communities, such as the *Atacameño/Lickanantay* in the Salar de Atacama or the *Colla* in the Salar de Maricunga (OPSAL, 2021). The salt flats have also been fundamental for developing indigenous communities' traditional agricultural and transhumant grazing activities (Castro et al., 2004; Llagostera, 2004; Yáñez and Molina, 2011; Min. Minería, 2015; Prieto, 2015, 2016).[1]

A growing body of literature analyzes the historical development, the socioeconomic impacts, the water and energy injustices and inequalities linked to lithium mining in the Chilean salt flats. Some of these works argue that mining operations produce environmental degradation in terms of decreased vegetation cover, decreases in the population of endemic fauna such as flamingos, increased temperature in local climate and drier conditions (Gajardo and Redón, 2019; Liu et al., 2019; Gutiérrez et al., 2022). They also analyze the challenges faced by local communities, which on the one hand, receive substantial direct or indirect economic benefits from mining companies, but on the other hand, have to live in a profoundly changed environment and face increasingly uncertain water and climate conditions (Babidge, 2013, 2016, 2019; Gundermann and Göbel, 2018; Babidge et al., 2019; Liu and Agusdinata, 2020; Lorca et al., 2022). Scholars have also discussed the material, institutional and discursive processes supporting lithium-brine mining and its continuous expansion including forms of green extractivism (Barandiarán, 2019; Bustos-Gallardo et al., 2021; Jerez et al., 2021; Forget and Bos, 2022; Voskoboynik and Andreucci, 2022).

Several authors note that the expansion of lithium extraction is underpinned by an understanding of mineralized groundwaters as minerals, or better, as mining resources (Babidge et al., 2019; Bustos-Gallardo et al., 2021; Jerez et al., 2021; Blair et al., 2022; Hernandez and Newell, 2022). Such interpretation has been historically supported by mining companies and the Chilean State—although with some nuances across different State institutions. Others, including indigenous groups and part of the scientific community, argue that brine is a type of water and therefore point out that lithium mining in salt flats is nothing more than water mining (Babidge et al., 2019; Garcés and Álvarez, 2020; Ejeian et al., 2021; Jerez et al., 2021). The brine-water nexus has been analyzed from a diversity of perspectives among others molecular analysis (Ejeian et al., 2021), critical resource geography (Bustos-Gallardo et al., 2021), political ecology (Jerez et al., 2021) and hydrogeology and geochemistry (Marazuela et al., 2019; Munk et al., 2021). This article contributes to the above scholarship by providing a critical legal geography perspective.[2] To this end, we analyze by whom and on what grounds specific legal definitions and interpretation of mineralized groundwater are articulated and how they (might) influence the regulation of mining of lithium and other minerals in salt flats.

For our analysis, we draw from recent work at the intersection between hydrosocial research and critical legal geography. This emerging scholarship sets out to understand in detail how laws, decrees, legal institutions, meanings and practices play an active role in defining and reconfiguring water(s) and their governance (Jepson, 2012; Cantor, 2016; Campero and Harris, 2019; Cantor et al., 2020). We extend the application of such an approach to lithium mining showing how—as for the case of desalination discussed by Campero and Harris (2019)—the existence of legal loopholes and undefined techno-legal frameworks has been used by powerful actors—mining companies—to push forward an interpretation on mineralized groundwaters as mineral resources that underpin an ongoing hydrogeographic reconfiguration.

We also examine the legal basis and potentials in fostering more just and sustainable governance of salt flats (and lithium mining) of two alternative understandings of water/brines, namely brine as hybrid mineral/water and brine as a type of water. Our analysis speaks directly to debates on water justice as it shows how legal frameworks are far from neutral tools but embed particular understandings and ways of knowing of water-society relations, while excluding others (Zwarteveen and Boelens, 2014). The paper is organized as follows: in the next section we introduce the analytical framework guiding our research, namely hydrosocial analysis and legal geography approaches. Subsequently, we describe the research methods and the case studies. We then outline the legal foundations on which the current prevailing interpretation of mineralized groundwater is based and how it has been defended and operationalized within the environmental impact assessment processes of currently approved projects—including contestations. We also explore emerging regulatory alternatives and how they consider the hydrogeological complexity of salt flats and discuss how these might contribute to safeguarding the socioecological balances and functions of salt flats. We conclude with a summary

1 Indigenous communities and associations are the central legal and organizational structures recognized by the state under the 1993 Indigenous Law (No. 19.253). They do not necessarily coincide with indigenous communities' territorial claims and social organization (Lorca et al., 2022).

2 This paper is part of a broader PhD research project on lithium mining in Chile led by the first author. The legal analysis presented in the article was facilitated by the legal background and expertise of the first author.

of our argument and a reflection on the implications of our analysis beyond the case of Chile.

2. Multiple waters and critical legal water geographies

In an often-quoted book, Jamie Linton asks "What is water?" (Linton, 2010). In the text, he goes on to explain that how water is defined and by whom largely shapes how water-related problems are addressed and, relatedly, which solutions are found. In this and other works, Linton traces the emergence of the so-called modern water paradigm, which is a tendency to understand water as essentially one and manage it out of its geographical, historical, and sociocultural contexts using uniform measures and rules (Linton, 2010, 2022; Boelens, 2014; Budds et al., 2014; Linton and Budds, 2014). Linton's work is a key contribution in hydrosocial research, a growing field of study largely inspired by political ecology to underscores the geographical and historical process through which water and society make and remake each other over time and space (Linton and Budds, 2014, p. 170). The hydrosocial approach has been used to make visible water injustices—the processes, interventions and tools (including laws) that (re)produce unequal distributions of water (Boelens et al., 2018). This includes injustices related with the distributions of goods and bads (distributional justice), with inclusion/exclusion in decision-making (procedural justice), and with recognition and legitimization of political, social, and cultural standings and values (recognitional justice). The latter includes exposing how dominant actors (try to) impose belief systems and truth regimes on how water and socio-natural relations should be understood and governed, typically by excluding and assimilating alternative modes of representation and knowledges (see for instance Linton, 2010; Boelens, 2014; Linton and Budds, 2014; Boelens et al., 2016). These contested belief systems and regimes of truth contribute to define and order specific hydrosocial configurations that is the networks of humans, water flows, ecological relations, hydraulic infrastructure, financial means, legal-administrative arrangements, and cultural institutions and practices (Ferry and Limbert, 2008; Boelens et al., 2016; Swyngedouw and Boelens, 2018).

The hydrosocial literature has contested the "modern" paradigm of water and hydrological cycles proper to the western hydrological scientific discourse (Linton, 2010; Boelens, 2014; Budds et al., 2014; Linton and Budds, 2014; Hommes et al., 2016). Likewise, hydrosocial research has devoted growing attention to analyze waters' multiplicity that is "the particular conditions and circumstances out of which various meanings, or practices, emerge, giving rise to different waters" (Linton, 2022, n.a.). This in turn entails studying the "temporal menagerie of meaning, materiality and legal structure through which water becomes known when different regimes of exploitation and extraction become attached to it at various points in history and cascade forward in time" (Vogt and Walsh, 2021, p. 1). Importantly, different water here refers not merely to different representations of water but different underlining realities of water itself, or different ontologies (Bonelli, 2017; Yates et al., 2017; Jerez et al., 2021; Linton, 2022; Ramos and Tironi, 2022). Laws, regulations and legal frameworks more in general play a significant role in the process of defining water(s) and in shaping its allocation and access. For instance, Zurita et al. (2015) show how different definitions of water are embedded in and constructed by various EU legislations, including the European Water Framework directive. Bakker et al. (2018) show how regulatory frameworks work to exclude Indigenous groups with respect to water allocation in Canada. In the Latin American context, the works of Boelens and Prieto, for example, have explored how legal definitions and regulatory systems interact with the plurality of local water rights present in the region and analyzed the associated diverse dynamics of symbolic and material water disciplining, resistance and resurgence (Vos et al., 2006; Boelens, 2009, 2014; Prieto, 2015, 2016).

How hydrosocial relations are shaped by laws and regulatory practices and processes is the focus of critical legal water geographies research. This field builds on wider legal geography work on the symbolic (or "nomic") power of laws and on how law shapes territories through discourses and practices (Blomley, 1994, 2003; Delaney, 2010, 2015; Braverman et al., 2014). When applied to the study of water regulation and governance, the legal geography lens demonstrates how various legal discourses, frameworks and maneuvers contribute to shape hydrosocial configurations and produce socioenvironmental and economic injustices. Laws and legal frameworks are analyzed as socially and historically situated, products of social power, and productive of specific water and society relations (Meehan et al., 2023). This approach has been employed to analyze domestic water access and water governance in the USA (Jepson, 2012; Cantor, 2016; Cantor et al., 2020) and, more recently, to analyze desalinization projects in Chile (Campero and Harris, 2019). The work of Campero and Harris (2019) is of particular interest for us for it focuses on Chilean water governance and it points at how legal ambiguities in relations to the definition of waters—in their case desalinated seawater—open the space for various interpretations. They show how one of the basic techniques of legal interpretation or integration, legal coupling—that is "the insertion of one legal framework into another in order to fill gaps" (Campero and Harris, 2019, p. 5)—has significant consequences in shaping hydrosocial relations.

Beyond the work of Campero and Harris (2019), a wide body of hydrosocial research has analyzed Chilean waters. Several studies have focused on the effects—in terms of access to and distribution of water—of the application of the private property regime enshrined in the Water Code, making visible processes of dispossession and water appropriation in favor of productive activities (mainly agriculture and mining) in indigenous and non-indigenous territories (Budds, 2008, 2009, 2010; Prieto, 2015, 2016, 2022; Romero-Toledo and Jenkins, 2022). Researchers have also studied how hydrological knowledge has played an important role in the production of unequal water geographies by imposing a technocratic understanding of water management, excluding local knowledges and imaginaries and the social complexity linked to water (Budds, 2009; Usón et al., 2017). Hydrosocial approaches have been applied to the study seawater (Campero and Harris, 2019; Fragkou and Budds, 2020) and, more recently, mineralized groundwater (Jerez et al., 2021).

Taken together, legal geography and hydrosocial approaches allow for further understanding of who and based on what (legal and technical) assumptions and knowledge systems designs, control and have the power to (re)produce specific hydrosocial

configurations. In the case of lithium mining, it enables us to scrutinize how legal loopholes and techno-legal frameworks have facilitated public-private mining interests to push a particular interpretation of mineralized groundwater. Once put into practice, the legal definition imposed has allowed its promoters to (re)configure water governance and the articulation and disciplining of discourses that sustain the current hydrosocial configuration of the salt flat basins.

3. Case studies and methods

The analysis focuses on legislation related with water and mining and on the three single lithium projects that currently have an Environmental Qualification Resolution (RCA) to extract mineralized groundwater in salt flats.[3] The RCA is the official document that certifies that the project complies with environmental regulations and thus can be implemented. In this section we first briefly introduce the three projects and subsequently we describe the research methods. The location of these projects is illustrated in Figure 1 and their environmentally authorized extraction quota of brine and freshwater in Table 1.

Two of the mining projects we consider operate in the Salar de Atacama, the largest producing brine deposit in the world (Cabello, 2021). Both projects are characterized by a long history that goes back to the 1970s when explorations for lithium in the salt flat was initiated by the Chilean Economic Development Agency (CORFO). Both projects operate under contracts that CORFO established with two mining companies: MINSAL (today SQM Salar S.A.) and Sociedad Chilena de Litio (today Albermarle Lim.). Both projects underwent several changes in ownership and management over time shaped by political shifts in Chile particularly the neoliberal turn of the 1980s (for a historical overview see Poveda, 2020). The first project has been operating since 1996 and it is currently run by the Chilean company Sociedad Química y Minera de Chile (SQM), the second-largest lithium producer in the world and partially owned by the Chinese Tianqui. SQM extracts lithium and other minerals such as potassium. The second project has been operating since the 1984 and since 2015 it is run by the American Albemarle Corp. the largest lithium producer in the world. SQM and Albermarle pay rents and royalties to CORFO according to contracts renewed between 2016 and 2018 in a process not without controversy (CORFO, 2018; Poveda, 2020). In the study we consider a third project, "Proyecto Blanco" (in English, White Project). This project is located in the Salar de Maricunga and will be operated by Minera Salar Blanco (MSB) who owns the mining concession. The construction of the project should start in 2023. The project received the first RCA for lithium and potassium operations granted by the State environmental authorities outside the Salar of Atacama.

All three project have—or will have in the case of MSB—profound impacts on local communities, particularly indigenous people. The projects are located in recognized or claimed indigenous territories. MSB's project is located in the ancestral territories claimed by the *Colla* people, communities involved in small scale agriculture, livestock grazing, and transhuman pastoralism (Flores Fernández, 2021). Meanwhile, SQM and Albemarle operate in the territories of the several indigenous groups collectively referred to as *Atacameño/Lickanantay* under the 1993 Indigenous Law. Under the same law, the so-called Atacama La Grande Indigenous Development Area was created in 1997.[4] The *Atacameño/Lickanantay* practice traditional Andean terraced agriculture, livestock grazing, petty trade and some work as laborer in mining companies (Budds, 2010; Liu and Agusdinata, 2020). Some *Atacameño/Lickanantay* communities are reunited under the Consejo de Pueblos Atacameños (CPA). The CPA works as an indigenous association and it involves representatives from 18 indigenous communities (Río Grande, Machuca, Catarpe, Quitor, San Pedro de Atacama, Solcor, Larache, Yaye, Séquitor, Cúcuter, Coyo, Toconao, Talabre, Camar, Socaire, Peine, Solor y Huatín). Each community is represented by two members. The CPA seeks to express a single "indigenous voice" however its legitimacy in representing the *Atacameño/Lickanantay* people has been questioned by some communities (Lorca et al., 2022). Water has significant productive and symbolic-cultural meaning for indigenous communities who mobilize local rules and customary practices (*costumbres*) to recognize water as sacred subject and ensure its continuous flow, the success of crops, and community ties (Prieto, 2016).[5] The indigenous communities of the Atacama and Maricunga salt flats share a growing concern for the consequences that the extraction of brines has and will have on water, water-bodies, and ecosystems (Flores Fernández, 2021; Lorca et al., 2022). However, within and between different indigenous groups there are ambivalent positions with respect to the engagement with lithium companies and different strategies have been used including elements of both resistance and negotiation to respond to extractivism (Romero-Toledo, 2019; Jerez et al., 2021; Lorca et al., 2022).

The analysis is based on data obtained through interviews and the review of laws and documents related to plans and projects aimed at expanding lithium mining and extracting other minerals in Chilean salt flats. The first author carried out 25 interviews in 2021 and 2022. Interviewees include hydrologist and legal experts, members of civil society and State administrations including the Ministry of Mining and the General Directorate of Water (Dirección General de Aguas, DGA) that is the public agency in charge of water resources and basin management.

3 A fourth project, called "Producción de Sales Maricunga" in Salar de Maricunga, received an RCA in 2020 but was later revoked by the Supreme Court in 2022, and it is currently in the environmental assessment process for the completion of indigenous consultation. In this article we cover only those RCAs that authorize groundwater extraction quotas (brine and/or fresh water), not all those linked to production quotas and other mining processes.

4 The ADI was created in recognition of the close link between the Atacameño and the salt flat in terms of "agricultural activities, the rational use of water resources, grazing activities in meadows and wetlands and, in general, the use of the territory in the form of occupation of complementary ecological levels, based on the transhumance system between wintering and summer grazing" (Decree No. 70/1997 MIDEPLAN). However, its creation does not imply recognition of indigenous property rights over a geographical area.

5 It is noteworthy that *costumbres* and indigenous identity more in general are not fixed but dynamic transforming over time shaped by political, economic processes, changing power relations (Prieto, 2016; Lorca et al., 2022).

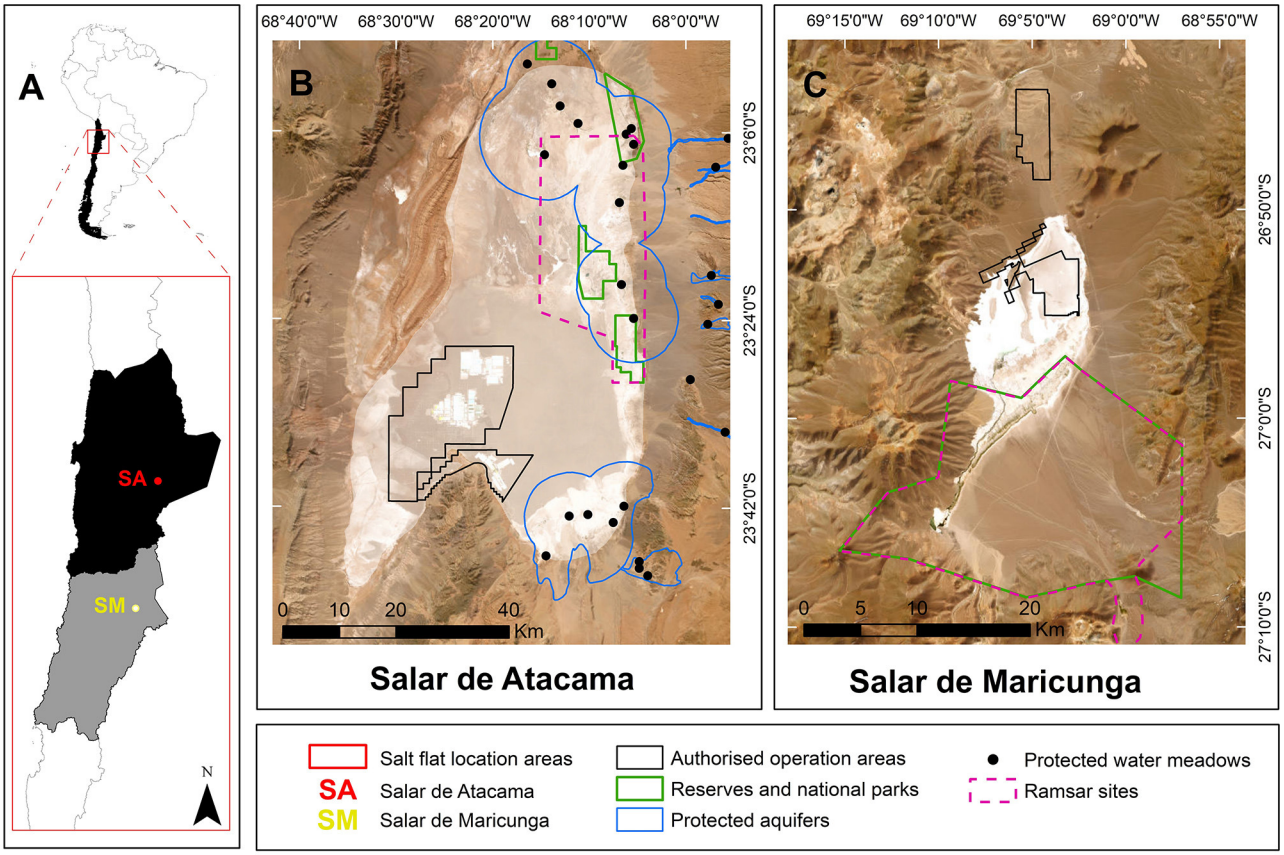

FIGURE 1
(A) Location of Atacama and Maricunga salt flats in Chile, **(B)** Atacama salt flat, and **(C)** Marigunga salt flat. Maps were created in ArcGis v.10.3.1 for desktop (ESRI, Redlands, California, USA) with Datum WGS 84 and projection UTM zone 21S. Geospatial information from CONAF (National Forestry Corporation of Chile; https://www.conaf.cl), DGA (Directorate General for Water of Chile; https://dga.mop.gob.cl/). Background for **(B, C)** from World Imagery - Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

TABLE 1 Characteristics of the mining projects.*

Mining company	Owner mineral concession	Location	Current authorized brine extraction quota**	Authorized freshwater extraction quota*	RCA associated
SQM	CORFO	Salar de Atacama	1.600 l/s	240 l/s	226/2006
Albemarle	CORFO	Salar de Atacama	442 l/s	23,5 l/s	21/2016
MSB	MSB	Salar de Maricunga	209 l/s	35 l/s	94/2020

*Approved figures, not necessarily total amount extracted.
**Net annual average.

Interviews focused on salt flat mineralized groundwater's legal and regulatory aspects and socioecological consequences of its extraction. Document review included legal texts such as the Chilean constitution, Chilean and foreign mining and water laws and regulations and a wide series of publicly available reports from governmental, judicial and administrative agencies related mainly to the three mining projects, particularly the environmental impact assessments. The analysis focused on how and if mineralized groundwaters are defined (as waters or mineral resources) as well as how their extraction is related with the extraction of other waters. As these documents are written in Spanish, the quotes we report below are our own translations.

4. Legal status quo: salt flats as mineral deposit and mineralized groundwaters as mining resources

> *"In our legal system, there is no regulatory treatment for the exploration and exploitation of brines located in salt flats. This legal vacuum is explained by the fact that mining legislation has been passed without considering the existence of mineral concentrations in liquid or aqueous mediums."* (Min. Minería, 2020b, p. 31).

In Chile, no specific legal framework regulates the extraction and use of minerals—like lithium and potassium—from mineralized groundwaters (Min. Minería, 2020a,b). Strictly speaking, as suggested by the quote above, mining legislation focuses on static mining deposits and not on liquid ones, like mineralized groundwaters. At the same time, as groundwaters, in principle, they should be governed by the Water Code, which stipulates that its provisions apply indistinctly to all terrestrial waters, both surface and groundwater. However, it has been considered that the Water Code does not explicitly recognize mineralized groundwater-brines as waters (Tala, 1994). This has left space for interpretation when it comes to the regulation of mineralized groundwater or brine extraction in salt flats.

In the absence of a dedicated legislation, the current prevailing interpretation extend mining legislation to salt flats and their mineralized groundwaters. The normative basis for this interpretation is found in the norms of the Constitution of 1980 and the 1983 Mining Code. According to these regulations, salt flats are part of the State mining patrimony: "the State has absolute, exclusive, inalienable and imprescriptible dominion over all mines, meadows, metalliferous sands, salt flats, coal and hydrocarbon deposits and other fossil substances, except for surface clays" (Chilean Constitution, article 19 No. 24, paragraphs 6 and Mining Code, article 1). In this sense, salt flats could be understood as another type of static mining deposit (Tala, 1994, p. 45; Min. Minería, 2020b, p. 5; Jerez et al., 2021). Specifically, the eminently "mining nature" of brines has been indicated by recent reports commissioned by the Ministry of Mining as linked to the provision contained in the Mining Code Regulations (art. 60), which define salt flat as "a superficial saline deposit, consisting of a saline crust of variable thickness, with occluded saline solutions (…)" (Min. Minería, 2020b, p. 13). Thus, mineralized groundwater could be defined as "occluded saline solutions" (not as water resources) and as constituent part of the salt flat being, therefore, a mining resource within mining deposits (Min. Minería, 2020a, p. 36; Min. Minería, 2020b, p. 13, 32).

Constitutional mining norms added that the law would define which substances may be subject to mining concessions for exploration or exploitation to private parties and which would be reserved for the State (Chilean Constitution, art. 19, No. 24, paragraphs 7). Lithium has fallen into this category since 1979 when it was declared as non-concessionable mineral (Decree Law 2.886 art. 5). This means that lithium extraction and exploitation can be carried out only by the State or its companies, under administrative contracts or special lithium operation contracts (CEOLs).[6] Following the purely mining logic, the mining concessions and contracts include the right to explore or exploit and even evaporate mineralized groundwater from the salt flat they cover (Tala, 1994, p. 45; Min. Minería, 2020b). According to Tala (1994), the above interpretation is justified since in these cases the extraction of such water does not have a "water purpose" as such, but is carried out as a necessary activity to exercise the rights derived from the mining permits and in order to appropriate the minerals (Tala, 1994, p. 44).[7]

A legal classification and treatment of salt flats as mineral deposits and brines as mining resources has important implications in the (re)configuration of hydrosocial relations. First, the State has ownership on salt flats and its mineralized groundwaters and may grant mining concessions, administrative contracts, CEOLs or explore and exploit them directly or through its companies depending on the mineral substances to be obtained. Moreover, it should be noted that the processes for the constitution of strictly mining concessions and permits do not consider environmental aspects, citizen participation or possible indigenous consultation. Therefore, they can be granted directly on, for example, protected areas or indigenous territories.[8]

Second, authorizations for extraction of mineralized groundwaters in salt flats for mining proposes do not follow the procedures established by the Water Code for the constitution of groundwater exploitation rights. Instead, the quotas to be extracted are defined and authorized within the environmental assessment processes of mining projects following the System of Evaluation of Environmental Impact Assessment System (Sistema de Evaluación de Impacto Ambiental, SEIA).[9] As functionaries of the DGA explained to us: "there is a special extraction of brine that is governed by a different legal regime... what is water extraction is under the tutelage of the DGA through water use rights and what is brine extraction is regulated through the environmental impact assessment system carried out by the Environmental Assessment Service [SEA]" (in similar vein DGA, 2021a, p. 196). According to the SEA, projects for the exploitation of lithium and other mineral substances must enter the SEIA based on the typology of mining projects and the amount of brine extracted (classified as a mineral by the SEA) (SEA, 2021, p. 15).[10] In the

6 To date, the only special lithium operation contract (CEOL) is the one signed in 2018 with the subsidiary of the State-owned company CODELCO for projects in the Salar de Maricunga (currently in the exploratory stage). Two tenders were awarded in 2022 to enter CEOLs with the State but were overturned by the Supreme Court in 2022. For commercial proposes, the Chilean Nuclear Energy Commission (CCHEN) must also have previously approved marketing lithium quotas according to DL 2.866 and Law No. 16.319.

7 Mining concessions and rights do not preclude the need for specific environmental permits such as the RCA. Since the entry into force of the SEIA, these permits must be obtained before the construction and operation of the projects.

8 Indigenous consultation, at least, has begun to be considered in the case of future CEOLs (Supreme Court, 2022).

9 The SEIA was established in the Environmental Basis Law (EBL) of 1994. Only after that date did projects begin to be environmentally evaluated, which became mandatory with the entry into force of its regulations in 1997. During the interim period, entry to the SEIA was voluntary.

10 Depending on the impacts of the project, an Environmental Impact Assessment (EIA) or an Environmental Impact Statement (EIS) might be submitted (Environmental Basis Law, art. 11). The EIA applies to projects that potentially involve, among others, health risks, adverse effects on renewable natural resources, resettlement or significant impacts on the living environment and customs of people and if they are in the vicinity of populations, resources and protected areas. When projects do not generate these effects, an EIS can be submitted. A significant difference between

assessments, the socioenvironmental impacts of projects are evaluated based on studies prepared and submitted by mining companies for the sole and exclusive purpose of obtaining an environmental license to operate (Broitman and Kreimer, 2018), including hydrological models, simulations and measurements or mathematical calculations (SEA, 2021). If the presented information is approved, the projects obtain his environmental license (RCA).

A third implication, resulting from the previous one, is that the extraction of brines from salt flats is managed separately from fresh and lower salinity water extraction, which are categorized and treated as a water resource according to the Water Code. For this reason, mineralized groundwater and its interactions with lower salinity aquifers have not been subject to greater analysis or integrated into the DGA's studies, models and water balances, an issue that has recently been attempted to be partially rectified, at least for the Salar de Atacama (CORFO, 2021; DGA, 2021a). By not applying water law restriction, permits to extract and consume brine may be obtained in basins with insufficient water balances. They may also not be declared as depleted or areas prohibited for the constitution of water rights. According to Jerez et al. (2021, p. 8) "by not explicitly recognizing brine as a water entity in legal terms but as mining property, the hydrosocial impacts of brine exploitation are invisible, and only the freshwaters of the salt flat are considered."

Lithium companies have promoted the legal interpretation of mineralized groundwaters as mining resources by publicly denying their water character (SONAMI, 2017; SQM Salar S.A., 2021a, p. 08). In official reports published, mining companies argue that extracted brines cannot be considered water resources because they contain more than 300.000 mg/L of total dissolved solids (TDS; ten times more than seawater). Therefore, the argument goes, they are unsuitable for human consumption or activities related to agriculture and livestock (SQM Salar S.A., 2021a; Albemarle, n.d.). Mining companies take as a reference water quality standard for irrigation water (Chilean norm 1333) and drinking water (Chilean norm 409) that establish corresponding maximum concentration limits of 5.000 and 1.500 mg/L respectively (SQM Salar S.A., 2021a). Thus, water that evaporates after extraction is not considered as part of water consumption by lithium companies, which point out that their operations consume practically no freshwater (SONAMI, 2017; Bustos-Gallardo et al., 2021; SQM Salar S.A., 2021a; Albemarle, n.d., p. 08). As we show below, the legal interpretation of brines as mining resources separates from water resources is used and reaffirmed by mining companies in the environmental impact assessments of mining projects. In these studies, "brine" aquifers are conceptualized as hydrogeological structures separated or mainly disconnected from the freshwater-brackish aquifers. This is in turn, the basis used to rule out or minimize the impacts on water resources, hydrological systems and related local community practices and livelihoods. This interpretation is, however, contested by some indigenous groups and others who rather support an understanding of brines as (a type of) waters.

5. Operationalizing the water/brine divide in the environmental impact assessments

5.1. SQM Salar S.A., Salar de Atacama

The first mining project for exploiting mineral groundwaters that entered the SEIA was a potassium chloride production project in the Salar de Atacama. This project was presented in 1994 through and Environmental Impact Assessment (EIA) by the Sociedad Minera Salar de Atacama Ltda (MINSAL), company subsequently bought by SQM. The potassium project was approved in 1995 and subsequently started in 1996. In the same year, a new EIA was submitted and SQM obtained an RCA to start lithium carbonate production, authorizing the extraction of 215 l/s gross brine and 22.5 l/s of freshwater. Between 1996 and 2005, SQM submitted requests to increase its quotas, obtaining in 2006 the RCA 226/2006. According to this resolution SQM could today extract net annual quotas of 1,600 l/s of brine (to which are added extra quotas for the reinjection of waste brine) and 240 l/s of freshwater.[11] These extractions are carried out from aquifers that feed or are connected to lagoons and wetlands located on the eastern edge of the salt flat, part of which are included in the Los Flamencos National Reserve and Ramsar Site Soncor.

In the first EIA presented in 1994 and approved in 1995 (RCA 403/1995), brines are recognized as "saline groundwater underlying the salt flat" (MINSAL, 1994, p. 42). Despite this, SQM presented and treated its extractions of brines separately from the extraction of freshwater for mining processes. The EIA refers to data suggesting a limited hydraulic connection between brines and the lagoons (MINSAL, 1994, p. 185). Building on this, the numerical modeling presented to calculate the water balance and fluid flow indicated that the extractions requested would have a slight impact on the lagoon's groundwater table (phreatic level). The company argued that the predicted decline—of <10 cm in 25 years—would not imply a considerable loss in the amount of ecological soil capable of providing habitat for the biodiversity that inhabits the ecosystems. Hence, the company ruled out that its operations would significantly impact water resources—here referring to lagoon waters and not to brines—biodiversity and the traditional agricultural and livestock livelihoods of members of the *Atacameño/Lickanantay* ethnic group settled east of the salt flat (MINSAL, 1994, p. 187).

In its 2005 request for expansion of extraction quotas, SQM writes that "the brine does not correspond to any type of water resource, but a mining resource," and therefore its extraction would not be related to the intervention or exploitation of water

EIA and EIS is that citizen participation processes are mandatory for the former. For the latter, they are eventual. Importantly, the obligation to open indigenous prior consultation procedures only applies to EIAs and to the extent that one or more human groups belonging to indigenous peoples are "directly affected" (EBL art. 29 and 30, SEIA Regulation art. 85 and 94).

11 SQM started to reduce these extraction quotas due to environmental non-compliance (SMA, 2022a) and then in the context of its "Sustainable Development Plan" in which they indicate that they will gradually reduce their extractions to 50% of the total approved by RCA 226/2006 (DGA, 2021a, p. 171).

resources (SQM Salar S.A., 2005a, p. 307). The EIA reaffirmed the disconnections between brine aquifers and less saline aquifers—by a barrier of low hydraulic conductivity. This in turn was used by SQM to argue that despite the decreases in the water table generated by the brine extraction in the aquifers, neither the water resources nor the natural behavior of the lagoons and wetlands requested quotas would be significantly affect (SQM Salar S.A., 2005a, p. 210–216; SQM Salar S.A., 2005b). According to these assumptions, the company postulated that the project and its new extraction quotas would not generate significant adverse social or environmental impact (SQM Salar S.A., 2005a, p. 37–39).

It is important to note that citizen participation in the assessment process was limited. Indeed, groups such as the *Atacameño/Lickanantay* indigenous communities of Peine, Toconao and Socaire attempted to question the company's position on the impacts and meaning, and functioning of the salt flat and its multiple waters. Still, their comments were not included due to formal reasons. Eventually, SQM obtained the RCA 226/2006 authorizing its current extraction quotas, whose maintenance and management have involved subsequent updates of hydrogeological modeling initially presented. These updates are built on and continue to refine the understanding that brine extraction is separated from other waters. More specifically, water and brine aquifers are understood as divided by a low conductivity salt cradle or interface (SQM Salar S.A., 2021b) defined as a "zone of mixing between two fluids of different density (e.g., Water/Brine)" (SQM Salar S.A., 2017, p. 256).

The division between the water and brine aquifers has been discussed in recent years as part of the auditing and sanction processes started by the Superintendency of the Environment, SMA, against SQM. These processes summarize recent investigation by the SMA on the operation of SQM carried out after repeated environmental and contractual breaches, and illegal political financing of SQM became known (Poveda, 2020). Environmental non-compliance included, among others, the extraction of brine in excess of authorized quotas (3.9%), adverse impacts on protected flora and the non-compliance and modification of monitoring and warning plans without authorization (SMA, 2016). Importantly, as part of the auditing process, it was recognized that there is a high degree of scientific uncertainty regarding the hydrodynamic behavior of the salt flat and a lack of information regarding its hydrogeological functioning and water balance (First Environmental Court, 2019; see also Amphos21, 2018, p. 321; ff and DGA, 2021a). This implies that, despite more than 30 years of continuous exploitation, it still hard to assess the impacts caused by brine and freshwater extractions on the salt flat ecosystem. Eventually, no sanctions were applied and the SMA finally approved an Environmental Compliance Plan (PdC) in which in SQM committed to reducing water and brine quotas and to carrying out "more and better" studies and modeling (SMA, 2022a).

The techno-scientific and legal conceptualizations that separate mineralized groundwater and water have been challenged by the CPA. The CPA intervened both in the sanctioning procedure against SQM and in the claims filed against the agreement that CORFO signed with SQM in 2018 to continue exploiting the salt flat. According to the CPA, "the critical situation in which the Salar de Atacama finds itself today is also the result of a state policy that seeks to treat brine as an input and not as a water resource that is part of a very complex ecosystem of the salt flat, an issue that the Atacameño-Lickanantay communities have raised in all instances" (CPA, 2018, p. 17). Among other issues, the CPA argues that the PdC was based on a conceptual model that assumes hydraulic independence between the core of the salt flat and the lagoon systems of the marginal zone, without a robust scientific basis (CPA, 2022, p. 49). This interpretation of brine as non-water and as brines as separated from other waters opposes the conception of basin unity underpinning the cosmovision of the indigenous communities for whom all the waters are part of the salt flat ecosystem (CPA, 2017, p. 10).

5.2. Albemarle Limitada, Salar de Atacama

Albemarle Limitada started its lithium production in the Salar de Atacama in 1984. These facilities, initially operated by Sociedad Chilena del Litio (SCL) and then Rockwood, entered the SEIA system for the first time in 2000 through an Environmental Impact Statement (EIS), obtaining the environmental authorization to pump 113 l/s of mineralized groundwater in the RCA 092/2000 (Rockwood, 2014). Subsequently, in 2004 and 2009 the company requested to increase its brine extraction quota, first through an EIS and then through an EIA. In 2016 and after cumbersome environmental assessment processes Albemarle obtained RCA 21/2016 which authorizes it today to extract 442 l/s of brine and 23,5 l/s of freshwater from the salt flat basin. While mineralized waters are extracted from the core aquifer, freshwaters are extracted from the southwestern aquifers of the salt flat, mainly from the Monturaqui-Negrillar-Tilopozo (MNT) aquifer that sustain the Tilopozo meadows.

The case of Abemarle provides a good example of how different interpretations of the water/brine divide exist and are discussed within the environmental assessment. While Albemarle considers brine separately from water, (part of) the environmental authorities consider mineralized groundwaters as water in their own right to weigh the impacts of their extraction. This is evident in the assessment of the impacts related to the request for an increase of extraction quotas submitted in 2004. Initially, the company argued that its lithium extraction project does not generate adverse effects on renewable natural resources such as water since it "does not contemplate the intervention or exploitation of water resources in areas or zones of meadows, peatlands or humid zones" nor "the exploitation or intervention of water resources from one basin or sub-basin transferred to another" (SCL, 2004, p. 34). Based on this argument it submitted an EIS that was rejected by the environmental authorities. The latter argued that the project was likely to cause significant adverse effects on the quantity and quality of renewable natural resources and thus a EIA should be submitted (COREMA II, 2005). Indeed, contrary to the company's statements, both the regional DGA and environmental authority considered that the extraction of brine as affecting water resources since: "the project implies an additional extraction of 29 l/s of brine, that is, exploitation of water resources and intervention of the Salar de Atacama aquifer, whose rise or fall in groundwater levels could affect the meadows

and peatlands of the sector [of the salt flat]" (COREMA II, 2005; DGA, 2005a). However, the decision was later revoked by the national environmental assessment bodies following a complaint filed by the company. This change of opinions was based on the change of interpretations of the National Directorate of the DGA which—in contrasts to the regional DGA-accepted the mining company's thesis that the extraction would be carried out "in the core of the Salar de Atacama, as a mining resource and not in the freshwater groundwater aquifers" (DGA, 2005b; SCL, 2005; CONAMA, 2006, p. 9) and thus the project's impacts would be practically null on the protected areas of lagoons and meadows (CONAMA, 2006). Accordingly, the request for extraction of an extra 29 l/s brine quota, totaling 142 l/s, was approved (RCA 3132/2006).

Later, in 2009, Albemarle sought to increase its brine quota by 600 l/s as an annual average by submitting an EIA. After three complementary submissions (addenda) the EIA was rejected in 2011 due to deficiencies in the baselines and hydrogeological models presented to identify and estimate impacts (COREMA II, 2011). Nevertheless, the project was revived by filing an appeal for reconsideration (SCL, 2011), leading to the submission of two new addenda, halving the requested brine quota increase to 300 l/s. In these addenda, the company presented evidence based on a new hydrological model that considered a semi-impermeable saline interface between brine aquifers and freshwater-saline ones. This structure would physically separate the core brine and the freshwater-saline aquifer that feeds the lagoons and wetlands (Rockwood, 2014, 2015). The new studies and hydrogeological models concluded that the requested increase in extraction would not generate adverse impacts on the lagoon and aquifer systems of the salt flats, and on the life systems and customs of the groups living in the basin. It is important to keep in mind that the RCAs of Albemarle and SQM and the commitments established therein are concatenated (e.g., the execution of their monitoring and warning plans are conditioned to those of the other company) (DGA, 2021a, p. 133).

Within the EIA process, different interpretations of brines were put forward. For instance, the indigenous community of Peine questioned the brine/Water divide included in the EIA presented in 2009 arguing: "For us, there is no distinction between freshwater and brine (...). The water is one and belongs to us, the communities on the edge of the salt flat as owners of the surface and groundwater, as users of the basin and the various ecological services it provides (...)" (CIA Peine, 2009, p. 1). The indigenous community of Toconao argued for its part that "the hydrological system of the Salar de Atacama is one, it is intercommunicated; therefore, anything that happens in a specific sector will alter the entire salt flat (...) many times, the modeling of the waters that the companies carry out, in Ancestral Indigenous territories, are erroneous (...)" (COREMA II, 2011, n.d.). The mining company dealt with these concerns by establishing agreements with *Atacameño/Lickanantay* community of Peine and the CPA and thus ruling out adverse impacts on them (Rockwood, 2015, p. 151–153). These agreements stated to have had as an express frame of reference Convention 169 of the International Labor Organization setting a direct contribution of 3.5% per year of their sales (nearly US$40 million from 2022 sales), establishing, among other aspects, a "participatory, voluntary and integrated" monitoring (Rockwood, 2012, 2016; Albemarle, 2019). As a result, these indigenous groups supported the project, which was approved by RCA 21/2016.

The economic agreements have allowed Albemarle to establish an apparently better relationship with the main indigenous organizations than its neighbor SQM. However, the environmental management of the operation has not been without its share of problems. For instance, in March 2022, Albemarle was charged with environmental non-compliance for, among other things, pumping more brine than authorized in its environmental resolutions (SMA, 2022b). In the same month, the State filed a lawsuit for environmental damage against Albemarle and two other companies that extracted water from the MNT aquifer. The lawsuit denounced that the extractions generated a decrease in the water level above what was environmentally permitted and affecting the Tilopozo meadows (CDE, 2022). In the context of the lawsuit, Albemarle offered to stop using its water rights from MNT (18.5 l/s of the 23.5 l/s authorized in RCA 21/2016) (Albemarle, 2023). This situation occurs in a general scenario where the functioning, evolution and water health of the lagoon systems, meadows, peatlands and native species are unknown, as well as the impacts that the extraction of freshwater and brine generate on them and the entire Salar de Atacama basin (DGA, 2021a, p. 274–276, 300).

5.3. Proyecto Blanco, Salar de Maricunga

The logic and vision that have guided the development of lithium mining in Salar de Atacama basin have begun to be also used in other salt flats. In September 2018, Minera Salar Blanco (MSB) submitted the EIA of the "Proyecto Blanco" in the Salar de Maricunga. The project involves the extraction of 209 l/s of brine and 35 l/s of freshwater to feed the industrial processes, both to be pumped from the Salar de Maricunga basin (SEA, 2020a).

According to previous studies by the DGA to determinate water availability, the salt flat basin had a water demand balance deficit of −344 l/s (DGA, 2016). Due to this basin deficit balance, if all fluids were considered water, the water/brine quotas requested by MSB would at least be problematic as the available "water resources" might not be sufficient to grant those quotas. The models and studies presented by MSB as part of the EIA indicated that the brine would be extracted mainly (86%) from deep "brine" aquifers. These aquifers were conceptualized in the hydrological models as disconnected from the shallow saline aquifers that support the socio-hydrological system of the Salar de Maricunga due to the presence of a clay hydrogeological structure. Based on this conceptualization of confined aquifers, MSB ruled out the generation of significant environmental effects on the water resource, loss of wetland vegetation, endemic flora, and in general, on the aquatic ecosystems associated with the protected areas of the salt flat belonging to the Nevado Tres Cruces National Park and the Ramsar site Complejo Lagunar Francisco and Laguna Santa Rosa (MSB, 2018; SEA, 2020a,b).

MSB used the thesis of no significant impacts on water resources and systems to rule out impacts on the agricultural and transhumant grazing practices and customs of a large part of the Colla indigenous peoples whose ancestral territories include the Salar de Maricunga and its wetlands (CVHNT, 2008; CONADI, 2017). The company's studies indicated that the Colla settlements,

lands, waters and transhumant routes were located far from the project works and outside the area of influence defined for impact on human groups which excluded the salt flat and wetlands (MSB, 2018; SEA, 2020b). Thus, MSB concluded that the project would only affect the transhumance practices of specific members of the Colla Community of Diego de Almagro due to the increased traffic generated by the operation of the project on surrounding routes. Therefore, the open indigenous consultation only considered this community, excluding those directly related to the salt flat basin (MSB, 2018; SEA, 2020a,b).

The information contained in the EIA and subsequent addenda was the subject of multiple requests for clarification, rectification or additions by sectorial bodies and observations made within the citizen participation instances. Among others, the Geology and Mining Service (Sernageomin) and the DGA questioned the central hypothesis of the models, which consisted of the supposed disconnection between the deep brine aquifer and the shallow aquifer (Sernageomin, 2019). They also indicate that the EIA lacked essential information to analyze the impacts generated by the affectation of groundwater flows on the lagoon and wetlands present in the National Park and the Ramsar Site and their characteristic flora and fauna, such as flamingos, vicuñas and guanacos' population (DGA, 2018a, 2019). Indigenous groups also intervened to question how MSB defined the impacts of the project. Among others, representatives of the Colla Pai Ote community indicated that "the justification of not affecting our community in the exploitation of the Salar de Maricunga, (…) ignores the cultural, social, religious, symbolic and economic life of our community, since the Salar de Maricunga, its waters, flora, fauna, minerals and even the ecological system in general, as well as the surrounding hills, are elements of our indigenous cosmovision, something that this study not only does not recognize, but omits (…)" (CICPO, 2018, p. 2). Despite the multiple observations, the SEA favorably qualified the project on 04 February 2020 through RCA No. 94/2020 endorsing the company's studies and assessments. Several administrative and judicial appeals were filed for the annulment of the RCA, alleging the unfounded exclusion of significant impacts and indigenous communities in the consultation process, among other infractions. Nevertheless, except for one claim still pending, all the appeals have been dismissed to date.

6. Alternative legal interpretations of mineralized groundwaters

The fact that a legal loophole nourishes the current legal treatment of mineralized groundwaters as mineral resource opens the door to alternative interpretations. Below we review two of them, starting from a recent attempt commissioned by State institutions to define the legal nature of brines and to recognize the brines/water interconnection. The second interpretation instead is based on understanding of brines as a type of water supported by indigenous groups and part of the academic community.[12]

6.1. Hybrid alternative: mineralized groundwater as aqueous reservoirs and joint extraction

In July 2020, the Ministry of Mining commissioned a study for the elaboration of a regulation for the extraction and use of brines located for mining purposes (Min. Minería, 2020a). Specific objectives of the study included defining the legal nature of mineralized groundwaters, the permits required for their extraction and its treatment in relation to other water sources present in a specific site (Min. Minería, 2020a, p. 36). Delivered in November 2020, the final report indicated that "the nature of brines involved two dimensions: on the one hand, brines share characteristics with groundwater, and on the other hand, they share the characteristics of a deposit of mineral substances" (Min. Minería, 2020b, p. 15). The report states that the legal nature of mineralized continental brines would be that of an "mineralized aqueous deposit contained in a salt flat with high salinity levels (…) in which different types of salts or soluble minerals are dissolved and susceptible to exploitation, which cannot be exploited without the extraction of the brine that contains them" (Min. Minería, 2020b, p. 135). According to the report, brines could "technically be identified as a water resource with high salinity levels" (Min. Minería, 2020b, p. 14).

Although the report talks about "brine-waters" and it recognizes that they are not mineral substances—hence mining permits are not an enabling title to extract them—it does introduce an exception for the case of joint extraction (Min. Minería, 2020b, p. 18). This occurs when, in the course of extracting minerals, substances that do not qualify as minerals (for instance brines) must be extracted at the same time (Min. Minería, 2020b, p. 15–19). Under this interpretation, the mining concessionaire, administrative concession or CEOL holder could dispose of brines involved in such extraction, having to comply with the common environmental requirements (Min. Minería, 2020b, p. 30–37). As one author of the report pointed out, "the reluctance to legally recognize brines as water is because this would make the development of lithium mining in salt flats unfeasible or very complex" (personal communication, senior Lawyer, January 12, 2021). This is since salt flats are often located in basins and areas where there are limitations, prohibitions, or restrictions for the granting of new water use rights (Min. Minería, 2020b, p. 23). For this reason, in the proposed regulation was necessary to look for an alternative that would make extraction legally viable (Min. Minería, 2020b, p. 15).

The report recognizes a degree of interaction and interdependence between waters and brines requiring brine extraction operations to be registered in the DGA's public water

12 The following exposition excludes the interpretation according to which the extracted mineralized groundwater carried out in the context of mining operation would be part of the so-called "miner's water": groundwater founded while mining operations over which the holder of a mining concession has, by virtue of law a right of use insofar as they are necessary for mining activities (Water Code art. 56 bis and Mining Code art. 110). This is because one of the requirements for its origin is that it is a fortuitous finding and not a work aimed at finding it intentionally, as is the case of non-metallic mining of lithium, potassium and boron, in which its extraction is the very purpose of the mining activity. In such a case, they should be recognized as groundwater.

cadastre: "the hydrogeological nature of these processes cannot be ignored, and their information is relevant for the DGA to consider in its water balances, as well as being available to the community in general" (Min. Minería, 2020b, p. 21). Moreover, the report suggests the application of groundwater extraction control regulation: since "groundwater basins containing the brines are located in sectors with a high degree of hydrogeological vulnerability which, in many cases, have been the object of formal declarations by the DGA (prohibition zones or restricted areas). This situation of fragility imposes on the authority the obligation to maintain permanent measurement, control and information systems" (Min. Minería, 2020b, p. 24). Likewise, those who extract brine should be part of the groundwater communities of the hydrogeological sectors of common use (HSCU).[13] In addition, the implementation of early warning plans should be required (Min. Minería, 2020b, p. 24).

The impacts of regulatory frameworks such as one proposed are difficult to foresee. As it remains within the scope of mining regulations, the current regulation of brines extraction regime likely not change beyond the direct involvement of the DGA in monitoring and research. Indeed, the purpose of the study was to find a way for make mining use of brines still viable. Although it proposes a hybrid water/brine interpretation, it does not entail restrictions or prohibitions for granting extraction quotas in basins or degraded or environmentally valuable areas, a previous understanding and integrated management of the basin, nor greater participation or consideration of water uses and visions of local communities. At the end, the proposal did not result in regulatory innovations and remained unknown to the current governmental authorities such as the Ministry of Mining itself (at least until the date of the interviews in 2022).

6.2. Mineralized groundwaters as waters and salt flat as integrated ecosystems

Beyond the current prevailing interpretation of mineralized groundwaters as mining resources, and the hybrid position illustrated above, a third interpretation understands brine as a type of waters. From this view, mineralized groundwaters should be treated as waters that form part of a hydrogeological ecosystem of great ecological and ancestral sociocultural value. The interpretation of brines as a type of (ground)water is supported by several researchers (e.g., Garcés and Álvarez, 2020; Ejeian et al., 2021; Jerez et al., 2021). It is also in line with the claims raised repeatedly by representatives of some indigenous groups during the environmental impact assessment and other contestation process (see Section 5). In this section, avoiding falling into utopian and romantic notions about Andean indigeneity (Gelles, 2010, p. 122; Romero-Toledo, 2019), we reflect on the legal implications of such an interpretation could have for the governance of salt flats, waters and for the recognition of the claims of indigenous people.

If mineralized groundwaters were legally consider waters (as they are terrestrial waters hidden in the bosom of the earth and which have not been illuminated), they would be governed by the Water Code and its regulations regardless of their mineral content (Water Code art. 1 and 2). This would have several other effects. First, in addition to the need to obtain mining permits and environmental permits, mining projects involving brine extraction would need to obtain water rights and such extractions would be categorized as water resource extraction. (Ground)water rights are granted by the DGA considering (i) groundwater availability and its long-term conservation; (ii) the protection of water use rights of third parties considering the relationship between surface and groundwater under the principle of "unity of stream"—which encompasses all waters that flow, continuously or discontinuously, surface or groundwater, into the same basin or watershed—and (iii) the presence of a RCA or pronouncement from the SEA if the catchment point is located within protected areas (Water Code, art. 3, 22, 59 and regulations on groundwater exploration and exploitation art. 20).

Second, the allocation and use of mineralized groundwaters or brines from salt flats should observe the principle of "unity of stream." That is, it should be considered and evaluated in the context of all waters in a specific basin and their hydrogeological interaction as a whole. Likewise, other general water norms would be directly applicable to brine extractions rights, such as regulations on ecosystem preservation, non-extractive rights and reduction of extractions in case of affecting the sustainability of an aquifer (including the declaration of restriction zones), and brines should be considered as water within the strategic plans for water resources in basins (Water Code, art 5bis, 5ter, 62–66,129 bis1°, 1A and 293bis). One of the most controversial aspects would be that a large part of the salt flats basins would become no-take zones because it corresponds to aquifers that feed meadows, peatlands and wetlands declared as threatened, degraded ecosystems or priority sites (Water Code art. 63). This essentially revocable measure could be extended to the entire basin for future extraction given the prevailing uncertainty about the interconnections of groundwater aquifers (Blair et al., 2022).

The interpretation of water as brines and relatedly, the application of water-related legislation, would have important implications for indigenous peoples. First, the special protection norms in favor of indigenous ancestral waters and lands, such as pastures, wetlands, meadows and other lands used by auquenid livestock would be applicable (Indigenous Law, art. 63, 64, and 3 transitory; Water Code art. 5). These are complemented by the provisions of International Labor Organization (ILO) Convention 169, which establishes the duty of States to consult indigenous peoples prior to any legislative or administrative measure that may directly affect them. Such convention is applicable to processes for the constitution of groundwater rights in indigenous territories and areas (at least to those officially recognized) (CGR, 2019)—but not to processes for the constitution of mining concessions. Hence, a legal recognition of brines as type of water could contribute

13 "Hydrogeological Sector of Common Use" means an aquifer or part of an aquifer whose spatial and temporal hydrological characteristics allow for delimitation for the purpose of independent hydrogeological assessment or management.

to foster the involvement of indigenous groups in decision-making related with lithium mining (representative justice). It also could contribute to the recognition of indigenous claims and knowledge systems (recognitional justice). Indeed, such a view could go beyond interpretations, as it would reflect a particular indigenous ontology of water according to which water "is a living, intelligent, self-creating thing that seeks the means for human survival" (Ramos and Tironi, 2022, p. 6) and "as a holistic and inseparable part of nature" (Budds, 2010, p. 205). For instance, representatives of the Coyo community have claimed that "there is only one water (the 'puri' [in kunza language]), and what is called 'brine' is the water deposited in the center of the salt flat. About 70% of what is contained in the brine is water. (...) the basin of the Salar de Atacama is an interconnected system of surface and underground runoff that feeds meadows, peatlands, lagoons and salt flats" (Sandón et al., 2019, p. 26). The need to treat brine as groundwater for better and integrated governance of the salt flat basins was also recently raised by members of the Atacameño/Lickanantay community of Talabre and the Atacameño Irrigation Association within the development of the strategic management plan for water resources in the Salar de Atacama basin (DGA, 2021b).

Importantly, recognizing brines as a type of waters does not in itself ensure more sustainable and just governance of salt flats. Indeed, the DGA who is responsible to manage the water resources according to the Water Code, has a structural lack of staffing, financing, information and limited management tools and knowledge of water resources in the country (World Bank, 2011). Groundwater and surface water are not managed jointly, and there is scarce control over legal or illegal abstractions (World Bank, 2011). Likewise, recent reports indicate that the DGA has not fulfilled its functions of protecting and conserving water resources (CGR, 2021). DGA's management in the salt flat basins is carried out in a fragmented manner. As a result, even though the general water balances of the basins are in deficit, limitations have only been introduced reactively without preventing overexploitation and environmental damage to local ecosystems (DGA, 2018b, 2021a; Babidge et al., 2019; CDE, 2022). In addition, environmental participation and indigenous consultation processes in the country have historically been limited in scope (Aylwin et al., 2013; Guerra, 2017). Notably, the application of the Water Code in the past has led to cases of water grabbing in favor of most productive uses and to the detriment of the local populations, especially indigenous groups, and ecosystems (Budds, 2009, 2010, 2020; Yáñez and Molina, 2011; Prieto, 2015, 2016; Prieto et al., 2022).

Therefore, even though recognizing brines as groundwater could be a minimum starting point for the integrated management of salt flats, it would require institutional strengthening and significant advances in information sharing, knowledge and research. In particular, it would be essential to develop prior and public baseline studies of salt flats in terms of water and society dynamics in cases with and, especially, without brine-mining interventions. However, the time needed to cover these gaps and to carry out the appropriate participation and consultation processes clashes with the clamor of global markets to accelerate and increase brine extraction for mining production. It also runs counter to the government's urgency to expand lithium mining from salt flats and wetlands, given the revenues this could bring to the country's ailing economy.[14] In the meantime, inaction could mean that the impacts of anthropogenic intervention on these unique ecosystems will continue to be underestimated locally, nationally and globally, masking the unsustainability of extractive operations.

7. Conclusion

In this article, we analyze how different legal interpretations and definitions of brines shape the regulation, governance and assessment of the socioecological impacts of lithium mining and other minerals in Chilean salt flats and wetlands. In the absence of specific legislation, mining companies and State agencies have extended mining legislation to brines through a process of legal coupling. As a result, brines are treated for all legal proposes as mineral resources and not as waters. Such interpretation has been consolidated through studies developed by mining companies and endorsed by State authorities as part of the environmental impact assessments of mining operations. In these studies, brines and freshwaters of the salt flats are conceptualized as separate entities on scientific grounds that are currently the subject of intense scrutiny. This, in turn, has made it possible to argue that the extraction of brine does not affect water resources and wetlands part of the salt flat ecosystems and, therefore, the people and biodiversity that depend on them. The treatment of brines as minerals and the consequent definition of the impacts of their extraction has also contributed to excluding and/or co-opt alternative ways of conceiving brines as a type of waters and the salt flat and wetlands as an integrated and interconnected ecosystem. We show that alternative interpretations are not only possible and are being put forward by (some) State institutions, by indigenous groups and researchers but also that these interpretations are legally sound.

In conclusion, we offer some reflections on how our analysis contributes to further understanding and problematizing lithium mining in Chile and beyond. First, our work sheds further light on the internal logics and importance of legal definitions and frameworks in the hydrosocial configuration of lithium mining, which has been highlighted by other works on the subject (Babidge et al., 2019; Bustos-Gallardo et al., 2021; Jerez et al., 2021; Blair et al., 2022; Hernandez and Newell, 2022). As Campero and Harris (2019), we show that legal coupling is a powerful tool with outcomes that transcend the legal realm and influence environmental impact assessments and, ultimately the material practices of lithium extraction. In fact, defining mineralized waters

14 A new lithium policy is expected to be launched in March 2023 (originally announced for January) integrating public-private partnership modalities to take advantage of the lithium boom. By 2022, revenues for the State from lithium mining doubled the contribution of CODELCO, the State-owned copper mining company to US$ 5 billion. This is equivalent to 1.6% of GDP and 6.4% of all fiscal revenues last year (CFA (Comité Fiscal Autónomo), 2023). This figure is likely to increase in 2023 due to higher growth in companies net sales.

as minerals—legally but then also technically in EIAs and EISs—is the basis for conceiving brine flows as separate from other water flows, lithium mining as a low water impact industry, and structuring the current exploitation regime in salt flats focused on fractional governance of waters in the basin (see also Bustos-Gallardo et al., 2021 and Jerez et al., 2021). The shortcomings of the current way of understanding the functioning and water balances of the salt flats and ecosystems and the impact of lithium mining have been criticized and demonstrated (SMA, 2016; First Environmental Court, 2019; Liu et al., 2019; DGA, 2021a; Gutiérrez et al., 2022). Based mainly on the conception of salt flats' freshwater separated from brines, it is possible to allow brine extraction in basins with deficit water balances as the Salar de Maricunga and generating extreme situations in hydrogeological balances as in the Salar de Atacama (CORFO, 2021; DGA, 2021a).

Second, we show that the legal interpretations—and the hydrosocial configurations they underprint—are contestable and contested. As a Meehan et al. (2023) write in a recent book, "law is a battlefield, a site of struggle" (p.51). While mining companies back the interpretation of brine as a mineral and on this, they build a particular understanding of hydrosocial relations in the Salar de Atacama and Maricunga, indigenous groups put forward different understandings of brine as a type of water. However, these conceptions remain marginalized at least regarding to the impact assessments and other formalized water decision-making processes where they are raised (see DGA, 2021a,b). Alternatively, they tend to be assimilated into the prevailing approach through corporately driven participatory and consultative mechanisms. In between, we find proposals developed for public mining institutions highlighting brines' water character by promoting a hybrid interpretation. Legal frameworks play a role in reproducing but also tackling water injustice as they can open up and/or close down spaces of contestation (such as the processes of citizen participation and indigenous consultation in the SEIA). Laws and regulations could also be used to support alternative interpretations, for example, using legal coupling to make applicable to brine the rules of the Water Code and groundwater regulations. This could lead to changes in the hydrosocial understanding of the salt flats including a more holistic conception of water flows above and below the ground. It could also contribute to address water injustices by fostering involvement of local communities, especially indigenous people and their knowledge systems in decision-making related with lithium mining.

Third, although regulatory alternatives on brine count with solid legal basis, introducing an explicit recognition of brine's water character seems (still) far from governmental priorities. From a legal perspective, this would not require a new law but only a new regulation (which could be introduced by the current government without need parliamentary approval). Instead, the focus of the debate tends to be on the appropriate business model to push forward and expand lithium mining in the short and medium term and take advantage of the boom in price and demand at almost any cost. In this sense, although creating a strong State-owned company was one of the campaign banners of the current government, more expeditious public-private partnership modalities close to those currently operating are gaining greater importance within the non-participatory, announced and delayed new National Lithium Strategy. Whichever option is finally adopted, socioenvironmental impacts will probably continue to be addressed as externalities to be managed within environmental assessment processes and contracts or agreements between local communities, mining companies and eventually the State leading to the adoption of the social and environmental license. As a result, mineralized groundwaters will continue be treated as minerals and salt flats and wetlands ecosystems affected and threatened by lithium mining will likely continue to be considered "green sacrifice zones" (Zografos and Robbins, 2020; Jerez et al., 2021; Sovacool, 2021) and water injustices perpetuated. An open debate on the different interpretations of brine is much needed, given their implications for assessing the socioenvironmental impacts of mining operations. We see the space for formal recognition of brines as waters and suspect that this would allow for better evaluating impacts on ecosystems, biodiversity, human rights and traditional lifestyles. These impacts are undoubtedly at the heart of the socioenvironmental contradictions, inequities and injustices linked to lithium mining in salt flats, both Chile and its neighboring countries, which seeks to exploit their groundwater for the sake of the green energy transition.

This brings us to our fourth and final point, the lack of an unequivocal definition and regulation of brines and lithium mining does not only regard Chile. Argentina and Bolivia, which host the largest lithium resources in their salt flats (USGS, 2023), also lack specific regulations, so analyses like this one would be pertinent and relevant. As in Chile, mining regulations apply mainly by extension to brine mining, but with greater intervention of the water authority in authorizations for certain cases (Lopez Steinmetz and Fong, 2019; Min. Minería, 2020b). In Nevada, United States, the extraction of all groundwater for mining production without distinction has a specific regulation requiring water rights (Min. Minería, 2020b), while in Canada regulations and definitions vary across provinces (Tscherning and Chapman, 2021). Given that lithium mining in salt flats is receiving increasing attention internationally, paraphrasing Linton (2010), it is essential to ask the question: what is brine? We show that how this type of groundwater is defined, by whom and through what legal frameworks shapes how its flows and the socioecological impacts of lithium mining are understood, assessed, and addressed. Clearly, brine (as water) escapes singular definitions; it lends itself to be understood as a mineral resource and/or as a type of water or another. Defining brines is thus a highly political process where laws but also knowledge practices—like modeling and legal analysis—play a role. This recognition is necessary to critically analyze the multiple discursive and material dynamics that frame new forms of water and nature appropriation and their highly uncertain socioenvironmental impacts. Especially those linked to new technological developments such as green hydrogen or, in this case, lithium water mining in salt flats, which are based on the intensive exploitation of saline or mineralized waters. These kind of debates and analyses are needed to be aware of and responsible for the effects of perpetuating an economic model based on extraction and to prevent that solutions to the

climate crisis end up exacerbating the current biodiversity and socioenvironmental crises.

Data availability statement

The datasets presented in this article are not readily available because, due to the sensitive nature of the research, supporting data is not available. Requests to access the datasets should be directed at: florescr@hu-berlin.de.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

CF developed the research design, the data collection and analysis, and the first draft of the article. RA contributed to the analysis, the revision, and editing of the article. Both authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Albemarle (2019). *Albemarle Reafirma su Compromiso de Sustentabilidad con el Salar de Atacama*. Available online at: https://media.business-humanrights.org/media/documents/files/documents/20190826_Albemarle.pdf (accessed September 3, 2022).

Albemarle (2023). *Propuesta de Acuerdo en Proceso de Conciliación Estado Fisco de Chile y Albemarle Limitada.* Available online at: https://causas.1ta.cl/causes/259/expedient/7631/?attachmentId=13220 (accessed January 2, 2023).

Albemarle (n.d.). *En Albemarle Tenemos un Compromiso Claro Con el Futuro de Nuestras Fuentes Productivas por lo que Respetamos el Ecosistema y a las Comunidades con las que nos Relacionamos*. Available online at: https://www.albemarlelitio.cl/Sostenibilidad/medioambiental (accessed September 2, 2022).

Amphos21 (2018). *Modelo Hidrogeológico Consolidado Cuenca Salar de Atacama.* Available online at: https://snifa.sma.gob.cl/Sancionatorio/Ficha/1459 (doct. # 77) (accessed July 20, 2022).

Aylwin, J., Meza-Lopehandía, M., and Yáñez, N. (2013). *Los Pueblos Indígenas y el Derecho*. Santiago: LOM Ediciones y Observatorio Ciudadano.

Babidge, S. (2013). "Socios": the contested morality of "partnerships" in indigenous community–mining company relations, Northern Chile. *J. Lat. Am. Caribb. Anthropol.* 18, 274–293. doi: 10.1111/jlca.12020

Babidge, S. (2016). Contested value and an ethics of resources: water, mining and indigenous people in the Atacama Desert, Chile. *Aust. J. Anthropol.* 27, 84–103. doi: 10.1111/taja.12139

Babidge, S. (2019). Sustaining ignorance: the uncertainties of groundwater and its extraction in the Salar de Atacama, northern Chile. *J. R. Anthropol. Inst.* 25, 83–102. doi: 10.1111/1467-9655.12965

Babidge, S., Kalazich, F., Prieto, M., and Yager, K. (2019). 'That's the problem with that lake; it changes sides': mapping extraction and ecological exhaustion in the Atacama. *J. Polit. Ecol.* 26, 738–760. doi: 10.2458/v26i1.23169

Bakker, K., Simms, R., Joe, N., and Harris, L. (2018). "Indigenous peoples and water governance in Canada: regulatory injustice and prospects for reform," in *Water Justice*, eds R., T. Perreault, and J. Vos (Cambridge: Cambridge University Press), 193–209. doi: 10.1017/9781316831847.013

Barandiarán, J. (2019). Lithium and development imaginaries in Chile, Argentina and Bolivia. *World Dev.* 113, 381–391. doi: 10.1016/j.worlddev.2018.09.019

Blair, J. J., Balcázar, R., Barandiarán, J., and Maxwell, A. (2022). *Exhausted: How We Can Stop litHIUM mining from Depleting Water Resources, Draining Wetlands, and Harming Communities in South America*. Available online at: https://www.nrdc.org/resources/exhausted-how-we-can-stop-lithium-mining-depleting-water-resources-draining-wetlands-and (accessed August 20, 2022).

Blomley, N. (2003). Law, property, and the geography of violence: the frontier, the survey, and the grid. *Ann. Assoc. Am. Geogr.* 93, 121–141. doi: 10.1111/1467-8306.93109

Blomley, N. K. (1994). *Law, Space, and the Geographies of Power*. New York, NY: Guilford Press.

Boelens, R. (2009). The politics of disciplining water rights. *Dev. Change* 40, 307–331. doi: 10.1111/j.1467-7660.2009.01516.x

Boelens, R. (2014). Cultural politics and the hydrosocial cycle: water, power and identity in the Andean highlands. *Geoforum* 57, 234–247. doi: 10.1016/j.geoforum.2013.02.008

Boelens, R., Hoogesteger, J., Swyngedouw, E., Vos, J., and Wester, P. (2016). Hydrosocial territories: a political ecology perspective. *Water Int.* 41, 1–14. doi: 10.1080/02508060.2016.1134898

Boelens, R., Perreault, T., and Vos, J. (2018). *Water Justice*. Cambridge: Cambridge University Press. doi: 10.1017/9781316831847

Bonelli, C. (2017). "Aguas equívocas en el sur de Chile," in *A Contracorriente. Agua y Conflicto en América Latina*, eds G. Vila and C. Bonelli (Quito), 119–135.

Braverman, I., Blomley, N., Delaney, D., and Kedar, A. (eds.) (2014). *The Expanding Spaces of Law: A Timely Legal Geography*. Stanford, CA: Stanford University Press. doi: 10.1515/9780804791878

Broitman, C., and Kreimer, P. (2018). Knowledge production, mobilization and standardization in Chile's HidroAysén case. *Minerva* 56, 209–229. doi: 10.1007/s11024-017-9335-z

Budds, J. (2008). "Whose scarcity? The hydrosocial cycle and the changing waterscape of La Ligua River Basin, Chile," in *Contentious Geographies: Environmental Knowledge, Meaning, Scale*, eds M. K.Goodman, M. T. Boykoff, and K. T. Evered. (Farnham: Ashgate), 59–68.

Budds, J. (2009). Contested H2O: science, policy and politics in water resources management in Chile. *Geoforum* 40, 418–430. doi: 10.1016/j.geoforum.2008.12.008

Budds, J. (2010). "Water rights, mining and indigenous groups in Chile's Atacama," in *Out of the Mainstream: Water, Rights, Politics and Identity*, eds R. Boelens, D. Gatches, and A. Guevara-Gil (London: Routledge), 215–230. doi: 10.4324/9781849774796-18

Budds, J. (2020). Securing the market: water security and the internal contradictions of Chile's Water Code. *Geoforum* 113, 165–175. doi: 10.1016/j.geoforum.2018.09.027

Budds, J., Linton, J., and McDonnell, R. (2014). The hydrosocial cycle. *Geoforum* 57, 167–169. doi: 10.1016/j.geoforum.2014.08.003

Bustos-Gallardo, B., Bridge, G., and Prieto, M. (2021). Harvesting Lithium: water, brine and the industrial dynamics of production in the Salar de Atacama. *Geoforum* 119, 177–189. doi: 10.1016/j.geoforum.2021.01.001

Cabello, J. (2021). Lithium brine production, reserves, resources and exploration in Chile: an updated review. *Ore Geol. Rev.* 128, 103883. doi: 10.1016/j.oregeorev.2020.103883

Campero, C., and Harris, L. M. (2019). The legal geographies of water claims: seawater desalination in mining regions in Chile. *Water* 11, 886. doi: 10.3390/w11050886

Cantor, A. (2016). The public trust doctrine and critical legal geographies of water in California. *Geoforum* 72, 49–57. doi: 10.1016/j.geoforum.2016.01.007

Cantor, A., Kay, K., and Knudson, C. (2020). Legal geographies and political ecologies of water allocation in Maui, Hawai'i. *Geoforum* 110, 168–179. doi: 10.1016/j.geoforum.2020.02.014

Castro, V., Aldunate, C., and Varela, V. (2004). Ocupación humana del paisaje desértico de Atacama, Región de Antofagasta. *ARQ* 57, 14–17. doi: 10.4067/S0717-69962004005700004

CDE (2022). *Demanda de Reparación de Daño Ambiental Contra Minera Escondida, Albemarle y Minera Zaldivar por la Extracción Continua de Recursos Hídricos del Acuífero de Monturaqui-Negrillar-Tilopozo*. Available online at: https://causas.1ta.cl/causes/269/expedient/5699/books/216/?attachmentId=9417 (accessed June 30, 2022).

CFA (Comité Fiscal Autónomo) (2023). *Reflexiones Sobre los Desafíos Fiscales del Litio en Chile*. Nota del CFE N°15. Available online at: https://www.cfachile.cl/noticias/cfa-plantea-ahorrar-un-componente-importante-de-los-mayores-ingresos-fiscales (accessed February 3, 2023).

CGR (2019). *Dictamen N°25.667/2019. Derechos de Aprovechamiento de Aguas Subterráneas, Autorización Ocupación Terrenos Fiscales, área de Desarrollo Indígena, Consulta Indígena*. Available online at: https://www.contraloria.cl/pdfbuscador/dictamenes/025667N19/html (accessed January 15, 2023).

CGR (2021). *Informe Final N°265/2021 Auditoría sobre Acciones Desarrolladas por la DGA en Relación con la Protección de la Cantidad de las Aguas y la Conservación del Recurso*. Available online at: https://www.doe.cl/alerta/22072022/202207223002 (acceseed June 30, 2022).

CIA Peine (2009). *Observaciones al EIA "Modificaciones y Mejoramiento del Sistema de Pozas de Evaporación Solar en el Salar de Atacama" Presentada por Sociedad Chilena del Litio Ltda. (SCL)*. Available online at: https://seia.sea.gob.cl/archivos/314_Observaciones_Peine.pdf (accessed July 20, 2022).

CICPO (2018). *Carta CICP – SEIA Proyecto "Proyecto Blanco" N°3*. Available online at: https://seia.sea.gob.cl/archivos/2019/03/04/04122018_Comunidad_Indigena_Colla_Pai_Ote.PDF (accessed July 30, 2022).

CONADI (2017). *Proyecto "Conservación de Rutas de Trashumancia y Sitios de Significación Cultural Indígena de las Región de Atacama"*. Concepción: Ingeland.

CONAMA (2006). *Resolución Exenta N°3132/2006 que Resuelve Recurso de Reclamación del Proyecto "Modificaciones al Proyecto de Construcción de pozas de Evaporación Solar" de SCL*. Dirección Ejecutiva. Available online at: https://seia.sea.gob.cl/archivos/d8c_Acogido.pdf (accessed July 30, 2022).

COREMA II (2005). *Resolución Exenta N°0064/2005 Califica Desfavorablemente DIA Modificación al Proyecto Construcción de Pozas Evaporación Solar*. Available online at: https://infofirma.sea.gob.cl/DocumentosSEA/MostrarDocumento?docId=27/58/ede92b3cc67cec36a27520e8e6b9cd177678 (accessed July 30, 2022).

COREMA II (2011). *Resolución Exenta N°156/2011 Califica Desfavorablemente el EIA Modificaciones y Mejoramiento del Sistema de Pozas de Evaporación Solar en el Salar de Atacama*. Available online at: https://infofirma.sea.gob.cl/DocumentosSEA/MostrarDocumento?docId=02/f1/c38edadd9b42a81393f884d03de199264e80 (accessed 30 July, 2022).

CORFO (2018). *Modificación y Texto Refundido de Contrato de Proyecto y de Contrato de Arrendamiento de Pertenencias Mineras OMA, con SQM Salar S.A., SQM S.A. y SQM Potasio S.A*. Santiago.

CORFO (2021). Modelo Integrado de Gestión Hídrica de la Cuenca del Salar de Atacama. *Octubre* 2021. Santiago.

CPA (2017). *Se Tenga Como Parte Interesada al Consejo de Pueblos Atacameños*. Available online at: https://snifa.sma.gob.cl/Sancionatorio/Ficha/1459 doc. # 38 (accessed July 30, 2022).

CPA (2018). *Recurso de Protección Contra Suscripción de Contratos Que Modifican y Fijan Texto Refundido y Actualizado de Contratos Entre CORFO y SQM*.

CPA (2022). *Reclamación Judicial Contra la Resolución N° 38/ F-041-2016, de Fecha 29 de Agosto de 2022, que "Aprueba el Programa de Cumplimiento presentado por SQM Salar S.A. y Suspende Procedimiento Administrativo en su contra"*. Available online at: https://causas.1ta.cl/causes/324/expedient/6703/books/275/?attachmentId=11125 (accessed September 30, 2022).

Cubillos, C. F., Paredes, A., Yáñez, C., Palma, J., Severino, E., Vejar, D., et al. (2019). Insights into the microbiology of the chaotropic brines of Salar de Atacama, Chile. *Front. Microbiol.* 10, 1611. doi: 10.3389/fmicb.2019.01611

CVHNT (2008). *Informe de la Comisión de Verdad Histórica y Nuevo Trato con los Pueblos Indígenas*. Available onlite at: https://www.corteidh.or.cr/tablas/27374.pdf (accessed October 10, 2022).

Delaney, D. (2010). *The Spatial, the Legal and the Pragmatics of World-making: Nomospheric Investigations*. London: Routledge-Cavendish. doi: 10.4324/9780203849101

Delaney, D. (2015). Legal geography I: constitutivities, complexities, and contingencies. *Prog. Hum. Geogr.* 39, 96–102. doi: 10.1177/0309132514527035

DGA (2005a). *Oficio Ordinario N° 052 de 14.01.2005 de la Dirección Regional DGA*. Available online at: https://infofirma.sea.gob.cl/DocumentosSEA/MostrarDocumento?docId=01/01/09dcb1c28d3e5d2bf83f65fb26ad5d5a08b8 (accessed July 30, 2022).

DGA (2005b). *ORD N°874 de 30.11.2005. Se Pronuncia con Relación al Recurso de Reclamación Interpuesto por Sociedad Chilena de Litio*. Available online at: https://seia.sea.gob.cl/archivos/871_InformeServicio4.pdf (accessed July 30, 2022).

DGA (2016). *Informe Final Diagnóstico de Disponibilidad Hídrica en las Cuencas Altoandinas de la Región de Atacama, Fase 3*. Elaborado por AMPHOS 21. Available online at: https://bibliotecadigital.ciren.cl/bitstream/handle/20.500.13082/32771/DGA_2016_diagnostico_disponibilidad_hidrica_cuencas_alto_andinas_Region_Atacama.pdf?sequence=1andisAllowed=y (accessed October 1, 2022).

DGA (2018a). *Ord.: 70/2018. Se pronuncia sobre el Estudio de Impacto Ambiental antes indicado* [Proyecto Blanco]. Available online at: https://seia.sea.gob.cl/archivos/2018/11/16/Direccion_General_de_Aguas_Ord._N701-18_Proyecto_Bklanco.pdf (accessed July 20, 2022).

DGA (2018b). *Resolución N°13/2018. Declara Zona de Prohibición Para Nuevas Explotaciones de Aguas Subterráneas en el Sector Hidrogeológico de Aprovechamiento Común Denominado C2 de la Cuenca del Salar de Atacama, Región de Antofagasta*. Available online at: https://www.bcn.cl/leychile/navegar?i=1121804 (accessed September 20, 2022).

DGA (2019). *Ord.: 24/2019. Envía Pronunciamiento sobre adenda "Proyecto Blanco"*. Available online at: https://seia.sea.gob.cl/archivos/2019/04/23/DGA_Ord._N24-19_Proyecto_Blanco.pdf (accessed September 15, 2022).

DGA (2021a). *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*. Informe final PEGH Salar de Atacama. Available online at: https://snia.mop.gob.cl/repositoriodga/handle/20.500.13000/125704 (accessed November 30, 2022).

DGA (2021b). *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*. Informe final PEGH Salar de Atacama. Anexo I. Detalles Participación Ciudadana. Available online at: https://snia.mop.gob.cl/repositoriodga/handle/20.500.13000/125704 (accessed September 23, 2022).

Dorador, C., Fink, P., Hengst, M., Icaza, G., Villalobos, A. S., Vejar, D., and Harrod, C., (2018). Microbial community composition and trophic role along a marked salinity gradient in Laguna Puilar, Salar de Atacama, Chile. *Anton. Van Leeuw.* 111, 1361–1374. doi: 10.1007/s10482-018-1091-z

Dorador, C., Meneses, D., Urtuvia, V., Demergasso, C., Vila, I., Witzel, K. P., and Imhoff, J. F. (2009). Diversity of bacteroidetes in high-altitude saline evaporitic basins in northern Chile. *J. Geophy. Res.* 114, 1–11. doi: 10.1029/2008JG000837

EC (2023). *Critical Raw Materials: Ensuring Secure and Sustainable Supply Chains for EU's Green and Digital Future*. Available online at: https://ec.europa.eu/commission/presscorner/detail/en/ip_23_1661 (accessed March 16, 2023).

Ejeian, M., Grant, A., Shon, H. K., and Razmjou, A. (2021). Is lithium brine water? *Desalination* 518, 115169. doi: 10.1016/j.desal.2021.115169

Ferry, E. E., and Limbert, M. (2008). "Timely assets," in *Timely Assets: The Politics of Resources and their Temporalities*, eds E. E. Ferry, and E. Limbert (Santa Fe: School for Advanced Research Press), 3–24.

First Environmental Court (2019). *Sentencia causa N° R-17-2019, Comunidad Indígena Atacameña de Peine con Superintendencia del Medio Ambiente*. Available online at: https://causas.1ta.cl/causes/38/expedient/2539/books/31/?attachmentId=4007 (accessed June 5, 2022).

Flexer, V., Baspineiro, C. F., and Galli, C. I. (2018). Lithium recovery from brines: a vital raw material for green energies with a potential environmental impact in its mining and processing. *Sci. Total Environ.* 639, 1188–1204. doi: 10.1016/j.scitotenv.2018.05.223

Flores Fernández, C. (2021). "Desposeer para descarbonizar? El avance de la minería de Litio en el Salar de Maricunga, la última frontera del extractivismo verde," in *Salares Andinos. Ecología de Saberes por la Protección de Nuestro Salares y Humedales*, ed OPSAL (Santiago de Chile: Fundación Tantí), 215–235.

Forget, M., and Bos, V. (2022). Harvesting lithium and sun in the Andes: exploring energy justice and the new materialities of energy transitions. *Energy Res. Soc. Sci.* 87, 102477. doi: 10.1016/j.erss.2021.102477

Fragkou, M. C., and Budds, J. (2020). Desalination and the disarticulation of water resources: Stabilising the neoliberal model in Chile. *Trans. Inst. Br. Geogr.* 45, 448–463. doi: 10.1111/tran.12351

Gajardo, G., and Redón, S. (2019). Andean hypersaline lakes in the Atacama Desert, northern Chile: between lithium exploitation and unique biodiversity conservation. *Conserv. Sci. Pract.* 1, e94. doi: 10.1111/csp2.94

Garcés, I., and Álvarez, G. (2020). Water mining and extractivism of the Salar de Atacama, Chile. *WIT Trans. Ecol. Environ.* 245, 189–199. doi: 10.2495/EID200181

Gelles, P. (2010). "Cultural identity and indigenous water rights in the Andean Highland," in *Out of the Mainstream: Water, Rights, Politics and Identity*, eds R. Boelens, D. Gatches, and A. Guevara-Gil (London: Routledge), 119–144.

Guerra, F. (2017). Los Tribunales Ambientales en la implementación de los derechos indígenas durante la evaluación ambiental de proyectos de inversión en Chile. *Revista Justicia Ambiental* 9, 19–38.

Gundermann, H., and Göbel, B. (2018). Comunidades indígenas, empresas del litio y sus relaciones en el Salar de Atacama. *Chungará* 50, 471–486. doi: 10.4067/S0717-73562018005001602

Gutiérrez, J. S., Moore, J. N., Donnelly, J. P., Dorador, C., Navedo, J. G., and Senner, N. R. (2022). Climate change and lithium mining influence flamingo abundance in the Lithium Triangle. *Proc. R. Soc. B*. 289. doi: 10.1098/rspb.2021.2388

Hernandez, D. S., and Newell, P. (2022). Oro blanco: assembling extractivism in the lithium triangle. *J. Peasant Stud.* 49, 945–968. doi: 10.1080/03066150.2022.2080061

Hommes, L., Boelens, R., and Maat, H. (2016). Contested hydrosocial territories and disputed water governance: struggles and competing claims over the Ilisu Dam development in southeastern Turkey. *Geoforum* 71, 9–20. doi: 10.1016/j.geoforum.2016.02.015

IEA (2022). *Global EV Outlook 2022: Securing Supplies for an Electric Future*. Available online at: https://www.iea.org/reports/global-ev-outlook-2022 (accessed September 1, 2022).

Jepson, W. (2012). Claiming water: contested legal geographies of water in South Texas. *Ann. Assoc. American Geographers* 102, 614–631. doi: 10.1080/00045608.2011.641897

Jerez, B., Garcés, I., and Torres, R. (2021). Lithium extractivism and water injustices in the Salar de Atacama, Chile: the colonial shadow of green electromobility. *Polit. Geogr.* 87, 102382. doi: 10.1016/j.polgeo.2021.102382

Linton, J. (2010). *What is* Water? *The History of a Modern Abstraction*. Vancouver, BC: UBC press.

Linton, J. (2022). Waters in the plural: approaches and opportunities for more grounded research and management", *Géocarrefour*. doi: 10.4000/geocarrefour.19295

Linton, J., and Budds, J. (2014). Hydrosocial cycle: defining and mobilizing a relational-dialectical approach to water. *Geoforum* 57, 170–180. doi: 10.1016/j.geoforum.2013.10.008

Liu, W., and Agusdinata, D. B. (2020). Interdependencies of lithium mining and communities' sustainability in Salar de Atacama, Chile. *J. Clean. Prod.* 260, 120838. doi: 10.1016/j.jclepro.2020.120838

Liu, W., Agusdinata, D. B., and Myint, S. W. (2019). Spatiotemporal patterns of lithium mining and IV-11environmental degradation in the Atacama Salt Flat, Chile. *Int. J. Appl. Earth Obsv. Geoinf.* 80, 145–156. doi: 10.1016/j.jag.2019.04.016

Llagostera, A. (2004). *The ancient inhabitants of the Salar de Atacama, Atacameña Prehistory*. Santiago: Editorial Pehuén.

Lopez Steinmetz, R., and Fong, S. (2019). Water legislation in the context of lithium mining in argentina. *Resour. Policy* 64. doi: 10.1016/j.resourpol.2019.101510

Lorca, M., Andrade, M. O., Escosteguy, M., Köppel, J., Scoville-Simonds, M., and Hufty, M. (2022). Mining indigenous territories: consensus, tensions and ambivalences in the Salar de Atacama. *Extr. Ind. Soc.* 9, 101047. doi: 10.1016/j.exis.2022.101047

Marazuela, M. A., Vázquez-Suñé, E., Ayora, C., García-Gil, A., and Palma, T. (2019). Hydrodynamics of salt flat basins: the Salar de Atacama example. *Sci. Total Environ.* 651, 668–683. doi: 10.1016/j.scitotenv.2018.09.190

Meehan, K., Mirumachi, N., Loftus, A., and Akhter, M., (2023). *Water: A Critical Introduction*. Hoboken, NJ: John Wiley and Sons.

Min. Minería (2015). *Comisión Nacional del Litio. Informe Final. Litio: Una fuente de energía, una oportunidad para Chile*. Available online at: https://ciperchile.cl/pdfs/2015/06/sqm/INFORME_COMISION_LITIO_FINAL.pdf (accessed July 22, 2022).

Min. Minería (2020a). *Resolución Exenta N°2200/2020. Aprueba Bases y llama a Licitación Pública para Contratar Estudio de "Propuesta de Reglamento de Salmueras en Salares"*.

Min. Minería (2020b). *Informe Final Análisis Normativo y Comparado Para la Dictación de un Reglamento de Salmueras*. Realizado por Asesorías e Inversiones AandP Limitada.

MINSAL (1994). *Estudio de Impacto Ambiental (EIA) Proyecto Producción de 300.000 ton/año de Cloruro de Potasio*. Available online at: https://seia.sea.gob.cl/expediente/expedientesEvaluacion.php?id_expediente=906andidExpediente=906 (accessed June 22, 2022).

MSB (2018). *Estudio de Impacto Ambiental (EIA) Proyecto Blanco*. Stantec. Available online at: https://seia.sea.gob.cl/elementosFisicos/enviados.php?id_documento=2141401302 (accessed July 20, 2022).

Munk, L. A., Boutt, D. F., Moran, B. J., McKnight, S. V., and Jenckes, J. (2021). Hydrogeologic and geochemical distinctions in freshwater-brine systems of an andean salar. *Geochemistr. Geophysics. Geosystems 22*, e2020GC009345. doi: 10.1029/2020GC009345

OPSAL (2021). *Salares Andinos. Ecología de Saberes por la Protección de Nuestro Salares y Humedales*. Santiago de Chile: Fundación Tantí.

Poveda, R. (2020). *Estudio de caso Sobre la Gobernanza del Litio en Chile*. Serie Recursos Naturales y Desarrollo N°195. Santiago: Comisión Económica para América Latina y el Caribe (CEPAL). Available online at: https://www.cepal.org/es/publicaciones/45683-estudio-caso-la-gobernanza-litio-chile (accessed June 20, 2022).

Prieto, M. (2015): Bringing water markets down to Chile's Atacama desert. *Water Int.* 41, 191–212. doi: 10.1080/02508060.2015.1107400

Prieto, M. (2016). Practicing costumbres and the decommodification of nature: the Chilean water markets and the Atacameño people. *Geoforum* 77, 28–39. doi: 10.1016/j.geoforum.2016.10.004

Prieto, M. (2022). Indigenous resurgence, identity politics, and the anticommodification of nature: the chilean water market and the atacameño people. *Ann. Am. Assoc. Geogr.* 112, 487–504. doi: 10.1080/24694452.2021.1937036

Prieto, M., Calderón-Seguel, M., Fragkou, M. C., and Fuster, R. (2022). The (not-so-free) Chilean water model. The case of the Antofagasta Region, Atacama Desert, Chile. *Extr. Ind. Soc.* 11, 101081. doi: 10.1016/j.exis.2022.101081

Ramos, S., and Tironi, M. (2022). An inside sun: lickanantay volcanology in the salar de Atacama. *Front. Earth Sci.* 10, 909967doi: 10.3389/feart.2022.909967

Rockwood (2012). *Convenio de Cooperación, Sustentabilidad y Beneficio Mutuo entre Comunidad Atacameña de Peine y Rockwood Ltda*. Available online at: https://www.camara.cl/verDoc.aspx?prmID=70587andprmTIPO=DOCUMENTOCOMISION (accessed May 30, 2022).

Rockwood (2014). *Adenda N°4. EIA, Proyecto Modificaciones y Mejoramiento del Sistema de Pozas de Evaporación Solar en Salar de Atacama*. Available online at: https://seia.sea.gob.cl/archivos/Adenda_4_Rockwood_Litio_Rev_0.pdf (accessed September 10, 2022).

Rockwood (2015). *Adenda N°5. EIA, Proyecto Modificaciones y Mejoramiento del Sistema de Pozas de Evaporación Solar en Salar de Atacama*. Available online at: https://seia.sea.gob.cl/archivos/2015/12/12/13001_Adenda_5_Rev_0.pdf (accessed September 10, 2022).

Rockwood (2016). *Convenio de Cooperación, Sustentabilidad y Beneficio Mutuo Entre Consejo de Pueblos Atacameños, Comunidad Indígena Atacameña de Rio Grande y otras y Roockwood Litio Ltda*. Availabe online at: https://www.google.com/url?sa=tandrct=jandq=andesrc=sandsource=webandcd=andcad=rjaanduact=8andved=2ahUKEwjc6pnerbX9AhVJSPEDHd4PDpgQFnoECAgQAQandurl=http%3A%2F%2Fwww.chululo.cl%2Fincs%2Fdocs%2Fdownload.php%3Ff%3Dconvenio_rockwood_cpa_2016_02_21_.pdfandusg=AOvVaw0znBhrfdBR13dLYxjpaPpp (accessed June 20, 2022).

Romero-Toledo, H. (2019). Extractivismo en Chile: la producción del territorio minero y las luchas del pueblo aimara en el Norte Grande. *Colomb. Int.* 98, 3–30. doi: 10.7440/colombiaint98.2019.01

Romero-Toledo, H., and Jenkins, K. (2022). Contested waters, extractivisms, and territories: indigenous people in Chile and the neoliberal crisis. *Curr. Dir. Water Scarcity Res.* 4, 189–208. doi: 10.1016/B978-0-12-824538-5.00010-8

Sandón, L., Rodriguez, E., Álvarez, J., Reyes, L., and Sandón, G. (2019). *Recurso de Protección contra SEA de la Región de Antofagasta*.

SCL (2004). *Declaración de Impacto Ambiental (DIA) del Proyecto Modificación al Proyecto Construcción de Pozas de Evaporación Solar*. Available online at: https://seia.sea.gob.cl/expediente/expedientesEvaluacion.php?modo=fichaandid_expediente=540966 (accessed July 30, 2022).

SCL (2005). *Recurso de Reclamación contra RCA 0064/2005 de 18 de Marzo de 2005 que Rechazó el proyecto "Modificación al Proyecto Pozas de Evaporación Solar"*. Available online at: https://seia.sea.gob.cl/archivos/Recurso14_05.pdf (accessed July 30, 2022).

SCL (2011). *Recurso de Reclamación contra Resolución N° 156/2011 que Calificó Desfavorablemente el EIA Modificaciones y Mejoramiento del Sistema de Pozas de Evaporación Solar en el Salar de Atacama*. Available online at: https://seia.sea.gob.cl/archivos/RecursoREIA75-11.PDF (accessed August 25, 2022).

SEA (2020a). *Resolución Exenta N° 094/2020 que Califica Favorablemente el Proyecto Minero Blanco. Dirección Ejecutiva*. Available online at: https://validador.sea.gob.cl/validar/2145620378 (accessed August 20, 2022).

SEA (2020b). *Informe Consolidado de Evaluación Ambiental Proyecto Blanco*. Available online at: https://validador.sea.gob.cl/validar/2142295071 (accessed August 20, 2022).

SEA (2021). *Guía Para la Descripción de Proyectos de Explotación de Litio y otras Sustancias Minerales Desde Salares en el SEIA*. Available online at: https://www.sea.gob.cl/sites/default/files/imce/archivos/2021/03/12/guia_litio_version_para_publicar_compressed.pdf (accessed June 30, 2022).

Sernageomin (2019). *Se pronuncia Sobre el Estudio de Impacto Ambiental que Indica [Proyecto Blanco]*. Available online at: https://infofirma.sea.gob.cl/DocumentosSEA/MostrarDocumentodocId=fc/14/4e3fbe94bf00723cb8597eee30564fb6714f (accessed July 20, 2022).

SMA (2016). *RES. EX N° 1/ROL F-041-2016. Formula cargos que indica a SQM SALAR*. S.A. Available online at: https://snifa.sma.gob.cl/Sancionatorio/Ficha/1459 (accessed August 20, 2022).

SMA (2022a). *RES. EX. N° 38/ROL F-041-2016. Aprueba el Programa de Cumplimiento presentado por SQM Salar S.A*. Available online at: https://snifa.sma.gob.cl/Sancionatorio/Ficha/1459 (accessed August 20, 2022).

SMA (2022b). *RES. EX. N° 1/ROL F-018-2022. Formula Cargos que Indica a Albemarle Ltda*. Available online at: https://snifa.sma.gob.cl/Sancionatorio/Ficha/2832 (accessed August 20, 2022)

SONAMI (2017). *Informe Consumo de Agua en Minería 2016*. Available online at: https://www.google.com/search?client=safariandrls=enandq=SONAMI$+$(2017).$+$Informe$+$Consumo$+$de$+$Agua$+$en$+$Miner%C3%ADa$+$2016.andie=UTF-8andoe=UTF-8 (accessed July 30, 2022).

Sovacool, B. K. (2021). Who are the victims of low-carbon transitions? Towards a political ecology of climate change mitigation. *Energy Res. Soc. Sci.* 73, 101916. doi: 10.1016/j.erss.2021.101916

SQM Salar S.A. (2005a). *EIA proyecto "Cambios y Mejoras de la Operación Minera en el Salar de Atacama"*. Available online at: https://seia.sea.gob.cl/elementosFisicos/enviados.php?id_documento=2128723001 (accessed June 10, 2022).

SQM Salar S.A. (2005b). *Anexo III Adenda III EIA proyecto "Cambios y Mejoras de la Operación Minera en el Salar de Atacama"*. Available online at: https://seia.sea.gob.cl/expediente/expedientesEvaluacion.php?id_expediente=1040282andidExpediente=1040282 (accessed June 10, 2022).

SQM Salar S.A. (2017). *Cuarta Actualización del Modelo Hidrogeológico del Salar de Atacama. Proyecto Cambios y Mejoras de la Operación minera en el Salar de Atacama*. Santiago: IDAEA-CSIC.

SQM Salar S.A. (2021a). *Sustainability of Lithium Production in Chile*. Available online at: https://sqmiodine.com/wp-content/uploads/2021/08/SQM-Sustainable-Lithium-English-2020430-2.pdf (accessed August 20, 2022).

SQM Salar S.A. (2021b). *Informe de la Sexta Actualización del Modelo Hidrogeológico*. Los Angeles, CA: Hidroestudios.

Supreme Court (2022). *Sentence Case Rol 8.507-2022 of 01 June 2022*. Available online at: https://oficinajudicialvirtual.pjud.cl/indexN.php#modalDetalleSuprema (accessed September 20, 2022).

Swyngedouw, E., and Boelens, R. (2018). And not a single injustice remains": hydro-territorial colonization and techno-political transformations in Spain. *Water Justice* 115—133. doi: 10.1017/9781316831847.008

Tala, A. (1994). El estatuto de las aguas mineralizadas. Derecho de Minería o Derecho de Aguas? *Gaceta Jurídica* 164, 41–52.

Thiel, V., Tank, M., Neulinger, S. C., Gehrmann, L., Dorador, C., and Imhoff, J. F. (2010). Unique communities of anoxygenic phototrophic bacteria in saline lakes of Salar de Atacama (Chile): evidence for a new phylogenetic lineage of phototrophic Gammaproteobacteria from pufLM gene analyses. *FEMS Microbiol. Ecol.* 74, 510–522. doi: 10.1111/j.1574-6941.2010.00966.x

Tscherning, R., and Chapman, B. (2021). Navigating the emerging lithium rush: lithium extraction from brines for clean-tech battery storage technologies. *J. Energy Nat. Resour. Law* 39, 13–42. doi: 10.1080/02646811.2020.1841399

USGS (2023). *Mineral Commodity Summaries, January 2023*. Available online at: https://pubs.usgs.gov/periodicals/mcs2023/mcs2023-lithium.pdf (accessed January 30, 2023).

Usón, T. J., Henríquez, C., and Dame, J. (2017). Disputed water: competing knowledge and power asymmetries in the Yali Alto basin, Chile. *Geoforum* 85, 247–258. doi: 10.1016/j.geoforum.2017.07.029

Vogt, L., and Walsh, C. (2021). Parsing the politics of singular and multiple waters. *Water Altern.* 14, 1–11.

Vos, H. D., Boelens, R., and Bustamante, R. (2006). Formal law and local water control in the Andean region: a fiercely contested field. *Water Resour. Dev.* 22, 37–48. doi: 10.1080/07900620500405049

Voskoboynik, D. M., and Andreucci, D. (2022). Greening extractivism: environmental discourses and resource governance in the 'Lithium Triangle'. *Environ. Plan. E Nat. Space* 5, 787–809. doi: 10.1177/25148486211006345

World Bank (2011). *Chile: Diagnóstico de la Gestión de los Recursos Hídricos*. Available online at: https://documents1.worldbank.org/curated/en/452181468216298391/pdf/633920ESW0SPAN0le0GRH0final0DR0REV-0doc.pdf (accessed August 10, 2022).

World Bank (2020). *Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition*. Available onlin at: https://pubdocs.worldbank.org/en/961711588875536384/Minerals-for-Climate-Action-The-Mineral-Intensity-of-the-Clean-Energy-Transition.pdf (accessed August 15, 2022).

Yáñez, N., and Molina, R. (comps.). (2011). *Las aguas Indígenas en Chile*. Santiago: LOM Ediciones.

Yates, J. S., Harris, L. M., and Wilson, N. J. (2017). Multiple ontologies of water: politics, conflict and implications for governance. *Environ. Plan. D Soc. Space* 35, 797–815. doi: 10.1177/0263775817700395

Zografos, C., and Robbins, P. (2020). Green sacrifice zones, or why a green new deal cannot ignore the cost shifts of just transitions. *One Earth* 3, 543–546. doi: 10.1016/j.oneear.2020.10.012

Zurita, M. D. L. M., Thomsen, D. C., Smith, T. F., Lyth, A., Preston, B. L., and Baum, S. (2015). Reframing water: contesting H2O within the European Union. *Geoforum* 65, 170–178. doi: 10.1016/j.geoforum.2015.07.022

Zwarteveen, M. Z., and Boelens, R. (2014). Defining, researching and struggling for water justice: some conceptual building blocks for research and action. *Water Int.* 39, 143–158. doi: 10.1080/02508060.2014.891168