REPORT

EXHAUSTED:

HOW WE CAN STOP LITHIUM MINING FROM DEPLETING WATER RESOURCES, DRAINING WETLANDS, AND HARMING COMMUNITIES IN SOUTH AMERICA

AUTHORS:

James J. A. Blair, PhD, Assistant Professor, California State Polytechnic University, Pomona

Ramón M. Balcázar, Coordinator of Observatorio Plurinacional de Salares Andinos OPSAL

Javiera Barandiarán, PhD, Associate Professor, UC Santa Barbara

Amanda Maxwell, International Program, NRDC

APRIL 2022
R: 21-10-A

ACKNOWLEDGMENTS

This report would not have been possible without the contributions of many people, including scientists, technical and policy experts, environmental and human rights activists, and local community members, who all offered their time and thoughts. We are greatly appreciative. Special thanks to our reviewers, whose input significantly improved the report: Dr. Cristina Dorador, Dr. Manuel Prieto, Dr. Sally Babidge, Dr. Thea Riofrancos, Dr. Dustin Mulvaney, and Benjamin Hitchcock Auciello, as well as internal NRDC staff. Additionally, our team would like to thank Jorge Muñoz Coca of the Atacameño (Lickanantay) Community of Solcor and member of Observatorio Plurinacional de Salares Andinos (OPSAL); Brenda J. Rojas for creating our maps; Bianca Delgado and Karina Reyes for transcription assistance; Bernardo Reyes, Camila Sepúlveda Taulis, and the Language Divas (Laura Virella and Miriam Browning Nance), for their help with translation; and each of the community members who spoke with us about their experiences and allowed us to share their stories in this report.

NRDC Chief Communications Officer: Michelle Egan
NRDC Managing Directors of Communications: Lisa Goffredi and Jenny Powers
NRDC Policy Publications Editor: Leah Stecher

Cover: © Nicole Vilches Castillo
Design and Production: www.suerossi.com

Table of Contents

I. Introduction 4

II. A Snapshot of the Global Lithium Market 8

A. The Global Demand for Lithium-Ion Batteries Will Continue for Years 8

B. Different Government Approaches to Lithium Extraction in South America Have Similar Destructive Impacts 9

1. Chile 11

2. Argentina 11

3. Bolivia 12

III. Lithium Mining Endangers Water, Wildlife, and People in the Salt Flats of Northern Chile 16

A. Unique Wetlands and Wildlife Are Threatened by Lithium Mining 16

B. Industrial Mining Disrupts Millennia of Indigenous Agricultural and Pastoral Practices 18

C. Lithium Extraction Through Evaporation Is Water Extraction 19

D. Lithium Mining Is Compounding Water Problems That Have Been Building for Decades 20

IV. Recommendations for the Lithium Industry to Avoid Further Damage to the Puna de Atacama 25

V. Conclusions 29

I. Introduction

Worldwide, the power generation and transportation sectors are two of the largest sources of air pollution and greenhouse gas emissions (GHGs).[1] Scientists agree that one of the best ways we can mitigate the harmful impacts of climate change is by transitioning away from fossil fuels like petroleum and coal and toward clean energy generation and zero-emission transportation options.[2] Around the globe, governments are already deploying innovative technologies to support this energy transition.[3] Some of these crucial technologies, such as electric vehicles, smart devices, and renewable power plants, depend on lithium-ion batteries, which require lithium as well as other metals and minerals like copper, nickel, graphite, manganese, and cobalt.[4] Lithium is often considered a "critical mineral or material" due to its importance not only to developing technologies but also to everyday devices and national energy security.

Lithium is, in fact, an abundant element with *deposits* around the globe.[5] However, lithium *resources*—where it is present and quantifiable—are more limited, and lithium *reserves*—where it is present, quantifiable, and economically feasible to extract—are more limited still.[6] Lithium exists in high concentrations in only a few key locations, and those locations have long histories of destructive social and environmental impacts caused by the mining sector (Map 1).

Lithium is currently mined in three main ways, extracted from (1) hard rock pegmatites, especially in Australia; (2) sedimentary rock, particularly clay, an emergent source under development in the United States; or (3) brines pumped from beneath arid basins, including basins in South America. This report addresses the extraction of lithium that is pumped from brines in the region shared by northern Chile, northwestern Argentina, and southwestern Bolivia. This dry landscape includes internationally recognized wetlands and protected areas and is a critical refuge for migratory and native species. Despite this, most operations in the area use evaporation to extract the lithium from the brine, even though researchers have found that this mining technique contributes to ecological damage.[7] Local and Indigenous People have engaged in mining activities, both small and large scale, for centuries in the region. However, most large state-run or privately owned companies have failed to obtain free, prior and informed consent from local populations. That means that many local and Indigenous People have no say in—and receive little benefit from—the mining operations that are negatively impacting local water supplies and ecosystems.

This is a global climate justice conflict that cannot be ignored.[8] Solutions to the climate crisis must neither worsen water availability nor compromise the sovereignty of Indigenous Peoples. Nor do they have to. There are a number of options that governments, companies, and communities can employ to avoid or reduce the negative impacts of lithium mining in this region.

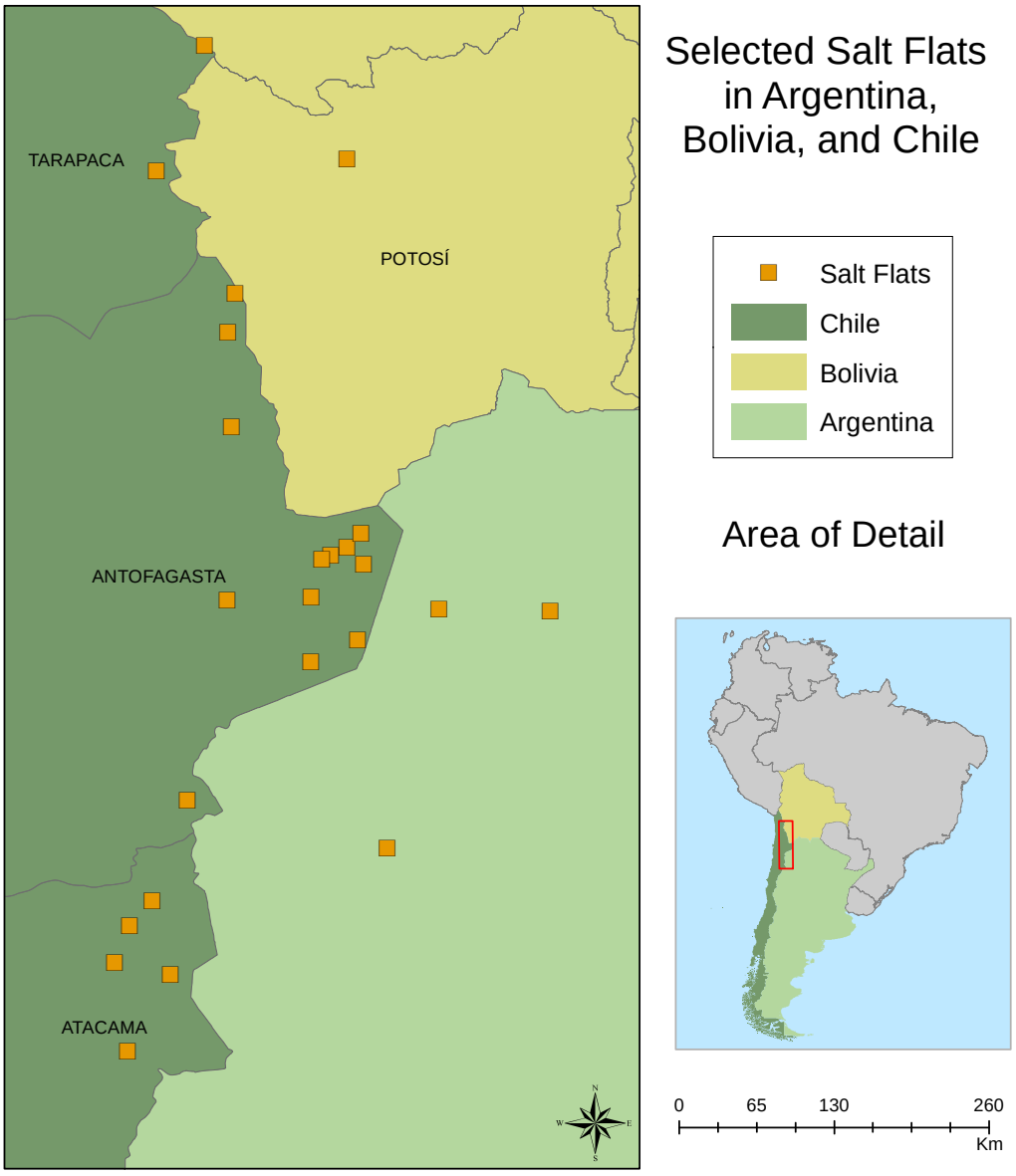
Solar evaporation ponds, like these in Chile's Atacama Salt Flat, use huge amounts of brine pumped from beneath the salt flat to obtain lithium

This paper has two purposes. First, we wish to raise international awareness of the social and environmental harms that lithium mining is already producing. South American lithium is widely understood to be a critical material for the transition away from fossil fuels, yet few apprehend how the global market for lithium is already negatively affecting some people and ecosystems in the region. To help understand this complicated issue, we detail six examples from different salt flats so that people from these communities can speak to their own experiences. Our researchers conferred with a range of Indigenous leaders,

local representatives, and those involved in environmental defense and advocacy in the region. Some community members feel they are benefiting from these developments; others do not. Sometimes these operations have the support of local and/or national governments; sometimes they do not. In all of the examples, relationships on the ground are complex and evolving.[9] These six communities are not monolithic, and the highlights we report are a mere sample; there are, of course, other salt flats, mining efforts, and peoples who are not included here.[10]

Second, we propose a variety of ways in which lithium extraction's detrimental effects—water depletion, drained wetlands, and community harm—can be avoided or reduced. Each actor in the lithium-ion battery supply chain can help ameliorate the current contentious and grave situation. Doing so will help create a globally just transition to clean energy generation and transportation without destroying this unique region or violating Indigenous rights.

MAP 1: SELECTED SALT FLATS IN ARGENTINA, BOLIVIA, AND CHILE



Map by Brenda J. Rojas

COMMUNITY HIGHLIGHT I

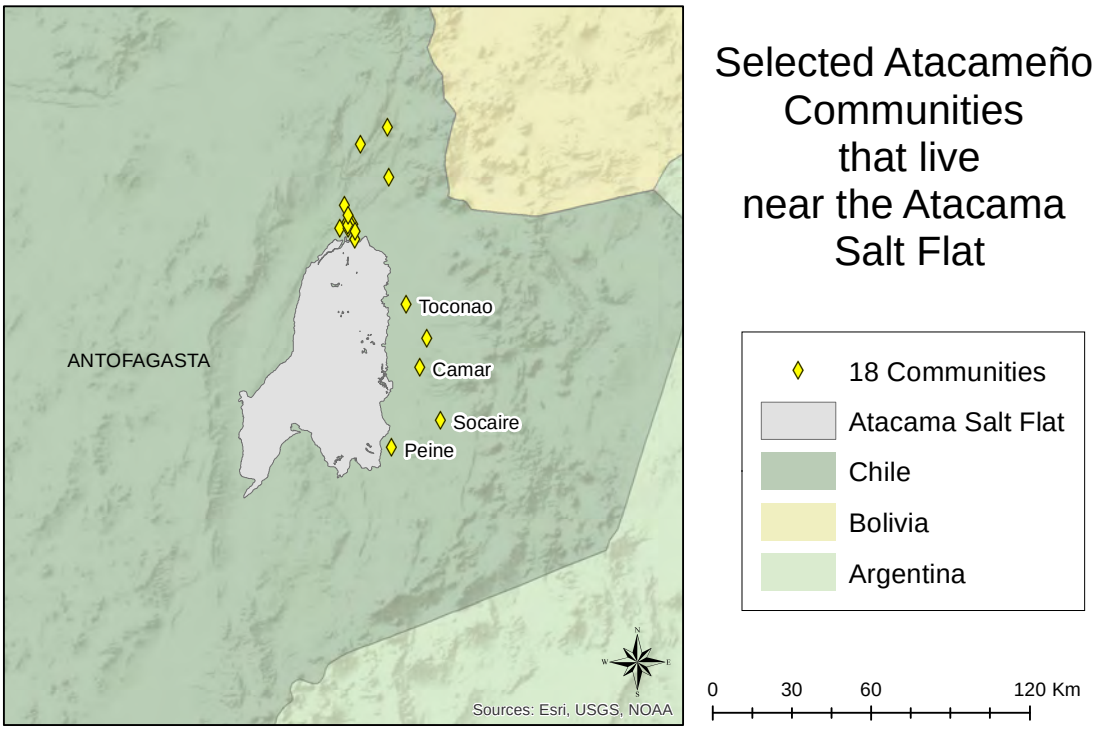
18 ATACAMEÑO/LICKANANTAY COMMUNITIES OF THE ATACAMA SALT FLAT[11]

Rudecindo Christian Espíndola

Development starts in Toconao, and the agriculture in that area starts to decay; craftwork starts to decay; customs start to go down. This monster is called 'mining with SQM or Albemarle.' It transforms the thoughts and way of life of Native people, in a way that causes division. They tell us lithium is clean. We can offer a way of life. But unfortunately, they're winning over there, and we're losing over here. They're drying up our waters. They're drying up the conscience we're lacking.

—Rudecindo Christian Espíndola, Atacameño Community of Toconao/Association of Irrigators and Farmers of Quebrada de Soncor/OPSAL[12]

MAP 2: SELECTED ATACAMEÑO COMMUNITIES THAT LIVE NEAR THE ATACAMA SALT FLAT



Map by Brenda J. Rojas


© Sergio Cubillos, 2021

Sergio Cubillos

In fact, we have told the state: Let's put together a working group through which we can first speed up the handing over of the lands, as per the constitutional acknowledgment of our Native people. And then let's take a look at different ideas or interests that may exist regarding the law. But today, ideally, the most important things are those two things I just mentioned. Also much more important is to find solutions for issues as basic and tangible as drinking water, sewage, electricity, accessibility. I mean, right in the middle of the 21st century, a country that has come out to say they're at the threshold of development, of being a 'developed country,' still has communities that lack these types of services. That speaks very poorly of an administration. And what's worse, the wealth in which the state lives, the wealth that the state has, which sustains the economy and the economic power of this country, comes precisely out of these communities. ... Chile, unfortunately, is a country that's still unable to see its Native peoples. —Sergio Cubillos, former president of the Consejo de Pueblos Atacameños[13]

The Atacama Salt Flat is the site of Chile's two largest lithium mining operations—by Sociedad Química y Minera de Chile (SQM) and Albemarle—and new projects by Wealth Minerals and Lithium Chile are currently in exploration. The region is home to 18 Atacameño/Lickanantay Communities who are collectively represented by the Consejo de Pueblos Atacameños (CPA), as well as other Indigenous communities and organizations that are not represented by the CPA. In addition to their proximity to lithium mining operations, communities located south of the salt flat have been affected by the large copper mining projects in the water basin, Minera Escondida and Minera Zaldívar. The Community of Peine is nested in between the lithium and copper mega-mining projects and has been particularly impacted by the mines. While we are focused here on the impacts of lithium mining, it is important to remember that many communities face overlapping effects of other mining operations.

When it comes to lithium mining, both SQM and Albemarle have reached accords with local stakeholders. The 2012 benefit-sharing *convenio* (agreement) established between Albemarle and the Community of Peine reflected Albemarle's new corporate social responsibility strategy to establish community relationships based on the principle of shared royalties. The company then signed a separate agreement with the government agency CORFO, which approved an expansion project that would triple the brine extraction quota of the salt flat.[14] Albemarle also approached the CPA to negotiate a 2016 agreement based on the historical demands of the Atacameño people, though not all residents found it to be satisfactory.[15] Under the CPA's principle that any economic activity that takes place in the salt flat should ensure the stability of the natural and human environment, this agreement established that 3 percent of the company's revenue would be divided among the 18 communities and the CPA.[16] Another 0.5 percent of revenue would be redistributed to the CPA for studies, plans and projects of Indigenous entrepreneurship, as well as additional funds for scholarships and monitoring. Two years later, this agreement resulted in the formation of the CPA's own Environmental Unit (UMA), whose main—though not exclusive—mission is to fully research and map the Salar de Atacama to build a picture of its ecological health.

Responding to popular criticism, Albemarle also launched a voluntary water monitoring program in 2020. Still, residents note that voluntary self-monitoring gives companies the power to greenwash the production of high quantities of lithium, regardless of broader impacts.[17] For example, in collaboration with Volkswagen, Albemarle asserted that its evaporation ponds use "absolutely zero water" in "a very sustainable process."[18] Focusing only on freshwater use and not water loss from brine evaporation, the company's executives have compared the water needed to produce a Tesla Model 3 to the amount of water used to produce 250 grams (8.8 ounces) of beef, 30 cups of coffee, and half a pair of jeans.[19] These comparisons willfully ignore possible interactions between freshwater aquifers and brine, which of course is also largely composed of water (see section C on page 19).

SQM, on the other hand, has agreements with CORFO and municipalities but has largely been adversarial to the CPA. For instance, tensions erupted during the expansion of operations among cohabiting workers and community members. Water resources have also been a major point of contention between the company and local residents. In 2019 the CPA filed a successful lawsuit in regional court that paused the approval process for SQM's $25 million compliance plan needed to expand operations due to the "particular fragility" of the Atacama Salt Flat.[20] Following this success, the CPA went further to demand that SQM's environmental permits be revoked.[21] In 2020 Chile's environmental superintendent decided not to rely on SQM's failed compliance plan but to develop its own comprehensive management plan that would assess impacts of all four of the mega-mining projects at the Atacama Salt Flat.[22] This signals a growing consensus, expressed in a declaration signed by more than 350 advocates and scientists in support of the CPA, not only that more precautions are necessary for expansion, but that the company's ongoing operations should stop.[23]

Atacameño leaders and community members from across Socaire, Toconao, Camar, and Peine have protested both companies for unauthorized operations, subpar working conditions, and inadequate environmental monitoring, employing direct action tactics like road blockades and hunger strikes.[24] In a 2020 report directed to the United Nations, the CPA demanded that SQM and Albemarle stop operations and halt the influx of their workforce, which reaches up to 10,000 personnel, in order to address the public health emergency of the Covid-19 pandemic.[25]

Ultimately, these problems stem from the fact that the communities have not been fully consulted under the principles of the International Labour Organization (ILO) Convention 169 or the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP).

II. A Snapshot of the Global Lithium Market

A. THE GLOBAL DEMAND FOR LITHIUM-ION BATTERIES WILL CONTINUE FOR YEARS

Governments, scientists and other experts, activists, and people in general around the world agree: The earth's climate is in crisis due to global warming.[26] As a result, actions that reduce GHG emissions and help mitigate climate change have become global priorities. Several of the most effective solutions for moving away from GHG-emitting fossil fuels, notably energy storage systems and electric vehicles, currently rely on lithium-ion batteries.

The cost of producing these important technologies is falling every year. In fact, by 2030, experts expect lithium-ion battery prices per kilowatt-hour to drop by half compared with recent prices.[27] Consequently, the demand for the components of lithium-ion batteries—e.g., lithium, manganese, and nickel—will grow over the coming decades as well. For example, the International Energy Agency calculates that if countries implement policies compatible with the goals of the Paris Climate Agreement, "clean energy technologies' share of total demand rises significantly over the next two decades to over 40 percent for copper and rare earth elements, 60 to 70 percent for nickel and cobalt, and almost 90 percent for lithium."[28] Even with the Covid-19 pandemic slowing vehicle sales, experts assume continued growth in the electric vehicle market in the coming years, albeit at a slower pace than previously expected.[29] Chilean experts project a sixfold increase in the global demand for lithium carbonate between 2019 and 2030, with electric vehicles accounting for 79 percent of that demand.[30]

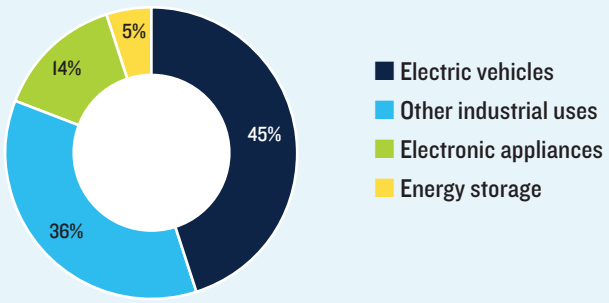
Most of the current demand for lithium comes from three places—China, the European Union, and the United States—where governments have employed a variety of policy tools such as incentives, regulations, and subsidy programs to support the growth of electric vehicles.[35] However, other countries and regions such as India, Australia, and Latin America are also growing markets for lithium-ion batteries.[36] In Latin America, for example, countries that have comparatively low emissions but face relatively high potential impacts from climate change, such as Costa Rica and Chile, have national plans to promote electric mobility to achieve carbon neutrality by 2050.[37] Major Latin American cities such as Bogotá, Mexico City, Montevideo, and Santiago have all introduced electric taxis. Chile, Colombia, Costa Rica, Ecuador, Mexico, Panama, and Paraguay all have specific goals for electric vehicles.[38] In 2019 Chile launched a new electric bus fleet that is the second-largest in the world, after China's.[39] Argentina has approved a decree that reduces duties on the import of electric cars from 35 to 2 percent and is in the process of passing a National Electromobility Law.[40] Uruguay launched the first "electric highway" in the region in 2018 with charging stations located every 60 kilometers, and Montevideo welcomed 30 e-buses in mid-2020.[41] In 2015, Bogotá, Quito, Caracas, Buenos Aires, and Mexico City as well as the Brazilian cities Curitiba, Rio de Janeiro, and Salvador all committed to substitute 40,000 buses for cleaner ones.[42]

WHAT IS LITHIUM, AND WHY IS IT SO IMPORTANT FOR BATTERIES?

Lithium is the lightest of the elemental metals. It is used in ceramics, glass, lubricants, and many other products (see Figure 1). Lithium plays an important role in batteries because of its ability to carry a charge back and forth between the battery's anode and cathode. The first lithium-ion batteries, which were non-rechargeable, became commercially available in the 1970s, and scientists have been trying to improve them ever since.[31] Various kinds of lithium-ion batteries now exist, each with different chemical compositions and related benefits and drawbacks.[32]

Due to lithium's chemical properties, it exists in nature only in compounds, such as lithium carbonate or lithium hydroxide. Those compounds must be processed in some way to extract lithium for use.

FIGURE 1: MAIN GLOBAL USES OF LITHIUM IN 2022 (PROJECTED)[33]



Source: Adapted by authors from R. Poveda Bonilla, CEPAL, 2020.[34]

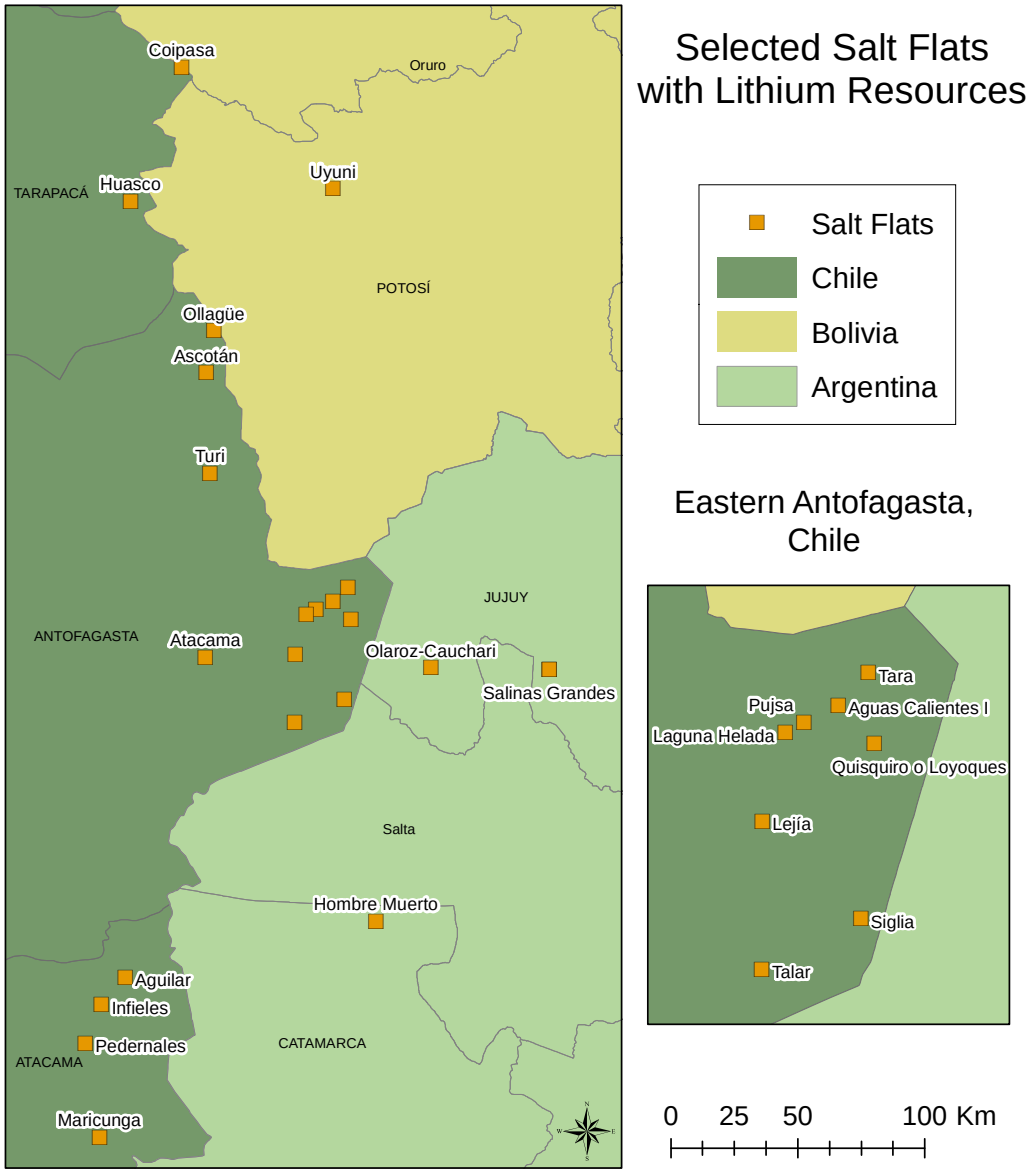
As the demand for electric vehicles and other clean energy solutions grows worldwide, so will the demand for lithium. Recognizing this, research is already well underway to develop battery technologies *without* lithium. The U.S. Department of Energy has an ongoing "Beyond Lithium" initiative whose purpose is to develop lithium-free batteries for things like energy storage and transportation.[43] Research into sodium-ion and aluminmum-ion batteries are among other efforts already showing significant potential.[44]

However, most of those projects will require years of research before they become cost-competitive with lithium-ion batteries at a commercial scale. So, while they may alleviate the impacts of lithium mining in the long and medium terms, for the immediate future lithium remains a key element of the clean energy economy.

B.DIFFERENT GOVERNMENT APPROACHES TO LITHIUM EXTRACTION IN SOUTH AMERICA HAVE SIMILAR DESTRUCTIVE IMPACTS

South America's lithium reserves are concentrated in the salt flats –or *salares*— of the high, arid region that spans northern Chile, northwestern Argentina, and southwestern Bolivia: the Puna de Atacama. These three countries are estimated to hold approximately 58 percent of global lithium resources.[45] This region is also home to large copper, gold, lead, and tin mines.[46] Map 3 identifies the major lithium resources in this region, which tend to share the names of the salt flats themselves.

MAP 3: SELECTED SALT FLATS WITH LITHIUM RESOURCES



Map by Brenda J. Rojas

THE ROLE OF THE UNITED STATES IN RESOURCE EXTRACTION IN OTHER COUNTRIES

After World War II, some wealthy nations including the United States began stockpiling strategic resources like uranium and lithium, which are used in nuclear energy as well as nuclear weapons. Since then, the United States has approached these kinds of resources with a type of "resource nationalism," all the while advocating for free markets for other countries.[47]

Resource nationalism refers to a set of policies that treat minerals as essential to national security and therefore too politically important to be left to markets alone. Historians and other experts point to the United States' and wealthy European governments' long history of blocking access to domestic sources of strategic minerals and securing, sometimes by force and trickery, preferential access to resources found in other countries.[48]

In this region of Latin America, distrust of U.S. and European interests remains high. Bolivians in particular have not forgotten a contract signed between their government and a U.S. company in the early 1990s to extract lithium from Uyuni.[49] Outraged by the lack of local control or input and what many perceived as an exploitative agreement, Bolivians rioted and forced the government to cancel the contract. This story is regularly retold to explain the initial popularity of President Evo Morales's lithium industrialization policy, as well as the questioning of it over time.[50]

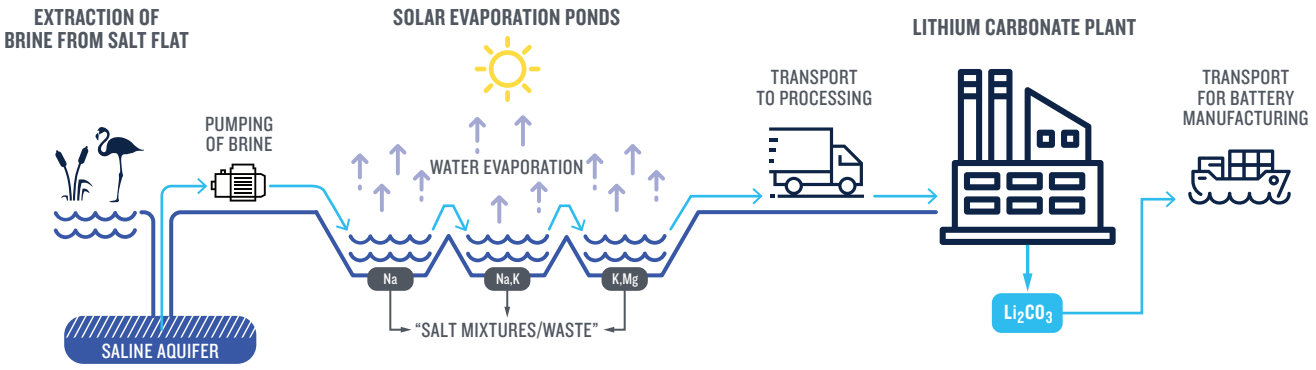
Resource nationalism remains strong in the United States and other wealthy countries that see securing privileged access to foreign resource deposits as crucial to their long-term stability and global power.[51] Indeed, in the United States, federal and state governments have not only subsidized new lithium-related industrial ventures, but often conditioned these on reopening old lithium mines and developing domestic sources of lithium.[52]

To remove lithium from the brine under these salt flats, operators drill down through the crust of the salt flat and begin pumping the brine at a rate of up to 1,700 liters per second.[53] The subsurface minerals are distributed into a series of cascading evaporation pools (Figure 2). These vast bodies of salty water soak up the desert sun and undergo chemical treatment before separation and transfer to a processing plant to produce lithium carbonate.[54] The evaporation process takes 18–24 months, and 95 percent of brine water evaporates in the process.[55]

Estimates of exactly how many liters of water are lost during the process vary widely—by nearly four orders of magnitude—from a low of 400 liters per kilogram (kg) of lithium to a high of 2 million liters per kg.[56] According to Dr. Ingrid Garcés, a professor of chemical engineering at the University of Antofagasta whose research focuses on the salt flat, around 2 million liters of water evaporate for every ton (approximately 907 kg) of lithium produced, which equals about 2,200 liters per kg.[57] The wide range of these estimates highlights a concerning lack of certainty and transparency around this information. Without them, it is difficult to reach a common understanding of how much water is available in this arid environment.

Despite its potential environmental impacts, the evaporation process is generally the standard, most cost-efficient way to extract lithium from brine in Argentina, Chile, and Bolivia. All three countries want to both increase production and create their own local value-added supply chains (i.e., not just to mine the lithium but also to develop local industries to refine and process it for manufacturers), but each country has adopted its own way of governing lithium exploration and production. These different policy characteristics shape the way the lithium mining industry has grown in the region to date.

FIGURE 2: THE EVAPORATION POND METHOD OF OBTAINING LITHIUM FROM BRINE. THIS IS THE MOST COMMON WAY LITHIUM IS SOURCED IN THE PUNA DE ATACAMA.



Source: Adapted by authors from https://doi.org/10.1016/j.scitotenv.2018.05.223.

WHY WE DON'T SAY "LITHIUM TRIANGLE"

The borderlands of Argentina, Bolivia, and Chile are commonly referred to by industry and state actors as the "Lithium Triangle."[58] However, the authors of this study find it more appropriate to use "Puna de Atacama" (which translates roughly in English to "Atacama Plateau"). The Puna de Atacama is a geographical term defined by the characteristics of the ecoregion such as its flora, fauna, elevation, and geology.[59] In contrast, the term "Lithium Triangle" distills the region to just its potential extractive value to industry rather than acknowledging its unique geography and broader significance to local communities. Before the imposition of national borders or industrial siting, the salt flats of the Puna de Atacama shared a common origin as ancient paleolakes that evolved into biodiverse wetlands.[60] Indigenous Peoples adapted to life in this ecoregion through agricultural and pastoral practices, based on local knowledge, that are now disrupted by industrial mining.

1. Chile

Chile's government exercises exclusive property rights over lithium through Decree 2886 (1979). This means that state institutions—particularly the Corporación de Fomento de la Producción (Production Promotion Corporation), known as CORFO—largely set the conditions under which private companies operate in the salt flats. [61]

In 1979, following the lead of the United States, the Chilean government under the dictatorship of Augusto Pinochet declared lithium a "strategic mineral" and took steps to safeguard long-term reserves by limiting production through quotas that are verified by Chile's Nuclear Commission. From the 1980s to today, only two private/public contracts have existed with CORFO: one with the Chilean company Sociedad Quimica y Minera de Chile, commonly referred to as SQM, and one with the U.S. company Albemarle, the latest owner in a long chain of corporate sales.[62] Chile is the leading producer of lithium from brines, and the government's goal has been to further develop 'value-added' lithium products that can be used in batteries, not just be a supplier of the raw material.[63] It expects that these two companies' operations in the Atacama Salt Flat can meet 40 percent of world demand.[64]

However, as demand for lithium has grown since 2008, the Chilean government has struggled to increase production and retain Chile's market leadership. The murky way lithium is addressed in law, combined with corruption scandals and public opposition, has complicated these efforts. In 2012 the government had to cancel a new lithium concession (an agreement for land access and extraction) after it was accused of unfairly privileging SQM, which was shortly thereafter discovered to be making kickback payments to politicians in all the mainstream political parties.[65] At the same time, Chileans from different sectors—especially university students and frontline communities—began to question the social benefits of mining.[66] It is worth noting that in Chile, the companies are obligated to provide some benefits to the government. For example, SQM's contract with CORFO requires the company to pay royalties and sell up to 25 percent of its production to Chilean businesses in an effort to develop a local value-added supply chain.[67] However, critics have challenged the government to demand higher payments from the mining companies to improve the flow of money to frontline communities and to take the environmental harms of lithium mining seriously.[68] A government-appointed committee in 2015 largely validated these concerns, though government action to address them has been slow.[69]

Since then, no new projects have been approved, although SQM and Albemarle's operations have expanded significantly despite myriad corruption scandals and controversies over data transparency (see Community Highlight 1 on page 7 for more details on benefit-sharing agreements the government reached with each company). As Chile enters a two-year period of constitutional reform after a series of protests about the country's deep inequality that began in late 2019, lithium policy could be revised to allow the state to extract and commercialize lithium directly so as to increase government revenues from lithium, which could then (in theory) be more equitably distributed.

2. Argentina

Without exception, Argentina's provincial governments (akin to U.S. state governments) have pursued mining as a source of foreign currency and economic growth.[70] The provincial governments manage lithium mining concessions within a federal framework that regulates taxes, environmental laws, and other issues. Since the early 1990s, this framework has encouraged foreign investment in mining, including lithium extraction. For example, the Hombre Muerto salt flat—perhaps the best known in Argentina—is home to the Fénix lithium mine owned by U.S. company Livent (formerly FMC). Fénix has been producing since 1998.[71] It straddles the Salta and Catamarca provinces, which have granted new lithium mining concessions to numerous multinational corporations without great scrutiny.[72]

In contrast, the provincial government of Jujuy established the Jujuy Energy and Mining State Society (JEMSE) as a government-owned enterprise that acts as a minority partner with multinational corporations operating in the area.[73] Through JEMSE, Jujuy has sought to both attract investment and retain strong local government oversight, with the goals of capturing more government revenue from mining; more equitably distributing mining's benefits to local businesses, social services, and others; and exerting greater oversight of environmental impacts.

Despite the influx of foreign investment in lithium mining, new mines across Argentina are struggling to produce; of 18 or so started since 2015, only Orocobre's mine at Jujuy's Salar de Olaroz has begun selling lithium.[74] The delays in Argentina reflect the scientific and technical complexity of extracting brine-based lithium, market conditions, and local opposition motivated by environmental and equity concerns—illustrated in quotes from various community members throughout this report.

3. Bolivia

The Bolivian state owns the country's lithium deposits, and in 2007 it embarked on an ambitious lithium-based industrialization project. The goal of the country's mining program is to correct what then-president Evo Morales and his supporters saw as a historical injustice: Countries like Bolivia have long provided the world with raw materials while receiving in exchange poverty wages and destroyed environments.

To break this pattern, the Corporación Minera de Bolivia (Mining Corporation of Bolivia), or COMIBOL, engaged Bolivian scientists who developed and patented a method for extracting lithium from the brines of the Uyuni salt flats. It then built research, production, transport, and other basic infrastructure and produced pilot-scale quantities of lithium and commercial-scale quantities of fertilizer extracted from the same brines. Although the government hired some foreign firms to work on downstream aspects of industrialization (e.g., cathode production), the bulk of this effort has been done by Bolivian experts and workers. Proponents hoped this approach would not only generate profits but also empower Bolivian science and industry.[75]

Despite the large size of Bolivia's lithium reserves and the energy put behind the project, a number of factors have delayed industrial levels of production.[76] Primarily, in December 2019 the Bolivian military forced Morales to resign. This change, along with the Covid-19 pandemic, largely paralyzed Bolivia's lithium development. In October 2020, Morales's party swept back into power, led this time by Luis Arce, raising hopes for a renewal of the state-led industrialization strategy. But even before these events, the program had its critics, with complaints about excessive centralization of resources and authority, the role of foreign interests in downstream stages of industrialization, and the slow pace of progress due to technical hurdles to overcome seasonal rain and high levels of magnesium in the salt flats.[77] Nonetheless, new alliances have formed with China, Russia and US entrepreneurs, promoting direct lithium extraction as a technological fix.[78]

While each of these three countries has its own structure for promoting lithium mining, none has yet succeeded in translating mining operations into equal benefits for a wide range of stakeholders. In Chile and Argentina, while select agreements have provided local employment and served other interests for local and Indigenous communities (see our Community Highlights), the main financial beneficiaries so far have been the lithium mining companies themselves.[79] In Bolivia, the government has invested a lot resources into the industry but has not yet seen a return on that investment.

COMMUNITY HIGHLIGHT 2

THE COMMUNITIES OF ANTOFAGASTA DE LA SIERRA NEAR THE HOMBRE MUERTO SALT FLAT (CATAMARCA, ARGENTINA)

Ezequiel Carrizo

An entire [water] vein that supplied the town, which was fundamental to the livestock and agricultural lifestyle of residents, dried up completely. Today there's nothing there. We're also suffering from police persecution. This past month they detained five members of one family in Antofagasta de la Sierra, because the mining company went into their land, cut some wires in order to make a path, and a conflict ensued. ... Later on, at Fiambalá, another town with a vast territory and many minerals ... they apprehended me at the square and arrested me, without a single question. ... They didn't hit me. But in Antofagasta they did beat two women and four men.

—Ezequiel Carrizo, Fiambalá Despierta and PUCARA (Pueblos Catamarqueños en Resistencia y Autodeterminación)[80]

The Fénix mining project, owned by Livent Corporation and operated by Minera del Altiplano S.A., has been in operation since 1998. The lithium operation is large, and plans to expand it further are underway. Fénix produced 15,153 tons of lithium carbonate in 2017 and aims to reach 19,000 tons per year in the short term.[81] After the approved expansion of the operation, it aims to double its output to up to 40,000 tons annually.[82] Minera del Altiplano has worked with the provincial government to appeal to residents—most of whom depend on government jobs—through corporate social responsibility programs. It also directs 1.2 percent of its profits to a mining trust for use in regional infrastructure projects.[83] The company reportedly delivers food to residents, contributes to the church, funds school programs, and built a well and power station (partly for its own use). The project generated 600 jobs during construction and 158 direct jobs during operation.

Despite all of this, the mining project's relations with local communities have grown contentious over time, as the increased mining activity has not significantly improved quality of life in the long term for residents.[84] People who have been impacted by Fénix include the Indigenous Communities of Antofagasta de la Sierra, often represented by the Comunidad Indígena de Atacameños del Altiplano, and nearby rural towns like Fiambalá, which are integrated with non-Indigenous or criollo (mixed race) populations. Many began organizing against the lithium project as early as 2000; most recently, opponents protested the approval of Fénix's expansion.[85] Their primary complaint is the operation's overuse of the area's limited water resources: The operation's water consumption ranges from 280 to 304 cubic meters per hour, 24 hours a day.[86] The Trapiche River and local lagoons have dried up, resulting in the deaths of llamas and sheep grazing on the range in the area.[87] The communities fear the continued use of local water resources will further affect local farmers and the surrounding wetland ecosystem, which is recognized as a Ramsar Wetland of International Importance due to the endangered, native, and migratory species that inhabit the area.[88] Concerned communities also argue that the Fénix project was approved without public consultation or a proper environmental impact assessment process.

Fénix's relations with the regional government have also been rocky, as the company has worked to dodge paying royalty fees.[89] Nonetheless, those who stand in opposition to mining have faced violent repression and harassment from the police. Since the Covid-19 pandemic, 250 workers have gone on strike in response to the company's attempts to keep them working.[90]

COMMUNITY HIGHLIGHT 3

ATACAMA COMMUNITIES IN THE SUSQUES DEPARTMENT NEAR THE OLAROZ AND CAUCHARÍ SALT FLATS (JUJUY, ARGENTINA)

Members of the Colectivo La Apacheta

Our struggle to defend water and land, shaken in this area by the arrival of superprojects of lithium mining and other mines that are about to open, I know it affects all of us Atacameños, and that it changes our culture and our ancestral lives, so rich in our history. But what's most worrisome is that they're taking our water away: water, which means life to all survivors.

—Carlos Guzmán, Colectivo La Apacheta[91]

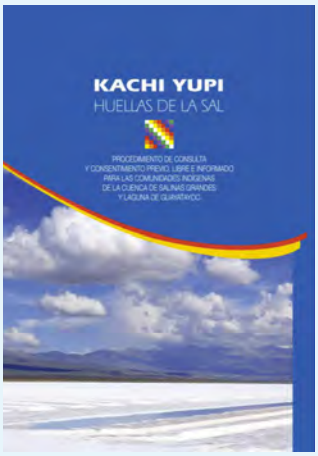
Two major lithium projects have grown around the Olaroz and Caucharí Salt Flats in the Argentine province of Jujuy, near the borders of Chile and Bolivia. The Olaroz Lithium Facility formed in 2010 and is a joint venture among Orocobre (Australia), Toyota Tsusho Corporation (Japan), and the state-owned company Jujuy Energía y Minería Sociedad del Estado (JEMSE). The Olaroz facility currently has the capacity to produce 17,500 tonnes of lithium carbonate per year, and the owners plan to expand the facility to produce 42,500 tonnes per year.[92] The Caucharí-Olaroz project, located in the Caucharí Salt Flat, is in the advanced construction stage. Operated by Minera Exar, the project is owned by Gangfeng Lithium (China), Lithium Américas (Canada), and JEMSE (Argentina).[93] It is anticipated to produce 40,000 tonnes of lithium carbonate annually when at full capacity.[94]

The area is also home to approximately 4,000 people, including 10 Indigenous Atacama Communities who continue their agro-pastoral practices of raising goats and llamas as well as subsistence farming of quinoa and potatoes and making artisanal crafts.[95] These rural societies, particularly the villages of Huancar, Pastos Chicos, and Olaroz Chico, have felt the impacts—some negative, some positive—of the Olaroz Lithium Facility and the Caucharí-Olaroz project. Indigenous communities in the region have been divided over the benefits and burdens of lithium development there.

JEMSE's partnership with Orocobre has resulted in community-based projects that have brought transmission lines, a business park, technical job training, microcredit loans, a community center, transportation, clothing drives, and even sports tournaments to the area.[96] At the same time, many residents believe they have not had sufficient opportunity to participate in the decision-making processes, and benefit sharing is largely symbolic.[97] Some community members argue that depleted water levels in wells, lagoons, groundwater, and wetlands have had detrimental impacts on their agro-pastoral practices, and they have observed increased mortality of flamingos and camelids because of dust pollution resulting from mining activities.[98] A new social movement of agro-pastoral workers called La Apacheta has formed, drawing membership from across local Indigenous communities, to denounce the projects' approval processes and challenge irregularities in impact studies of water resources.[99]

COMMUNITY HIGHLIGHT 4

33 KOLLA AND ATACAMA COMMUNITIES IN THE SALINAS GRANDES SALT FLAT AND LAGUNA DE GUAYATAYOC (JUJUY, ARGENTINA)



Indigenous People who work with the salt know where to find it. Its rational management has been an ancestral conception in our communities, avoiding uncontrolled extraction. This practice, as an ancestral heritage of our elders, is being ignored, compromised and exiled by new large-scale mineral mining initiatives (lithium, lead, copper, zinc, borax and others) that prioritize technology and disregard the value of a workforce, to maximize profits, no matter the consequences, even if these modify, damage or degrade the land.[100]

—Kachi Yupi Protocol

The cover of the Kachi Yupi Protocol, agreed to by the Kolla and Atacama communities in the Salinas Grandes and Laguna de Guayatayoc Basin, 2015

The border area between the Atacama Argentine provinces of Jujuy and Salta contains the Salinas Grandes–Guayatayoc Basin. There, the region's 33 Indigenous Kolla and Atacama Communities have been at odds with the Salinas Grandes lithium mine owners, Pluspetrol Resources Corporation B.V. and Dajin Resources S.A., and its operator, LitheA Inc. Sucursal, almost since its inception.[101] The project is in a state of advanced exploration, with the developers estimating lithium resources totaling 239,187 tons of lithium carbonate.[102] Communities anticipate the loss of artisanal salt extraction and textile work, as well as depleted reservoirs of the Puna for livestock (sheep and llamas) and agriculture.[103]

Commercial explorations of the Salinas Grandes–Guayatayoc Basin as early as 2009 led to protests and confrontations, resulting in a Supreme Court hearing on March 28, 2012.[104] Sixty people from the 33 communities participated, seeking to hold the governments of Jujuy and Salta accountable for licensing mining explorations without prior consultation or assurances of Indigenous rights guaranteed by ILO 169, which Argentina ratified in 1992 and adopted into its constitution in 2000.[105] In 2015 the communities crafted a biocultural protocol called *Kachi Yupi: Huellas de la Sal*, based on local knowledge in the Salinas Grandes–Guayatayoc Basin, to outline appropriate procedures for free, prior and informed consent.[106] JEMSE, representing the province, has sided with the mining industry.

In December 2019 the communities, which had worked in alliance with the organization Fundación Ambiente y Recursos Naturales (FARN) for more than a decade, filed an environmental protection action against the provincial governments of Salta and Jujuy and the federal government of Argentina, requesting a proper environmental study of impacts on water, grounded in Indigenous rights to consultation and consent.[107] The Supreme Court rejected the communities' claims, so their case has been mired in provincial courts. The 33 Indigenous communities have heightened their plurinational profile through a vast communications network, a visit from a U.N. special rapporteur on the rights of Indigenous Peoples, and actions filed with the Inter-American Commission on Human Rights.

III. Lithium Mining Endangers Water, Wildlife, and People in the Salt Flats of Northern Chile

Despite the differences between Argentina, Bolivia's, and Chile's approaches to lithium mining, one common theme in all three countries is strong discontent among nearby communities toward the industry's negative impacts on the environment and water resources. These impacts affect people's livelihoods and cultural practices. Due to resource and research constraints, this report focuses on the lithium mining industry and its environmental and social impacts in Chile, with examples from Argentina and Bolivia where relevant. While the national differences are important to bear in mind, similarities in geography and the evaporation processes used across the region make the impacts in Chile fairly representative of the Puna de Atacama as a whole.

A. UNIQUE WETLANDS AND WILDLIFE ARE THREATENED BY LITHIUM MINING

At the foothills of the northern Chilean Andes, the high-altitude geography and the cool, dry climate interact to form a series of salt pans. Rainfall that does not evaporate at the surface mixes with salts in the earth and seeps into deep aquifers. Beneath the crusty surface layer of salt, sand, and pebbles lie dense masses of brine: a salty solution containing 75 percent water and 25 percent dissolved salts, plus high concentrations of lithium and other compounds and minerals.[108] For comparison, the ocean is about 3.5 percent dissolved salts.[109] The Atacama Salt Flat Basin, the largest and one of the first to be mined for lithium in Chile, is part of the extensive cross-border region of the Puna de Atacama (see "Why We Don't Say 'Lithium Triangle,'" above).[110] Since ancient times, its waters have run through ravines and under rocks from the Andes, seeking, without success, the sea.

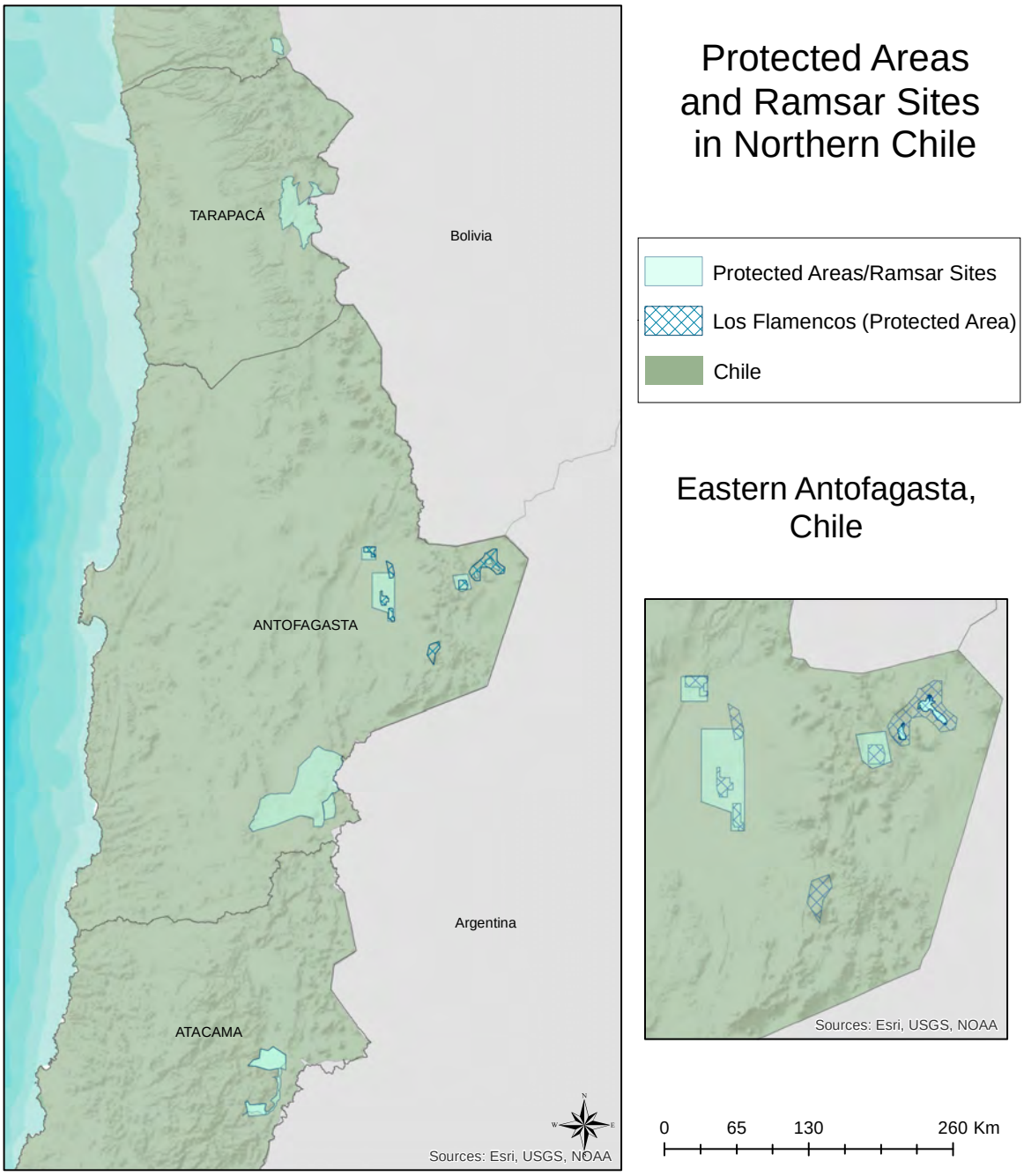
Despite being a desert, the area is hardly a wasteland.[111] On the contrary, it features vital wetlands that are the product of ecological and social interaction over millennia. Biodiverse fauna and flora have coevolved in a fragile symbiosis across multiple scales of life in the hypersaline lakes of the Andes, from flamingos and small mammals to unique communities of microorganisms.[112]

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Global Assessment identified wetlands as the world's most threatened ecosystems.[113] Wetlands serve as key sites for migratory birds, and many of the lagoons in this area host migratory and native wildlife. Three of the world's six species of flamingo migrate there. Approximately 80 percent of the animals residing in Andean salt flats are native, including the culpeo (Andean fox) and a tenacious lizard nicknamed "the salt flats fighter."[114] For these reasons, several of the lagoons in the region are already designated as Ramsar Wetlands of International Importance or nature reserves, and many of the salt flats have some sort of national protected status. Yet many of these same unique areas are adjacent to or overlap with lithium mining, as is evident in Map 6.

Flamingos at Laguna Chaxa in Chile

The salt flat fighter lizard

MAP 4: PROTECTED AREAS AND RAMSAR SITES IN NORTHERN CHILE



Map by Brenda J. Rojas

CAN THE DESERT'S WETLANDS STORE CARBON?

It is worth noting that some scientists are studying the carbon capture potential of the wetlands in the Puna de Atacama, to better understand how protecting these ecosystems can contribute to global efforts to fight climate change.[115] Some research demonstrates that the Salar de Huasco is an important carbon dioxide sink.[116] Although this line of research is fairly nascent, this issue is highly relevant given the current climate crisis, and it presents another possibility for how this unique place could help fight global warming.

The stressors of brine extraction on water availability and quality pose a significant threat to the area's wildlife. The most immediately impacted life forms are unique species of microbes and bacteria that are at risk of extinction due to brine evaporation.[117] Scientists and biodiversity conservationists are concerned that this may have knock-on effects for more charismatic megafauna higher up on the food chain.[118] Collective memory from local residents suggests that flamingos are disappearing, but access to relevant data is limited, in part because the flamingo monitoring program is effectively managed by the lithium company SQM through an agreement with Chile's National Forest Corporation (CONAF). As with much scientific research that has been supported by the private sector in Chile, biological reports exclude mining impacts.[119] So these data are either not being collected, are not publicly available, or are viewed with distrust.[120] We do know, however, that on SQM's property, 32.4 percent of the native algarrobo trees (*Prosopis chilensis*)—a drought-tolerant species that sends roots deep underground to survive—were found dying as early as 2013 due to the effects of water shortages.[121]

At the same time, climate change is hastening the retreat of glaciers and the disappearance of lakes from the landscape.[122] As a result, the area has been suffering from the slow violence—the uneven effects that take place gradually and often invisibly—of an ongoing water crisis.[123] Climate adaptation, human rights, and environmental degradation are more serious concerns than ever.[124]

Although many questions remain about the impacts of brine extraction and climate change in Puna de Atacama, scientists know that healthy lagoons are vital for flora and fauna in the salt flats.[125] Recognizing the importance of protecting the biodiversity and the cultural value of the Atacama region, Chile's Ministry of the Environment has called its national salt flat aquifers areas of "biocultural patrimony."[126] In 2015 a government-appointed committee acknowledged that extraction negatively impacts the ecosystem, but rather than regulating brines accordingly, it reaffirmed the Chilean state's longstanding policy of regulating lithium production.[127] On January 9, 2020, the International Rights of Nature Tribunal issued a nonbinding verdict denouncing lithium mining for endangering water and proposed a moratorium on lithium mining in the Atacama Desert.[128]

B. INDUSTRIAL MINING DISRUPTS MILLENNIA OF INDIGENOUS AGRICULTURAL AND PASTORAL PRACTICES

Humans have lived in the area of the Atacama Salt Flat since at least 10,000 B.C.[129] Atacameño (also known as Lickanantay) culture and livelihood adapted to the seemingly hostile high-desert environment through local agro-pastoral practices such as growing maize, quinoa, alfalfa, and fruit as well as raising llamas and other livestock. For the Atacameño (Lickanantay) Indigenous People, water relations have been the guiding thread of a long history of adaptation to one of the most arid environments in the world. "We are grateful for every drop of water and understand its cycles," says Jorge Muñoz Coca, of the Atacameño (Lickanantay) Community of Solcor and member of Observatorio Plurinacional de Salares Andinos (OPSAL).[130]

In addition to the Atacameño (Lickanantay) Communities encircling the salt flats near San Pedro, multiple transandean Indigenous communities have survived and thrived in the area since Spanish colonial dispossession—from the Aymara People, whose territory crosses over from Bolivia and Peru in the far north, to Colla and Diaguita Communities located in Norte Chico, Chile, and northwest Argentina. Depletion of local water resources and the imbalance of water rights are threatening the agricultural and pastoral practices of these Indigenous communities.

AGRICULTURE AND PASTORALISM IN THE DESERT

In simple terms, there are two main types of agriculture in the Atacama: valley agriculture and highland agriculture.

Valley agriculture refers to the agriculture practiced in the town of San Pedro de Atacama (elevation: 2,420 meters), and is associated with the San Pedro and Vilama Rivers. The oasis of San Pedro de Atacama is the most populated area in proximity to the Atacama Salt Flat and is home to small farms that have long conserved the biological and genetic diversity of the territory.[131] Raising grazing animals, although less visible, continues to occupy a small part of the population of the valley and provides nonindustrial fertilizer to the lands that are sown each spring with the beginning of irrigation.

Highland agriculture refers to the various agro-pastoral practices encountered in higher-altitude areas (elevation: 2,700 to 3,700 meters) associated with ravines and rivers that descend, from east to west, from the mountain range to the Salar de Atacama. This type is found in the Indigenous Atacameño (Lickanantay) Communities of Toconao, Soncor, and Peine, among others. There, the soils tend to be sandier, and the surface shallower, mainly due to the slope and the presence of volcanic rock.

Both of these systems depend on irrigation channels that are managed by irrigation associations and farmers or by the communities themselves. This practice is passed down from generation to generation.

The availability of water for irrigation in the Atacama is decreasing, in terms of both quantity and quality.[132] This led the irrigation associations of both of the local rivers, the San Pedro and the Vilama, to limit water concessions by requesting a Declaration of Exhaustion (*agotamiento*) of these sub-basins. The request was ratified by the government agency charged with managing the country's water resources, the General Water Directorate (DGA), in 2017.[133] This declaration officially states that the watershed is "exhausted" and does not have enough surface water to allow additional water rights to be granted. Even with this intervention, the remaining water is insufficient for the communities' needs, according to irrigators who measure the decrease in water every planting season. Many farmers have had to reduce the planting area of native corn by up to two-thirds, giving way to new tensions among disparate groups of irrigators who seek to ensure their own access to water in order to save their respective crops.[134]

In 2018, technical reports indicating ecological exhaustion caused the DGA to declare a prohibition on groundwater use for extractive purposes in the aquifer by the Atacama Salt Flat.[135] Additionally, it recognized that it had given out more rights to fresh water resources than were available.[136] Despite this overpromising of water resources, local communities have received rights to far less water than the mining companies have; in the Atacama, they have rights to about 92 liters per second, compared with a combined 2,739 liters per second owned by the mining companies operating in the area.[137]

Although water scarcity in the basin is widespread, it is the communities and ecosystems to the south of the salt flat, which are closer to the freshwater and brine extraction wells, that are now experiencing the most direct impacts of mining activities in the territory. When an elder of the Peine Community was asked how lithium mining affects her daily life, she responded, "What can I do alone against other human beings, against the government? When they come to ask me, I don't want to go to give an opinion, because it makes me sad. We are divided by money . . . Who controls that? . . . My father practiced agriculture and livestock there in Tilopozo . . . Today we can't have any animals." This woman did not know that the aquifer that feeds her family's *vegas* (wetlands) and fields was declared depleted by the DGA.[138]

C. LITHIUM EXTRACTION THROUGH EVAPORATION IS WATER EXTRACTION

As mentioned above, this northern area of Chile contains internationally recognized wetlands and nationally protected areas whose boundaries often overlap with salt flats. As a result, lithium mining companies are also exploring and operating in or very near these areas.

Lithium mining operates under the assumption that the brines extracted from the salt flats are separate from the adjacent wetlands and aquifers. Industry actors acknowledge that lithium brine contains water, but they point out that brine is not suitable for irrigation or human consumption without high-energy processing.[139] For that reason, the lithium industry argues that brine is not water and should not be regulated as such. Moreover, lithium mining operators have argued that their extraction methods are "natural" or "artisanal," downplaying the industrial use of water required to extract lithium from brine.[140]

However, these assumptions are overly simplistic. Researchers still are not in full agreement about how fresh groundwater connecting distant wetlands across the region interacts with the salty brine water.[141] Recent studies of the Salar de Atacama suggest the briny area is recharged mostly through the surface (particularly through rainfall in the mountains), while an underground "mixing zone" separates brine aquifers from freshwater aquifers.[142] Definitive hydrogeological research at the time of this paper's publication remains contradictory, inconclusive, or unavailable because, controversially, mining companies have pursued their own independent research without full disclosure.[143] But there is heightened concern about the quantity and speed of fresh (or less salty) groundwater flowing into the salt flats to fill the space left by evaporated brine water.[144] This may decrease freshwater availability for flora and fauna as well as humans.

Salt flats are inextricably connected to the wetlands and rivers that support life in this arid region. The evaporation methods that the lithium mining industry uses are contributing to conditions of ecological exhaustion for these high-altitude environments.[145] What's more, the brine extraction process not only potentially stresses water availability but also transforms the landscape by leaving behind hills of salt on the surface of the salt flat and contaminates the environment with an array of toxic chemicals including diesel, magnesium, lime, organotin, and polyvinyl chloride (PVC) from pond linings and tubing.[146]

A culpeo (Andean fox) trots along a pipeline at the Albemarle lithium operation

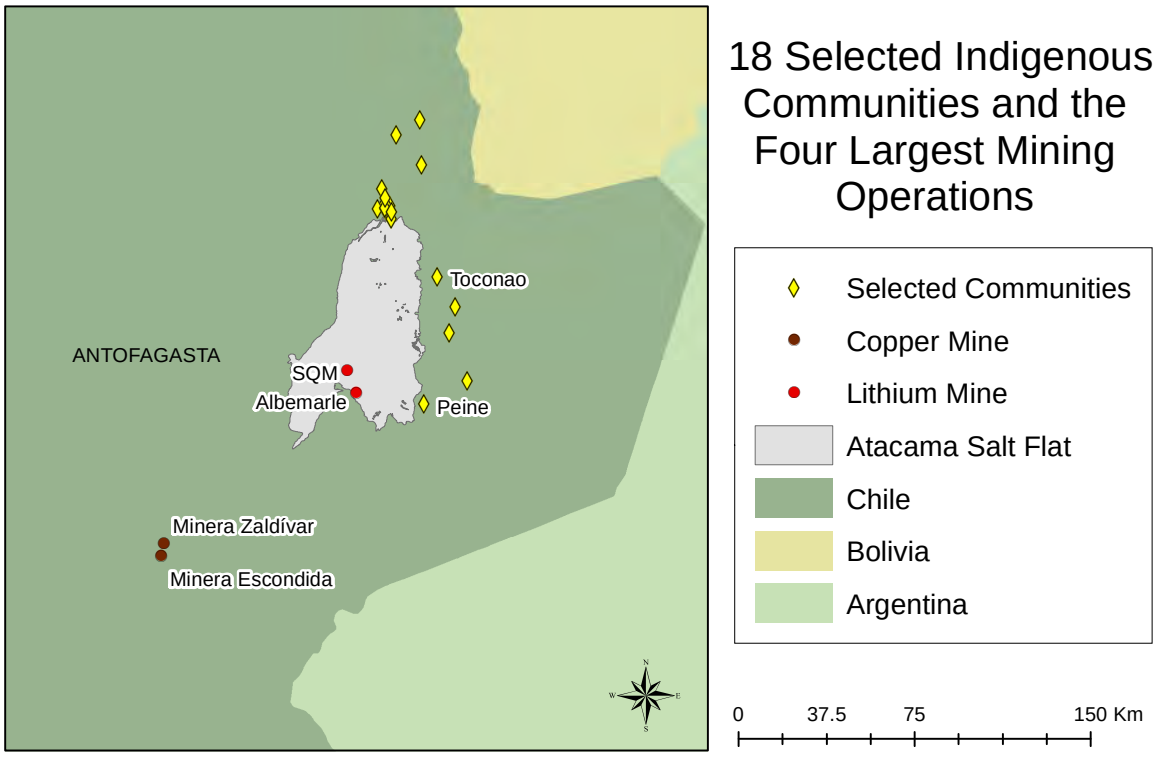
Lithium mining companies and government agencies are finally starting to take note of these issues. In response to concerns and pressure from their own clients, Albemarle announced in early 2020 a broad water monitoring program (details had yet to be released as of July 2021).[147] This comes after delays and inconclusive reports produced by CORFO regarding the Atacama's fragile water-based ecosystem.[148] Monitoring has been long overdue, and this could be an important first step. However, Chilean environmental and community advocates are concerned about the transparency and reliability of this effort.

D. LITHIUM MINING IS COMPOUNDING WATER PROBLEMS THAT HAVE BEEN BUILDING FOR DECADES

Mining, which can use large quantities of water regardless of the metal or mineral being mined, has been a significant activity in Chile's Atacama Salt Flat since even before the imperial intrusions of the Inca or the Spanish conquistadors. By the early 20th century, nitrates and copper from this region provided nearly all of the Chilean government's revenue. A century later, mineral extraction contributed around 10 percent of the nation's gross domestic product, with copper alone accounting for 7 percent.[149] Initially, small-scale extraction was a welcome source of employment for Atacameños. However, in the 1980s and 1990s, large-scale copper, gold, and brine-based fertilizer and lithium extraction boomed in the Atacama Desert due to global market demand and business-friendly policies that followed the neoliberal economic guidelines of the Pinochet dictatorship of 1973–1990.[150]

Despite decades of operations, the mining industry's devasting impacts on this region's water resources have been recognized as a serious problem only relatively recently. As of this report, there are four large mining operations in the Atacama Salt Flat in Chile's Antofagasta Region, two extracting copper and two producing lithium. The two main copper mines in the Salar de Atacama Basin, Minera Escondida and Minera Zaldívar, have been loudly criticized for their freshwater use and damage to the local environment.[151] Lithium extraction, the newest industry to the region, is now yet another way the scarce water resources are being depleted.

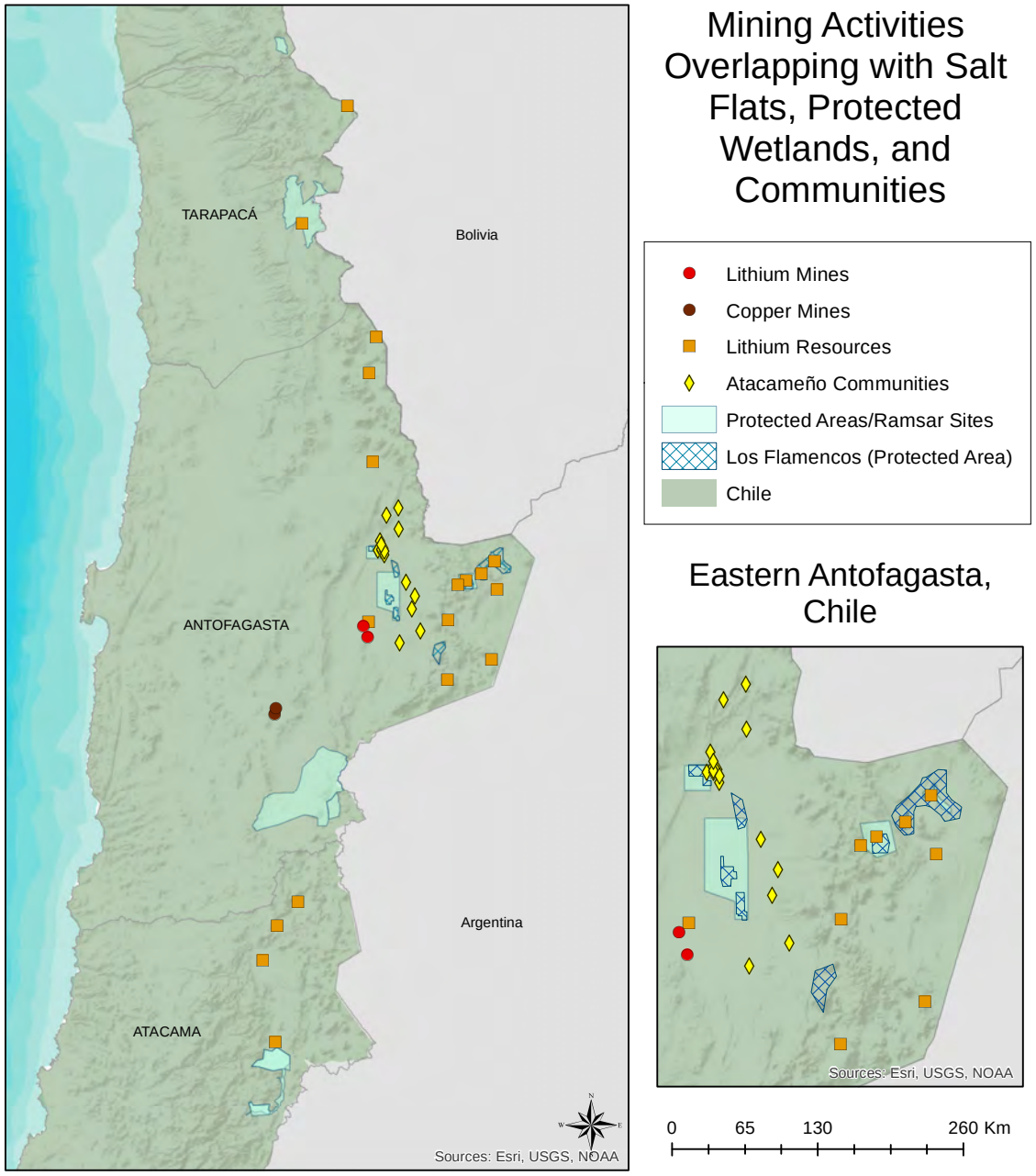
MAP 5: 18 SELECTED INDIGENOUS COMMUNITIES AND THE FOUR LARGEST MINING OPERATIONS



Map by Brenda J. Rojas

Unfortunately, Chile's water regulations have not kept pace with its mining activity. Chile's 1980 Constitution, together with the Mining and Water Codes, privatized access to and use of minerals and water.[152] Chilean regulators began tracking water consumption from copper mines only in 2009; consumption from all mines is unknown.[153] Notably, regulators count only surface water, freshwater aquifers, and ocean water—not the brines used by lithium mining. Neither the Mining Code nor the Water Code recognizes brines as resources to be regulated. As a result, Chilean authorities may not know precisely how much brine is drawn out or if any remaining portion is reinjected after minerals are extracted. While permits are needed for brine under the environmental authority, these documents do not consider the specifics of lithium extraction, which some experts argue is more akin to water-intensive forms of agro-industrial "harvesting" than to mining in the first place.[154]

MAP 6: MINING ACTIVITIES OVERLAP WITH SALT FLATS, PROTECTED WETLANDS, AND COMMUNITIES



Map by Brenda J. Rojas

PUNTA NEGRA: AN EXAMPLE OF HOW MINING CAN DESTROY SALT FLATS

The economic boom of the mining sector in proximity to the Atacama Salt Flat has already resulted in the "ecocide" of the nearby Punta Negra Salt Flat, which may serve an example for the Puna of Atacama more broadly.[155] In April 2020, the Environmental Court of Antofagasta accepted a lawsuit against Minera Escondida for "continuous, cumulative, permanent and irreparable environmental damage to the Punta Negra Salt Flat," citing 27 years of intensive water extraction from 1990 to 2017.[156]

Concerned local citizens are arguing that the depletion of water resources threatens wildlife, including more than 30 species of birds like flamingos and ducks; mammals like vizcachas, foxes, guanacos, and vicuñas; and 24 plant species. They also argue that Minera Escondida's activities threaten their culture and traditions.[157] Meanwhile, in July 2020, the superintendent of the environment for Antofagasta charged Escondida with extracting more than the maximum level of water allowed, in violation of its 2005 commitment to lower its extraction rate.[158] In June 2021, the mining company reached an accord with local Indigenous communities to implement measures to try to rehabilitate the area.[159]

This example points to the mining sector's record of carelessly exhausting water resources and its disregard for local wildlife and cultures around the Atacama Salt Flat.

At the same time, freshwater scarcity in Atacama Salt Flat is compounded by the growth in tourist activity over the last two decades. Locally, tourism represents the highest income and number of jobs in the area, which has led to a progressive increase in population to more than 10,996 inhabitants in 2017 (including tourists), up 121 percent from 2002.[160] The village of San Pedro de Atacama provides an example of the impact of tourism: Potable water there comes from brine that's treated by reverse osmosis for a capacity of up to 6,000 people. Neither the osmosis plant nor the sewage treatment plant is capable of providing service to the current number of inhabitants. This has led to a sanitary emergency due to contamination from black waters and a serious crisis in the management of rural potable water.[161]

Unfortunately, the investment in, taxation of, and even a large part of employment in tourism is directed outside the region, the territory, and its original inhabitants. The tourism boom has not been reflected in infrastructure development, which remains unchanged from when only 3,000 people lived in the area. Without supervision or investment to respond to the needs of this new and growing industry, the population suffers constant cuts in electricity and drinking water.

COMMUNITY HIGHLIGHT 5

COLLA COMMUNITY OF COMUNA DE COPIAPÓ IN THE MARICUNGA SALT FLAT (ATACAMA REGION, CHILE)

Lesley Muñoz Rivera

We have Indigenous consultations in which, if they come and ask you as an Indigenous person and part of the territory they are interested in exploiting, "Do you agree with what we want to do?" and as Indigenous people, we say no, then this consultation process is considered done and fulfilled. That is to say, there is no interest in preserving Indigenous cultures, territories, and environments in general. What's more, this means that our knowledge is not taken into consideration, and therefore there is little that we can do to stop projects that seek to extract lithium from the Maricunga Salt Flat under the current normative order of the Indigenous consultation process.

—Lesley Muñoz Rivera of the Indigenous Colla Community, Comuna de Copiapó and member of OPSAL[162]

The Maricunga Salt Flat is the site of much exploration by the lithium mining sector. Currently, Codelco (the National Copper Corporation of Chile), SIMCO SpA, Sales de Maricunga SpA, ENAMI-Wealth Minerals Ltd., Talison Lithium, and SQM all have projects in some stage of early development. The most advanced project in the salt flat is Minera Salar Blanco S.A., a joint venture whose primary participants are Lithium Power International (Australia), Borda Grou (Chile), and Bearing Lithium Corp (Canada). Minera Salar Blanco received environmental approval in February 2020.[163] Project developers anticipate an annual yield of 20,000 tons of lithium and 58,000 tons of potassium chlorate over a 20-year period.[164]

The Colla People of the Comuna de Copiapó and the Community of Diego de Almagro, whose ancestral territories stretch east of the mining city of Copiapó, are the Indigenous groups most impacted by the activities of Minera Salar Blanco and the other prospectors. Minera Salar Blanco asserts that its environmental impact assessment included a "lengthy process of social engagement with the Colla Indigenous communities in the area," but free, prior and informed consent to operate has not been obtained from all Colla Peoples in the area.[165] According to local Indigenous leaders from the Colla Community of the Comuna de Copiapó, a consultation was held with the Community of Diego de Almagro but not with them.[166]

Perhaps more egregiously, developers of another mining project, Sales de Maricunga, never offered a consultation at all.[167] Thus, while the companies claim to have the same baseline status, only one has gained approval, and the consultation process remains incomplete. In addition, mining activities have disrupted ancestral ceremonies of the Colla People, violating their Indigenous rights.

On top of procedural concerns, environmental impacts are at issue, for Maricunga is the southernmost salt flat of the whole Altiplano, which gives it particular biogeographical importance. According to Dr. Ingrid Garcés, this salt flat hosts 11 native plant species. At the southern end of the salt flat, just 10 kilometers from one of the extraction sites, is Laguna Santa Rosa, located within Parque Nacional Nevado de Tres Cruces, which is also a Ramsar Wetland of International Importance. The Laguna is home to three species of flamingo and seven more native flora species. Seventeen of its 53 animal species are endangered (nine are vulnerable, five are at risk of extinction, and three are considered rare).[168]

COMMUNITY HIGHLIGHT 6

AYMARA COMMUNITY OF ANCOVINTO, COMUNA DE COLCHANE IN THE COIPASA SALT FLAT (TARAPACÁ, CHILE)

© James J. A. Blair

María Gómez

We are desperate, and there's no way to stop this. We are facing a tank well protected by the republic's constitutional law. And they tell us that neither the Indigenous Law can help us, nor did ILO 169 help us. We can't grow our quinoa; we can't raise our llamas; we can't carry out our ceremonies and customs, etc. If lithium arrives, it will also be the end of animal life, of agriculture, of our Indigenous people, of our ancestors.

—María Gómez, president of the Aymara Community of Ancovinto, Comuna de Colchane, Tarapacá, Chile[169]

The Coipasa Salt Flat straddles the Chile–Bolivia border and is the site of several lithium exploration projects. In Chile, Lithium Chile (Canada) and Minera Atacama (Chile) are the two companies with the most advanced efforts, with Lithium Chile controlling more than 70 percent of the land on the Chilean side of the Coipasa Salt Flat.[170] The Indigenous Aymara Community of Ancovinto in the Comuna de Colchane, of the Tarapacá region, is likely to be most impacted by these explorations; its members are the surface rights holders of the land, which is their ancestral territory. Even though no project is operational yet, local residents have felt the impacts of lithium exploration for years. One community member reported in December 2019 that Minera Atacama had been a presence for more than a decade, with welding and mining operations underway without consent.[171]

Lithium Chile has also done extensive surveys, mineral sampling, and geophysical analysis, identifying a 58-square-kilometer lithium brine target area to drill on May 7, 2018.[172] Lithium Chile asserts that it received approval from the Indigenous Aymara Community of Ancovinto by a vote of "over 65 percent" in March 2019.[173] The company celebrated reaching the final stage of a process to grant a binding access easement in Chilean court on September 12, 2019, and met with Chile's Ministry of Mining to confirm government support on September 25, 2019.[174] However, as of May 31, 2021, a compensation plan for the community—a key element of community approval—had not yet been established or agreed on, even though the company was preparing to drill.[175] Community members view this as a coercive form of accessing lithium through legal avenues while disregarding the community's right to water on its own ancestral territory.

IV. Recommendations for the Lithium Industry to Avoid Further Damage to the Puna de Atacama

Lithium-ion batteries are, for the short and medium term, a critical component of the global strategy to fight climate change and mitigate air pollution by electrifying vehicles and providing energy storage for intermittent renewable energy. Yet the ecosystems that contain the earth's lithium resources—and the people who live there—should not be sacrificed to extract this material and build a market. Experts looking at a variety of global lithium demand and supply trends have specifically noted that the "long-term sustainability of the transport sector" is at risk "unless a mix of measures is taken to ameliorate the challenge" of balancing demand with the need to protect local communities.[176]

Fortunately, there are myriad ways that communities, governments, and the private sector throughout the lithium-ion battery supply chain can mitigate or even eliminate the negative impacts of lithium mining in the Puna de Atacama and other environments. Every actor—from local authorities to local and international mining companies to global battery vehicle manufacturers and even to governments in consumer countries—should embrace these solutions by implementing the actions appropriate to their roles in the chain and requiring those they do business with to do their parts as well.

1. RESPECT AND ENSURE FREE, PRIOR AND INFORMED CONSENT FOR INDIGENOUS AND LOCAL COMMUNITIES.

While the existing benefit-sharing agreements in this region may offer a foundation for industry partnerships with communities, these agreements have thus far formalized conflicts: they describe the conflicts on paper but have not necessarily resolved all problems on the ground. In order to operate in a sustainable and *equitable* way, it is imperative that mining firms and state agencies respect and uphold the rights of Indigenous and local communities every step of the way. Specifically, governments should require and monitor, and companies should fulfill, the requirements of:

- International Labour Organization Convention 169 (ILO 169), which recognizes the rights, cultures, and land ownership of Indigenous Peoples and requires that "studies are carried out, in co-operation with the peoples concerned, to assess the social, spiritual, cultural and environmental impact on them of planned development activities."[177]
- The United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), particularly the right to free, prior and informed consent for use of land, territory, and resources.
- The United Nations Declaration on the Rights of Peasants and Other People Working in Rural Areas (UNDROP), which suggests that traditional agricultural and pastoral practices should be protected as a means of food sovereignty and security.

It is worth noting that ILO 169 is ratified and in force in Chile, Argentina, and Bolivia and that all three countries voted in favor of UNDRIP and UNDROP.

In addition, although they are often ignored or inconsistently applied, several Indigenous-led land-use protocols, such as the Kachi Yupi Protocol, are instructive.[178] The concepts and practices these protocols outline—especially those developed locally—should be prioritized by the relevant governments and companies. This includes recognizing communities' rights to say no to mining proposals and instead continue making a living through established local economies like salt extraction and livestock raising in Salinas Grandes or small-scale agriculture and tourism in Atacama.

2. PRIORITIZE INDIGENOUS KNOWLEDGE AND SCIENCE OF LOCAL ECOSYSTEMS.

As we have seen throughout this report, many community members in the Puna de Atacama are concerned that they and their local environments are being sacrificed to create national economies based on the global lithium market. If sourcing agreements or battery chemistries change, the growth of South America's lithium market could reverse, meaning the sacrifice would be for nothing.

The lithium sector is applying the conventional business practices of industrial mining companies, which depend on global markets and on decades of experience garnered from projects in other parts of the continent or the world. This approach ignores local needs and the *millennia* of experience gained by communities that have developed deep knowledge of their area's natural resources and how to use those resources sustainably. Current industry practices ignore and diminish the contributions of traditional ecological knowledge. Instead, companies and governments should prioritize learning from local Indigenous Peoples and earnestly incorporate that knowledge into the heart of their practices.

Indigenous knowledge of local ecosystems may also help with environmental monitoring, building local food production, and safeguarding biodiversity. As highlighted in the UNDROP, peasant and rural societies have for centuries contributed to conserving and improving biodiversity, "which constitute the basis of food and agricultural production throughout the world."[179] There

are myriad models of Indigenous-led land-use planning and environmental management to follow for protecting areas of high biodiversity, and Indigenous knowledge and science may be complementary in the formation of appropriate co-management of resources by local communities and governments.[180] Recognized systems of environmental governance that prioritize environmental health over corporate profit, like Integrated Watershed Management, can provide useful guidelines for privileging local knowledge and avoiding ecological and social harm.[181]

A more just and equitable approach to resource management is critical to building a relationship that is more democratic among all actors. Fortunately, Chile may be in a position to incorporate this change during its process to create a new constitution after massive protests in 2019–2020 resulted in a call to replace the current one.[182] The Constitutional Convention has commenced presided by Dr. Elisa Loncón, an Indigenous Mapuche linguist, with regional constituent representation of Antofagasta by Dr. Cristina Dorador, a microbiologist with expertise on the biodiversity of salt flats. In this context, Dr. Dorador joined OPSAL in launching the Plurinational Initiative for the Valorization and Protection of Andean Salt Flats and Wetlands, a community-based dialogue that will form the basis for a bill to recognize the importance of defending these ecosystems against further industrial extraction in a participatory and inclusive manner. According to Dr. Dorador, "The north of Chile has been viewed by the country as an exploitable territory because 'there is no life there.' Deconstructing that image implies profound changes. The extraction of lithium is like taking the soul out of the salt flats."[183] Dr. Dorador emphasizes the great need to integrate knowledge of Indigenous Peoples and break with the dominant hierarchies of knowledge, highly centralized in Chile's capital of Santiago. On October 4, 2021 the Constitutional Convention, led by Drs. Loncón and Dorador, voted to declare a Climate and Ecological Emergency.

3. STRENGTHEN ENVIRONMENTAL STANDARDS FOR MINING OPERATIONS AND MONITOR ACTIVITIES.

In addition to deeper engagement with Indigenous communities, mining activities should meet stronger environmental and social standards in general. Many organizations and institutions, from the United Nations Development Program to a variety of nongovernmental organizations, have produced recommendations that could be used.[184] Some of their key points address community engagement, mining waste, water consumption and pollution, and air pollution.[185]

Experts on the Puna de Atacama area also suggest that more robust environmental monitoring is both possible—through a combination of remote sensing, oral history and ethnography—and necessary.[186] These techniques could help identify changes to the water table, shifts in the population dynamics of local plants and animals, and other key environmental indicators. Monitoring should happen in ways that build trust locally and nationally and produce meaningful data that communities and citizens can use to hold mining companies accountable. To this end, funding for monitoring efforts should be transparent and independent of these companies; they could be carried out by, for example, universities or public agencies.

4. REGULATE AND MONITOR THE USE OF BRINES AND MAKE DATA ABOUT LOCAL WATER RESOURCES AVAILABLE AND TRANSPARENT.

Governments and mining companies alike should address the lack of regulation and transparency over the water resources involved in lithium extraction from brine and take steps to obtain robust, transparent, and publicly available data on brine and water usage. In Chile specifically, the Water and Mining Codes taken together classify brine as a mineral, not as water, and do not require the government to regulate it or monitor how much brine is being pumped out of the salt flats by mining companies. Companies do not have to disclose this information. As a result, these resources cannot be adequately regulated, and the local environments and communities suffer for it.[187] Particularly in Chile, authorities should reclassify brine so they are able to better monitor and safeguard this resource.

If not already in place, governments around the Puna de Atacama should also adopt legislation and regulations that would enable them to:

- Study and measure available groundwater and brine resources and/or provide funding to independent professionals who can do so.
- Regulate the distribution and use of these resources.
- Require companies to disclose their use of these resources.
- Make the data available to the public in a transparent and regularly updated way.

A potential guide is the California Sustainable Groundwater Management Act. Though still recent, this framework is designed to empower local agencies to sustainably manage groundwater resources, by limiting overuse of aquifers in the long term. However, given the urgency of addressing water depletion in both California and the Puna de Atacama, a less gradual timeline is advisable.[188]

It is worth noting that the lack of available data is not just a sticking point in the community–company relationship. It is also causing friction between SQM and Albemarle, the two companies operating in Chile, as well as between Albemarle and CORFO, the government regulator.[189] This is a fundamental problem for all actors and should be addressed.

5. ENCOURAGE, INVEST IN, AND IMPLEMENT ALTERNATIVE WAYS TO OBTAIN LITHIUM.

Given the rate of water use involved in the evaporation method of obtaining lithium and its impacts on the region, it behooves public and private actors not just to fund research and design but to deploy technological alternatives to the evaporation method in earnest. Many alternatives are already under development. These include (but are not limited to):

Extending the life of batteries on and off the road

One way to reduce the demand for lithium is to make more durable batteries that last longer, like Tesla's planned "million-mile battery."[190] Technological advances that can keep each battery on the road can help reduce the overall amount of materials needed to meet climate goals. Another way to limit demand for lithium is through innovative manufacturing practices. Advanced techniques that can reduce the amount of lithium lost during a battery's chemical reactions will lessen the need for new lithium material for the same energy storage payoff.

Additionally, there are several circular economy strategies that can lengthen the life of a lithium-ion battery or its components.[191] Once a lithium-ion car battery can no longer hold a sufficient charge to power a vehicle, it can still serve as energy storage elsewhere—in residences or buildings connected to the transmission grid or off the grid entirely. For example, the Johan Cruijff Arena in Amsterdam uses a hybrid first-life/second-life system to help power the stadium; Nissan's headquarters in Europe also has a second-life battery system.[192] Policies that support efforts to reuse batteries in these ways, accompanied by public and private sector investment, would help accelerate their development.

Similarly, researchers are studying ways to improve remanufacturing options for lithium-ion batteries, where only the worn-out components are replaced rather than the whole battery.[193] Remanufacturing has been found to reduce energy consumption and greenhouse gas emissions in the manufacturing process (relative to manufacturing completely new batteries) and can be cheaper as well.[194]

Recycling lithium-ion batteries

Recycling the pure chemical lithium contained in old batteries can reduce the need to mine more new minerals. Even though the chemistry involved is generally understood, recycling facilities are not focused on recovering the full range of materials in lithium-ion batteries.[195] Currently very few lithium-ion batteries are recycled, and when they are, in some cases only the cobalt or nickel is recovered while the lithium is discarded as waste.[196] However, we know that widespread battery recycling can be achieved, especially with the help of policy. For example, recycling rates of lead acid batteries (the type that power common consumer goods) have climbed to upwards of 90 percent in many countries.[197] This is partially a result of waste regulation practices that encourage recycling in places like the United States.[198] Recent research by Earthworks found that recycling EV batteries at the end of their useful life can reduce primary demand for lithium by as much as 25 percent. It can also reduce the primary demand for cobalt and nickel by 35 percent and for copper by 55 percent.[199]

One fundamental obstacle to widespread and thorough recycling of lithium-ion batteries is cost: extracting lithium from discarded batteries is more expensive than extracting it from brine via evaporation. To overcome this barrier, governments can and should establish policies to ultimately require full recycling of batteries. We can also anticipate that market forces will make recycling more cost competitive: as demand for lithium rises within the buildout toward our climate goals, the price of lithium will rise, increasing the value of the secondary market. At the same time, continued research into improved recycling technologies and systems can help recover more material more efficiently, driving down costs.

In fact, various types of recycling technologies are already in development to make the process more cost efficient and replicable on a wide scale.[200] Around the world, research centers have been established to improve existing lithium-ion battery recycling methods. Examples include the ReCell Center in the United States, the Faraday Institution ReLiB Project in the United Kingdom, the Commonwealth Scientific and Industrial Research Organisation in Australia, and the ReLieVe, Lithorec and AmplifII projects in the European Union.[201] Private companies such as Li-Cycle, Northvolt, and Umicore, among many others, have also stepped into the arena.[202]

Governments are assisting with funding for those efforts and are beginning to enact policies designed to support the development of lithium-ion battery recycling programs. For example, starting in February 2018, the Chinese government imposed a series of regulations to ensure that automobile manufacturers collect and recycle lithium-ion batteries, that collection is done safely, and that recycling recovers a minimum amount of major battery metals including lithium.[203] The European Union established its Battery Directive in 2006 to address battery waste and is currently finalizing a proposal to update the directive to address new challenges faced by the industry, particularly with respect to lithium-ion batteries, in line with the concept of circular economies and with the European Green New Deal.[204] The U.S. Department of Energy announced in January 2019 a new research and design center dedicated to lithium-ion battery recycling (the aforementioned ReCell Center) and a Recycling Prize for entrepreneurs to find innovative solutions for addressing recycling challenges.[205] Federal legislation, the Battery and Critical Mineral Recycling Act, has been introduced to invest $150 million in the next five years to support further research.[206]

Latin American countries looking to add value to the lithium battery supply chain beyond being a source for lithium can and should invest in becoming part of a more circular process.[207] They can do this by investing in recycling research and infrastructure themselves or by connecting with other countries or actors who are further along in developing those capacities.

Extracting lithium from geothermal brines

Experts are looking at ways to extract lithium from brines at geothermal power plants, combining clean energy generation with direct lithium extraction. Operators would remove lithium from the brines pumped up for geothermal energy generation before reinjecting the brines back into the closed cycle. Proponents position this process as the most sustainable way to recover lithium.[208] This technology is being developing in California's Salton Sea, Germany's upper Rhine Valley, and England's Cornwall region.[209] If done with appropriate safeguards for environmental justice and equity, this could be a beneficial coupling.[210]

Direct lithium extraction

Direct lithium extraction (DLE) technologies, including adsorption, ion exchange, and other selective electrochemical processes can remove lithium (as well as sodium and potassium) ions from brine water in hours rather than months, avoiding the loss of so much water in evaporation.[211] Less brine evaporation could reduce the risk of water depletion.[212] DLE is already being used or planned for use at brine fields in South America; for example, it is in use in at least one stage of the production process in Livent's mines at Hombre Muerto in Argentina.[213] Direct lithium extraction should be duly studied to ensure that its impacts—especially those of disposing treated brines and its use of freshwater—are understood and monitored.

6. ENSURE THAT COMPANIES THROUGHOUT THE BATTERY SUPPLY CHAIN REQUIRE BETTER PRACTICES FROM THEIR SUPPLIERS ON THE GROUND.

Pressure to protect the local environment and reduce the social impacts of lithium mining should come from companies farther up the battery supply chain—from battery makers to EV manufacturers—as well as from local stakeholders. For example, Tesla and BMW have signed agreements with cobalt mining companies. This gives them the ability to exert direct pressure on those companies to stop the child labor and human rights violations that have plagued the sector in the Democratic Republic of Congo.[214] Governments could also require companies to perform this kind of due diligence in their supply chains. Third-party certification efforts could support this with adequate safeguards to prevent greenwashing.

7. APPLY LONGER-TERM SOLUTIONS THAT REDUCE THE NEED FOR NEW BATTERIES, AND THEREFORE NEW BATTERY MATERIALS LIKE LITHIUM.

Another approach to reduce the impacts of the lithium mining industry is to enact policies that reduce the future demand for new lithium-ion batteries. Policymakers, private companies, and citizens can help push forward a range of strategies, including:

- Improved land use planning, local siting, and public policy tools to allow greater access to and use of public transit, biking, and walking to reduce long-term dependency on single-passenger vehicles (Chile is one of several Latin American countries already creating an electric corridor for public buses).[215]
- Retrofitting or building affordable, energy-efficient, and regenerative homes and buildings for all.
- Investing in and adopting long-duration methods of renewable energy storage (e.g., gravity-based or iron flow) that minimize extraction and maximize efficiency over time as an alternative to lithium-ion energy storage technologies.[216]

8. ENFORCE A MORATORIUM ON BRINE EVAPORATION THROUGH APPLICATION OF THE PRECAUTIONARY PRINCIPLE.

According to UNESCO's World Commission on the Ethics of Scientific Knowledge and Technology (COMEST), "When human activities may lead to morally unacceptable harm that is scientifically plausible but uncertain, actions shall be taken to avoid or diminish that harm."[217] This, essentially, is the precautionary principle. Because brine evaporation is thought to exacerbate ecological exhaustion in the Puna de Atacama, and because the actors responsible for this activity have failed to disclose clear evidence establishing that it does not do so, precautionary measures should be taken. In this instance, the burden of proof is on the extractive industry to show definitively that water availability is not threatened by brine evaporation, and until it has done so, it is in the public interest to cease this activity in the Puna de Atacama.

Following demands from the CPA, as well as the nonbinding verdict of the International Rights of Nature Tribunal denouncing lithium mining for threatening water availability, a moratorium should be enforced on lithium mining through brine evaporation in the Puna de Atacama.[218]

There is no single silver bullet to stop the environmental and social problems that lithium mining is currently producing in the Puna de Atacama. Rather, a diverse mix of the above solutions involving the urgent action of governments, the mining sector, other private sector actors, and civil society are required to fight climate change without perpetuating these impacts.

Conclusions

Given the urgency of the climate crisis, we cannot wait to move away from fossil fuels. Without a major technological change, lithium will likely continue to be a critical material for the global energy transition, particularly in transportation and energy storage sectors, which currently rely on lithium-ion batteries.

Yet, at the same time, climate action should not sacrifice local ecosystems and communities that have lived in and shaped the landscapes that contain the resources needed for batteries. The present and predominant method of extracting lithium from South America's Puna de Atacama region—the evaporation method—is destructive. As a result, the area's already scarce water resources are disappearing. As we have seen throughout this report, these changes are impacting people's livelihoods and environments in severe ways.

What's more, brine evaporation is a much longer process than the recycling and direct extraction methods discussed in the Recommendations section, taking months as opposed to just hours or days. The urgency of addressing global warming underscores the value of faster processes for sourcing materials, especially if they are better for communities and the environment.

The status quo is not just, not responsible, and not acceptable. Better solutions exist and should be implemented without delay. The recommendations above can help bring about these important changes and should be embraced by the full range of actors in this industry, from local stakeholders to global car manufacturers and everyone in between. Doing so could help heal the "exhausted" Puna de Atacama region without impeding the transition to a cleaner future for the planet.

ENDNOTES

1 "Historical GHG Emissions," ClimateWatch, https://www.climatewatchdata.org/ghg-emissions (accessed June 1, 2021).

2 See, for example, Kimon Keramidas et al., G*lobal Energy and Climate Outlook 2019: Electrification for the Low-Carbon Transition*, EUR 30053 EN, Publications Office of the European Union, 2020, https://publications.jrc.ec.europa.eu/repository/handle/JRC119619; Global 100% Renewable Energy Strategy Group, "Joint Declaration of the Global 100% Renewable Energy Strategy Group," https://global100restrategygroup.org/ (accessed June 1, 2021); and National Academies of Sciences, Engineering, and Medicine, *The Future of Electric Power in the United States* (Washington, D.C.: National Academies Press, 2021), https://doi.org/10.17226/25968.

3 Gavin Bridge and Ludger Gailing, "New Energy Spaces: Towards a Geographical Political Economy of Energy Transition," *Environment and Planning A: Economy and Space*, 52, no. 6 (July 2021): 1037–50, doi:10.1177/0308518X20939570. Peter Newell and Dustin Mulvaney, "The Political Economy of the 'Just Transition,'" *The Geographical Journal* 179, no. 2 (June 2013): 132–40, https://doi.org/10.1111/geoj.12008.

4 Éléonore Lèbr, et al., "The Social and Environmental Complexities of Extracting Energy Transition Metals," *Nature Communications* 11, art. 4823 (2020), https://doi.org/10.1038/s41467-020-18661-9. United Nations Conference on Trade and Development, "Developing Countries Pay Environmental Cost of Electric Car Batteries," July 22, 2020, https://unctad.org/news/developing-countries-pay-environmental-cost-electric-car-batteries. Andy Whitmore, *A Material Transition: Exploring Supply and Demand Solutions for Renewable Energy Minerals*, War on Want, July 2021, https://waronwant.org/sites/default/files/2021-03/A%20Material%20Transition_report_War%20on%20Want.pdf?emci=74d69860-8cdf-eb11-a7ad-501ac57b8fa7&emdi=0df5328e-11e0-eb11-a7ad-501ac57b8fa7&ceid=890106; Alejandro González, et al, *Manganese Matters*, SOMO and ActionAid, June 2021, https://actionaid.org/sites/default/files/publications/Manganese%20Matters.pdf.

5 European Commission, "Critical Raw Minerals," https://ec.europa.eu/growth/sectors/raw-materials/specific- interest/critical_en (accessed June 1, 2021). "European Commission, "Critical Raw Materials Resilience: Charting a Path Forward," September 3, 2020, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0474.

6 Some experts say that currently 10 percent of lithium resources are reserves, but there is not consensus. Luis Oliveira et al., "Key Issues of Lithium-Ion Batteries—From Resource Depletion to Environmental Performance Indicators," *Journal of Cleaner Production* 108, part A (2015): 354–62, https://doi.org/10.1016/j.jclepro.2015.06.021.

7 Sally Babidge et al., "'That's the Problem With That Lake; It Changes Sides': Mapping Extraction and Ecological Exhaustion in the Atacama," *Journal of Political Ecology* 26, no. 1 (2019): 738–60, https://doi.org/10.2458/v26i1.23169. Beatriz Bustos-Gallardo, Gavin Bridge, and Manuel Prieto, "Harvesting Lithium: Water, Brine and the Industrial Dynamics of Production in the Salar de Atacama," *Geoforum* 119 (February 2021): 177–89, https://www.sciencedirect.com/science/article/abs/pii/S0016718521000014?via%3Dihub. Victoria Flexer, Celso Fernando Baspineiro, and Claudia Inés Galli, "Lithium Recovery From Brines: A Vital Raw Material for Green Energies With a Potential Environmental Impact in Its Mining and Processing," *Science of the Total Environment* 639 (2018): 1188–1204, https://doi.org/10.1016/j.scitotenv.2018.05.223.

8 The authors of this paper use the following definition for "climate justice": *The transnational social movement to address the uneven distribution of benefits and burdens in the international climate regime within and across generations.* See Chukwumerije Okereke, "Climate Justice and the International Regime," *WIREs Climate Change* 1, no. 3 (2010): 462–74, https://doi.org/10.1002/wcc.52; Patrick Bond, *Politics of Climate Justice: Paralysis Above, Movement Below* (Scottsville, South Africa: University of KwaZulu-Natal Press, 2012); and Peter Newell and Dustin Mulvaney, "The Political Economy of the 'Just Transition,'" *The Geographical Journal* 179, no. 2 (2013): 132–40, https://doi.org/10.1111/geoj.12008.

9 Anita Carrasco, *Embracing the Anaconda: A Chronicle of Atacameño Life and Mining in the Andes* (Lanham: Lexington Books, 2020).

10 For example, a full list of lithium projects in Argentina (as of March 2019) can be found in Subsecretaría de Desarrollo Minero, Secretaría de Política Minera, Ministerio de Producción y Trabajo, Presidencia de la Nación, "Argentina: Advanced Lithium Projects in Salars," March 2019, http://cima.minem.gob.ar/assets/datasets/2019-04-15%20Advanced%20Lithium%20Projects-%20Argentina.pdf.

11 Consejo de Pueblos Atacameños, "Organización Consejo de Pueblos Atacameños," http://www.lickanantay.com/#!/-organizacion/ (accessed June 1, 2021). "El Consejo de Pueblos Atacameños es una asociación indígena que nace el año 1994 con personalidad jurídica bajo el amparo de la Ley Indígena. Nuestra organización actualmente reúne a 18 comunidades indígenas del Área de Desarrollo Indígena Atacama la Grande, quienes a través de sus presidentes eligen a su directorio que los unifica como pueblo. Uno de los objetivos, que establece nuestro Estatuto organizacional es preservar y promover el desarrollo de la cultura y valores propios del pueblo atacameño, velando por el fortalecimiento del espíritu de comunidad y solidaridad entre sus miembros."

12 Rudecindo Christian Espíndola, "Proyecto Paloma," Presentation at 2019 workshop, Fundación Tantí, Observatorio Plurinacional de Salares Andinos, San Pedro de Atacama, transcribed by Bianca Delgado and translated by Amanda Maxwell and Language Divas.

13 Dr. James J. A. Blair, Cal Poly Pomona, personal communication Sergio Cubillos, 2019, transcribed by Bianca Delgado and translated by Amanda Maxwell and Language Divas.

14 Ministerio del Medio Ambiente, Servicio de Evaluación Ambiental Región de Antofagasta, "Resolución 21 Exenta: Notifica Resolución de Calificación Ambiental Estudio de Impacto Ambiental 'EIA Modificaciones y Mejoramiento del Sistema de Pozas de Evaporación Solar en el Salar de Atacama,'" February 5, 2016, https://www.leychile.cl/Navegar?idNorma=1087335.

15 "Boom del Litio Podría Ser Una Amenaza Para los Flamencos del Salar de Atacama," *El Mostrador Mercados*/Bloomberg, July 5, 2016, https://www.elmostrador.cl/mercados/2016/07/05/boom-del-litio-podria-ser-una-amenaza-a-los-flamencos-del-salar-de-atacama/. Minería Chilena, "Litio: Una Fuente de Energía."

16 "Convenio de Cooperación, Sustentabilidad y Beneficio Mutuo Entre Consejos de Pueblos Atacameños, Comunidad Indígena Atacameña de Río Grande y Otras y Rockwood Litio Ltda.," February 21, 2016, 22. https://www.chululo.cl/incs/docs/download.php?f=convenio_rockwood_cpa_2016_02_21_.pdf

17 Dave Sherwood, "Exclusive: Top Lithium Miner Seeks to Monitor Water Scarcity in Parched Chile Salt Flat," Reuters, February 9, 2020, https://www.reuters.com/article/us-chile-lithium-albemarle-exclusive/exclusive-top-lithium-miner-seeks-to-monitor-water-scarcity-in-parched-chile-salt-flat-idUSKBN20407Z; Bárbara Jerez, Ingrid Garcés, and Robinson Torres, "Lithium Extractivism and Water Injustices in the Salar de Atacama, Chile: The Colonial Shadow of Green Electromobility," *Political Geography* 87 (May 2021), https://doi.org/10.1016/j.polgeo.2021.102382; Voskoboynik, Daniel Macmillen, and Diego Andreucci, "Greening Extractivism: Environmental Discourses and Resource Governance in the 'Lithium Triangle,'" *Environment and Planning E: Nature and Space* (April 2021), https://doi.org/10.1177/25148486211006345.

18 Volkswagen, "Fact-Finding Expedition to the Lithium Desert of Chile," video, March 11, 2020, https://www.volkswagenag.com/en/news/stories/2020/03/fact-finding-expedition-to-the-lithium-desert-of-chile.html#. Volkswagen and Daimler have since launched a study through the German aid and development agency GIZ to promote more "sustainable" lithium mining in Chile.

19 Eric Norris, "Albemarle Corporation: Making the World Safe & Sustainable by Powering the Potential of People," presentation at Benchmark Minerals EVFest, May 28, 2020, https://www.benchmarkminerals.com/video-library/. Jens Tartler, "Wenn elf Avocados umweltschadlicher als eine E-Auto-Batterie sind," *Der Tagesspiegel*, December 4, 2019, https://www.tagesspiegel.de/wirtschaft/tesla-akkus-wenn-elf-avocados-umweltschaedlicher-als-eine-e-auto-batterie-sind/25291904.html.

20 Dave Sherwood, "Chilean Regulators Scrap Lithium Miner SQM's Environmental Plan," Reuters, August 1, 2020, https://uk.reuters.com/article/us-chile-lithium-sqm-idUKKBN24X3Q6.

21 Dave Sherwood, "Indigenous Groups in Chile's Atacama Push to Shut Down Top Lithium Miner SQM," Reuters, August 14, 2020, https://www.reuters.com/article/us-chile-lithium-sqm-idUSKCN25A2PB.

22 Dave Sherwood, "Chilean Regulators Scrap Lithium Miner SQM's Environmental Plan."

23 Note that some communities have made separate agreements with SQM despite the CPA's resolute opposition. See Dave Sherwood, "Inside Lithium Giant SQM's Struggle to Win Over Indigenous Communities in Chile's Atacama," Reuters, January 15, 2021, https://www.reuters.com/article/us-chile-lithium-sqm-focus-idUSKBN29K1DB; and Observatorio Plurinacional de Salares Andinos, "Declaración por el Salar de Atacama y los Humedales Altoandinos de Chile Frente al Avance del Extractivismo Minero," August 26, 2020, https://observatoriosalares.wordpress.com/2020/08/26/declaracion-por-el-salar-de-atacama-y-los-humedales-altoandinos-de-chile-frente-al-avance-del-extractivismo-minero/.

24 Henríquez Jerez, "Impacto Socioambiental de la Extracción de Litio," 27. Hans Gundermann and Barbara Göbel, "Comunidades Indígenas, Empresas del Litio y Sus Relaciones en el Salar de Atacama," *Chungara Revista de Antropología Chilena* 50, 3 (2018): 471–86.

25 Comunidad Indígena Yagán de Bahía de Mejillones, Consejo de Pueblos Atacameños, Mesa de Coordinación de Pueblos Originarios del Budi, Municipalidad de Saavedra, Observatorio Ciudadano, and Plataforma Política Mapuche, *Emergencia Sanitaria en el Contexto de la Pandemia por COVID-19 en Chile y Su Impacto en los Derechos de los Pueblos Originarios,* June 2020, https://observatorio.cl/wp-content/uploads/2020/06/emergencia-sanitaria-en-el-contexto-de-la-pandemia-por-covid-19-en-chile-y-su-impacto-en-los-derechos-de-los-pueblos-originarios-11.pdf. Benjamin Hitchcock Auciello, "Indigenous Communities in Chile Raise Concerns About Public Health Risks Posed by Mining Operations During the COVID-19 Pandemic," Earthworks, July 28, 2020, https://www.earthworks.org/blog/indigenous-communities-in-chile-raise-concerns-about-public-health-risks-posed-by-mining-operations-during-the-covid-19-pandemic/.

26 Valérie Masson-Delmotte et al., eds., *Global Warming of 1.5 °C: An IPCC Special Report on the Impacts of Global Warming of 1.5 °C Above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*, Intergovernmental Panel on Climate Change, 2018, https://www.ipcc.ch/sr15/.

27 "Energy Storage Investments Boom as Battery Costs Halve in the Next Decade," Bloomberg New Energy Finance, July 31, 2019, https://about.bnef.com/blog/energy-storage-investments-boom-battery-costs-halve-next-decade/.

28 International Energy Agency, *The Role of Critical Minerals in Clean Energy Transitions*, World Energy Outlook Special Report, May 2021, 7, https://iea.blob.core.windows.net/assets/278ae0c8-28b8-402b-b9ab-6e45463c273f/TheRoleofCriticalMineralsinCleanEnergyTransitions.pdf.

29 Aleksandra O'Donavan, "Electric Vehicles Short-Term Outlook—COVID-19, 2020–2023," Bloomberg New Energy Finance, May 1, 2020, https://about.bnef.com/blog/electric-vehicles-short-term-outlook-covid-19/. "Electric Vehicle Sales Are Expected to Fall by 18% in 2020, But the Long Term Outlook Remains Positive," *Future Car*, May 19, 2020, https://www.futurecar.com/3936/Electric-Vehicle-Sales-Are-Expected-to-Fall-by-18-in-2020-But-the-Long-Term-Outlook-Remains-Positive.

30 "Demanda Litio Crecerá Casi 6 Veces a 2030 Gracias a la Electromovilidad," *ElectroMOV.cl,* November 12, 2020, https://www.electromov.cl/2020/11/12/demanda-litio-crecera-casi-6-veces-a-2030-gracias-a-la-electromovildiad/?utm_source=Newsletter+Grupo+Editorial+EDITEC&utm_campaign=235ac7922a-EMAIL_CAMPAIGN_2020_11_13_11_24&utm_medium=email&utm_term=0_24864427d2-235ac7922a-61099509.

31 "BU-204: How Do Lithium Batteries Work?," Battery University, June 1, 2018, https://batteryuniversity.com/article/bu-204-how-do-lithium-batteries-work.

32 "BU-205: Types of Lithium-Ion," Battery University, July 10, 2019, https://batteryuniversity.com/article/bu-205-types-of-lithium-ion.

33 Adapted by authors from: R. Poveda Bonilla, "Estudio de caso sobre la gobernanza del litio en Chile", serie RecursosNaturales y Desarrollo, N° 195 (LC/TS.2020/40), Santiago, Comisión Económica para América Latina y el Caribe (CEPAL), 2020.

34 Rafael Poveda Bonilla, "Estudio de Caso Sobre la Gobernanza del Litio en Chile," serie Recursos Naturales y Desarrollo, N° 195 (LC/TS.2020/40), Santiago, Comisión Económica Para América Latina y el Caribe (CEPAL), 2020, 25, https://repositorio.cepal.org/bitstream/handle/11362/45683/S2000204_es.pdf.

35 International Energy Agency, *Global EV Outlook 2019: Scaling Up the Transition to Electric Mobility*, May 2019, https://www.iea.org/reports/global-ev-outlook-2019.

36 ReportLinker, "India Lithium-Ion Battery Market: Growth, Trends, COVID-19 Impact, and Forecasts (2021–2026)," Intrado GlobeNewswire, March 22, 2021, https://www.globenewswire.com/news-release/2021/03/22/2196800/0/en/India-Lithium-Ion-Battery-Market-Growth-Trends-COVID-19-Impact-and-Forecasts-2021-2026.html. Avery Dyer, "Plugged-In: EVs Take the Road in Latin America," *Weekly Asado*, July 17, 2020, https://www.wilsoncenter.org/blog-post/plugged-evs-take-road-latin-america. *Analysis of the Latin American Electric Vehicle Market, Forecast to 2025* (Santa Clara, CA: Frost & Sullivan, December 2019), https://www.researchandmarkets.com/reports/4876628/analysis-of-the-latin-american-electric-vehicle?utm_source=dynamic&utm_medium=CI&utm_code=z858rj&utm_campaign=1343126+-+Latin+America+Electric+Vehicle+Market+Outlook+to+2025+-+Emerging+New+Mobility+Business+Models+Present+Growth+Opportunities&utm_exec=joca220cid. Henry Sanderson, "Batteries Charge Up Australia's Efforts to Shift Away From Coal," *Financial Times*, April 25, 2021, https://www.ft.com/content/825e1816-69e5-453c-865b-248727166b71.

37 Owen Mulhern, "Vulnerability to Climate Change and Emissions by Country," Earth.org, June 9, 2020, https://earth.org/data_visualization/vulnerability-to-climate-change-and-emissions-by-country/. *Estrategia Nacional de Electromovilidad: Un Camino Para los Vehículos Eléctricos*, Ministerio de Energía, Ministerio de Transportes y Telecomunicaciones, Ministro de Medio Ambiente, 2017, https://energia.gob.cl/sites/default/files/estrategia_electromovilidad-8dic-web.pdf. *Plan Nacional de Descarbonización: 2018–2050*, Gobierno de Costa Rica, 2017, https://cambioclimatico.go.cr/wp-content/uploads/2019/02/PLAN.pdf.

38 Gustavo Máñez Gomis et al., *Movilidad Eléctrica: Avances en América Latina y el Caribe y Oportunidades Para la Colaboración Regional: 2019*, United Nations Environment, MOVE LatAm, 2019, https://movelatam.org/transicion/.

39 "Chile's Capital Readies Largest Electric Bus Fleet Outside China," Bloomberg Law, December 6, 2018, https://news.bloomberglaw.com/environment-and-energy/chiles-capital-readies-largest-electric-bus-fleet-outside-china-1.

40 "El Gobierno Bajó los Impuestos Para Autos Híbridos y Eléctricos (Pero Sólo Para los Importados por Adefa)," AutoBlog.com.ar, November 5, 2020, https://autoblog.com.ar/2020/11/05/el-gobierno-bajo-los-impuestos-para-autos-hibridos-y-electricos-pero-solo-para-los-modelos-importados-por-adefa/; "Proyecto de Ley Electromovilidad: Lo Anunció Hoy el Presidente de Argentina Alberto Fernández," EnergíasRenovable.com.ar, March 2, 2021, https://energiasrenovables.com.ar/2021/03/02/proyecto-de-ley-electromovilidad-lo-anuncio-hoy-el-presidente-de-argentina-alberto-fernandez/.

41 UN Environment, *Electric Mobility: Developments in Latin America and the Caribbean and Opportunities for Regional Collaboration 2018*, November 2018, https://movelatam.org/wp-content/uploads/2019/06/MOVE-Regional-Report-2018-EN.pdf. "Se Incorporan 30 Buses Eléctricos a Montevideo," *El País*, May 18, 2020, https://www.elpais.com.uy/informacion/sociedad/incorporan-buses-electricos-montevideo.html.

42 The information in this paragraph is intended to be illustrative of the region's advances in this area; it is not comprehensive. See, for example, Oscar Ugarteche and Carlos de León, "The Electric Public Transport System in Latin America," *Latin America in Movement*, May 7, 2020, https://www.alainet.org/en/articulo/206403.

43 "Beyond Lithium-Ion XII Imagines the Future of Next-Generation Batteries. NREL Hosted Twlfth Annual Symposium on Energy Storage," National Renewable Energy Laboratory, July 16, 2019, https://www.nrel.gov/news/program/2019/beyond-lithium-ion-xii-imagines-the-future-of-next-generation-batteries.html.

44 K. M. Abraham, "How Comparable Are Sodium-Ion Battereis to Lithium-Ion Counterparts?," *ACS Publications*, 5, no. 11 (October 2020), https://doi.org/10.1021/acsenergylett.0c02181; Michael Taylor, "Developer of Aluminum-Ion Battery Claims It Charges 60 Times Faster Than Lithium-Ion, Offering EV Range Breakthrough," *Forbes*, May 13, 2021, https://www.forbes.com/sites/michaeltaylor/2021/05/13/ev-range-breakthrough-as-new-aluminum-ion-battery-charges-60-times-faster-than-lithium-ion/?sh=7f17f8d6d287.

45 There is a wide range of estimates of the global percentage of lithium *reserves* that Argentina, Bolivia, and Chile hold. Some sources say the three countries contain over 80 percent of reserves: Diazreus International Law Firm & Alliance, "ABCs of Lithium: An Economic Push in Latin America," https://diazreus.com/abcs-of-lithium-an-economic-push-in-latin-america/ (accessed June 1, 2021). Others say 85 percent: "El Triángulo de Litio: Argentina, Chile y Bolivia Poseen Más del 85% de las Reservas Mundiales de Litio," Fundación Para del Desarrollo y la Minería Argentina, https://web.archive.org/web/20130330092251/http://www.fundamin.com.ar/es/info/5-minerales-argentinos/315-el-triangulo-del-litio-argentina-chile-y-bolivia-poseen-mas-del-85-de-las-reservas-mundiales-de-litio.html (accessed June 1, 2021). While the U.S. Geological Survey estimates that Bolivia's lithium reserves total 9 million metric tons, the Bolivian government puts the figure at approximately 100 million metric tons: Juliana Ströbele-Gregor, "El Proyecto Estatal del Litio en Bolivia. Expectativas, Desafíos y Dilemas," *Nueva Sociedad* 244 (March–April 2013), https://nuso.org/articulo/el-proyecto-estatal-del-litio-en-bolivia-expectativas-desafios-y-dilemas/. The authors of this paper have chosen to err on the conservative side of these estimates.

46 Sociedad Nacional de Minería Chile, "Mapa Minero de Chile," https://www.sonami.cl/mapaminero/ (accessed June 2021).

47 Gabrielle Hecht, *Being Nuclear: Africans and the Global Uranium Trade* (Cambridge, MA: MIT Press, 2012).

48 Ibid. Timothy Mitchell, *Carbon Democracy: Political Power in the Age of Oil* (London: Verso, 2011). Megan Black, *The Global Interior: Mineral Frontiers and American Power* (Cambridge, MA: Harvard University Press, 2018).

49 Federico Nacif, "Bolivia y el Plan de Industrialización del Litio 100% Estatal: Desarrollo Autónomo y Soberanía Energética," *La Migraña*, Revista de Análisis Político 1, no. 3 (2012): 88-104, https://www.academia.edu/26412731/Nacif_Industrializacion_del_Litio_Bolivia_La_Migra%C3%B1a_2012_pdf?auto=download.

50 Juliana Strobele-Gregor, "Working Paper 14: Litio en Bolivia," International Research Network on Interdependent Inequalities in Latin America, 2012, https://www.desigualdades.net/Working_Papers/Search-Working-Papers/Working-Paper-14-_Litio-en-Bolivia_/index.html. Sanchez-Lopez, Maria Daniela. "From a White Desert to the Largest World Deposit of Lithium: Symbolic Meanings and Materialities of the Uyuni Salt Flat in Bolivia." *Antipode* 51, no. 4 (2019).

51 See, for example, "Executive Order 13817: A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals," *Federal Register*, December 20, 2017, https://www.federalregister.gov/documents/2017/12/26/2017-27899/a-federal-strategy-to-ensure-secure-and-reliable-supplies-of-critical-minerals. Other countries are taking similar steps; see "Canada and the U.S. Finalize Joint Action Plan on Critical Minerals Collaboration," Natural Resources Canada, January 9, 2020, https://www.canada.ca/en/natural-resources-canada/news/2020/01/canada-and-us-finalize-joint-action-plan-on-critical-minerals-collaboration.html.

52 Javiera Barandiarán, "Lithium and Development Imaginaries in Chile, Argentina and Bolivia," *World Development* 113 (January 2019): 381–91, DOI: 10.1016/j.worlddev.2018.09.019.

53 This rate is for one of the two major lithium producers, Sociedad Química y Minera de Chile (SQM). Ben Heubl, "Lithium Firms Depleting Vital Water Supplies in Chile, Analysis Suggests," E&T Engineering and Technology, August 21, 2019, https://eandt.theiet.org/content/articles/2019/08/lithium-firms-are-depleting-vital-water-supplies-in-chile-according-to-et-analysis/. In 2016, Albemarle gained approval to increase brine pumping from 142 to 442 liters per second.

54 Wenjuan Liu, Datu Buyung Agusdinata, and Soe W. Myint, "Spatiotemporal Patterns of Lithium Mining And Environmental Degradation in the Atacama Salt Flat, Chile," *International Journal of Applied Earth Observation and Geoinformation* 80, no. 12 (August 2019): 145–56, https://www.researchgate.net/publication/334839246_Spatiotemporal_patterns_of_lithium_mining_and_environmental_degradation_in_the_Atacama_Salt_Flat_Chile.

55 Michelle Lee Yin, "Tecnologías de concentración de litio alternativas a las pozas de evaporación," Tesis en Magíster en Ciencias de la Ingeniería, Pontificia Universidad Católica de Chile, Escuela de Ingeniería, Santiago de Chile, August 2020, https://repositorio.uc.cl/xmlui/bitstream/handle/11534/43337/TESIS_MLee_Firma%20Final.pdf. Nancy Yáñez and Raúl Molina, eds., *Las Aguas Indígenas en Chile* (Santiago: LOM Ediciones, 2011). Bárbara Jerez Henríquez, *Impacto Socioambiental de la Extracción de Litio en las Cuencas de los Salares Altoandinos del Cono Sur*, Observatorio de Conflictos Mineros de América Latina (OCMAL), August 2018, https://www.ocmal.org/wp-content/uploads/2018/08/Impacto-Sociambiental-Litio.pdf. "III Seminario Internacional: 'Boom del Litio y Extractivismo del Litio en los Salares Andinos,' " Observatorio Plurinacional de Salares Andinos, June 7, 2019. Mónica Castro, "El Litio en la Región de Atacama–Lípez: Bases Para un Modelo de Desarrollo Sostenible," in *La Sustentabilidad en la Región de Atacama-Lípez, un Futuro Que Compromete a Tres Países,* Mariángeles Bode y Carlos Rizzuti, coordinators, Programa Regional Seguridad Energética y Cambio Climático en América Latina de la Fundación Konrad Adenauer, 2015, 26–39, http://bibliotecadigital.ciren.cl/bitstream/handle/123456789/26658/HUM2-0229.pdf. Liu, Agusdinata, and Myint, "Spatiotemporal Patterns of Lithium Mining." Heubl, "Lithium Firms Depleting Vital Water Supplies."

56 For example, see Anna Schomberg, Stefan Bringezu, and Martina Flörke, "Extended Life Cycle Assessment Reveals the Spatially-Explicit Water Scarcity Footprint of a Lithium-Ion Battery Storage," *Communications Earth & Environment* 2, art. 11, January 2021, https://doi.org/10.1038/s43247-020-00080-9. Matthew A. Pellow et al., "Research Gaps in Environmental Life Cycle Assessments of Lithium Ion Batteries for Grid-Scale Stationary Energy Storage Systems: End-of-Life Options and Other Issues," *Sustainable Materials and Technologies* 23 (April 2020): e00120,. https://doi.org/10.1016/j.susmat.2019.e00120. Mie Obbekær, "How Much Water Is Used to Make the World's Electric Batteries?," Danwatch, December 1, 2019, https://danwatch.dk/en/undersoegelse/how-much-water-is-used-to-make-the-worlds-batteries/#:~:text=What%20is%20brine%3F&text=Scientists%2C%20research%20studies%20and%20companies,water%20per%20kilo%20of%20lithium.

57 Heubl, "Lithium Firms Depleting Vital Water Supplies." OCMAL.org, "Cada Tonelada de Litio Requiere la Evaporación de 2 Millones de Litros de Agua," May 29, 2019, https://www.ocmal.org/cada-tonelada-de-litio-requiere-la-evaporacion-de-2-mil-litros-de-agua/.

58 Note that reserves in Peru may change that geometric metaphor. Marco Aquino, "Peruvian Mining Minister Says Lithium Mining Regulation 'Ready This Year,'" Reuters, January 16, 2020, https://www.reuters.com/article/us-peru-mining/peruvian-mining-minister-says-lithium-mining-regulation-ready-this-year-idUSKBN1ZF2IW.

59 Silvia Diana Matteucci, "Ecorregión Puna," chapter 2 in *Ecorregiones y Complejos Ecosistémicos Argentinos*, J. Morello et al., eds. (Buenos Aires: Orientación Gráfica Editora S.R.L., 2012), 87–127, https://www.researchgate.net/publication/268448070_Ecorregion_Puna.

60 Cristina Dorador et al., "Bacterial and Archaeal Diversity in High Altitude Wetlands of the Chilean Altiplano," *Fundamental and Applied Limnology* 182, no. 2 (February 2013): 135–59, https://doi.org/10.1127/1863-9135/2013/0393; Cristóbal Bonelli and Cristina Dorador, "Endangered Salares: Micro-Disasters in Northern Chile," *Tapuya: Latin American Science, Technology and Society* (2021) https://doi.org/10.1080/25729861.2021.1968634.

61 Ministerio de Minería, Decreto Ley 2886: "Deja Sujeta a las Normas Generales del Código de Minería la Constitución de Pertenencia Minera Sobre Carbonato de Calcio, Fosfoato y Sales Potásicas, Reserva el Litio en Favor del Estado e Interpreta y Modifica las Leyes que Se Señalan," October 1979, https://www.leychile.cl/Navegar?idNorma=7029.

62 Pedro Pavlovic Zuvic, "La Industria del Litio en Chile," *Minería* 209 (March 2014): 30–35 https://www.academia.edu/22107555/P_Pavlovic_la_Industria_del_litio_en_Chile_Revista_Ingenieros_2014. Bruno Fornillo et al., *Litio en Sudamérica: Geopolítica, Energía y Territorios* (Buenos Aires: El Colectivo, CLASCO, Instituto de Estudios de América Latina y el Caribe, 2019), 152–53, http://www.exactas.unlp.edu.ar/uploads/docs/libro_litio_en_sudamerica.pdf.

63 Brian W. Jaskula, "Mineral Commodity Summaries: Lithium," U.S. Geological Survey, February 2019, https://prd-wret.s3-us-west-2.amazonaws.com/assets/palladium/production/atoms/files/mcs-2019-lithi.pdf; CORFO.cl, "Corfo y el Salar de Atacama," https://www.corfo.cl/sites/cpp/corfolitio (accessed Novemer 17, 2020).

64 CORFO.cl, "Corfo y el Salar de Atacama," https://www.corfo.cl/sites/cpp/corfolitio (accessed Novemer 17, 2020); "Chile launches tender for value-added lithium projects," Reuters, March 25, 2019, https://www.mining.com/web/chile-launches-tender-value-added-lithium-projects/.

65 Barandiarán, "Lithium and development Imaginaries."

66 Ibid. Sally Babidge and Paola Bolados, "Neoextractivism and Indigenous Water Ritual in Salar de Atacama, Chile," *Latin American Perspectives* 45, no. 5 (2018): 170–85, DOI: 10.1177/0094582X18782673.

67 CORFO.cl, "Corfo y el Salar de Atacama."

68 As of the time this report was published, there was no royalty under mining law in Chile. A specific tax on mining was created under Ley 20.026 in 2005. A royalty law is being discussed currently in the parliament despite resistance from mining sector; see Miriam Leiva, "Los Proyectos de Ley que Intranquilizan al Sector Privado en Medio del Covid-19," *La Tercera*, April 26, 2020, https://www.latercera.com/pulso/noticia/los-proyectos-de-ley-que-intranquilizan-al-sector-privado-en-medio-del-covid-19/7D24G27XYFHIRBIT3Z6YDQHPS4/.

69 Minería Chilena, "Litio: Una Fuente de Energía, una Oportunidad Para Chile," August 2015, https://www.mch.cl/multimedia/litio-una-fuente-de-energia-una-oportunidad-para-chile/#.

70 Federico Nacif, "El Litio en Argentina: De Insumo Crítico a Commodity Minero," in *El ABC del Litio Sudamericano*, F. Nacif and M. Lacabana, eds. (Quilmes: Universidad Nacional de Quilmes Editorial, 2015), 219–92. Barandiarán, "Lithium and Development Imaginaries."

71 Bruno Fornillo, et al., *Geopolítica del Litio: Industria, Ciencia y Energía en Argentina* (Buenos Aires: El Colectivo CLASCO, 2015), 94, http://biblioteca.clacso.edu.ar/clacso/se/20150918095017/Geopolitica.pdf.

72 Nacif, "El Litio en Argentina."

73 On their partnership, see "Salar de Olaroz: Olaroz Lithium Facility," Orocobre, https://www.orocobre.com/operations/salar-de-olaroz/ (accessed June 1, 2021).

74 Based on estimates from Subsecretaría de Desarrollo Minero, Secretaría de Política Minera, Ministerio de Producción y Trabajo, Presidencia de la Nación, "Argentina: Advanced Lithium Projects in Salars."

75 Barandiarán, "Lithium and Development Imaginaries."

76 Thomas P. Narins, "The Battery Business: Lithium Availability and the Growth of the Global Electric Car Industry," *The Extractive Industries and Society* 4, no. 2 (April 2017): 321–28, https://doi.org/10.1016/j.exis.2017.01.013.

77 Sanchez-Lopez, "From a White Desert to the Largest World Deposit of Lithium."

78 Vincent Bos and Marie Forget, "Global Production Networks and the Lithium Industry: A Bolivian Perspective," *Geoforum* 125 (October 1, 2021): 168–80. https://doi.org/10.1016/j.geoforum.2021.06.001; Clifford Krauss, and Meridith Kohut, "Green-Energy Race Draws an American Underdog to Bolivia's Lithium," *The New York Times*, December 16, 2021, sec. Business. https://www.nytimes.com/2021/12/16/business/energy-environment/bolivia-lithium-electric-cars.html; Tom Perreault, "Bolivia's High Stakes Lithium Gamble," *NACLA Report on the Americas* 52, no. 2 (April 2, 2020): 165–72. https://doi.org/10.1080/10714839.2020.1768739; "How Bolivian Lithium Could Help Fight Climate Change," *The Economist*, December 8, 2021, https://www.economist.com/the-americas/how-bolivian-lithium-could-help-fight-climate-change/21806677.

79 For example, see Felipe Brion, "Ganancias de SQM Suben a US$ 439 Millones en 2018 Ante un Crecimiento 'sin Precedentes' del Mercado de Litio," *Diario Financiero*, February 28, 2019, https://www.df.cl/noticias/empresas/mineria/ganancias-de-sqm-suben-a-us-439-millones-en-2018-ante-un-crecimiento/2019-02-28/080111.html; and David Nogales, "Ganancias de SQM Anotan Fuerte Caída Tal y Como los Ingresos por Ventas de Litio," *La Tercera,* March 3, 2020, https://www.latercera.com/pulso/noticia/ganancias-de-sqm-anotan-fuerte-caida-en-2019-tal-y-como-los-ingresos-por-ventas-de-litio/GHCHV4BSKZD4ZOVXVPBUWO47HA/.

80 Ezequiel Carrizo, "Transición energética, electromovilidad y extractivismo del litio en salares andinos de Chile, Argentina y Bolivia," Presentation at Parallel COP organized by the Sociedad Civil por la Acción Climática, December 5, 2019, Santiago, Chile, transcribed by Bianca Delgado and translated by Amanda Maxwell and Language Divas.

81 Subsecretaría de Desarrollo Minero, Secretaría de Política Minera, Ministerio de Producción y Trabajo, Presidencia de la Nación, "Argentina: Advanced Lithium Projects in Salars." Observatorio Plurinacional de Salares Andinos, "Conflicto en el Salar del Hombre Muerto, Antofagasta de La Sierra, Catamarca, Argentina," October 3, 2019, https://observatoriosalares.wordpress.com/2019/10/03/conflicto-en-el-salar-del-hombre-muerto-antofagasta-de-la-sierra-catamarca-argentina/. Valentina Ruiz Leotaud, "Lithium Miner Finances Solar Farm in Argentina," Mining[dot]com, November 24, 2019, https://www.mining.com/lithium-miner-finances-solar-farm-in-argentina/.

82 Ruiz Leotaud, "Lithium Miner Finances Solar Farm."

83 Ibid. Ministerio de Minería, Gobierno de Catamarca, "Minería Catamarca," http://www.mineria.catamarca.gov.ar/fideicomiso.html (accessed February 1, 2021).

84 Environmental Justice Atlas, "Minería de Litio en Salar del Hombre Muerto, Argentina," last updated January 14, 2019, https://ejatlas.org/conflict/salar-del-hombre-muerto-litio-argentina.

85 Observatorio Plurinacional de Salares Andinos, "Conflicto en el Salar del Hombre Muerto."

86 Environmental Justice Atlas, "Minería de Litio En Salar Del Hombre Muerto."

87 "Litio en Catamarca: Entre el Interés de Bill Gates y la Lucha Ambiental de las Comunidades," *Nuevo Jujuy*, March 7, 2020; https://www.nuevojujuy.com.ar/mas/internacionales-06/item/3706-litio-en-catamarca-entre-el-interes-de-bill-gates-y-la-lucha-ambiental-de-las-comunidades. Observatorio Plurinacional de Salares Andinos, "Conflicto en el Salar del Hombre Muerto."

88 Ramsar, "Argentina designates High Altitude Ramsar site," May 20, 2009, https://www.ramsar.org/news/argentina-designates-high-altitude-ramsar-site.

89 "Salta le Demandará a la ex Minera del Altiplano una Millonaria Deuda por Regalías Impagas," *inSALTA*, November 27, 2019, https://insalta.info/nota-principal/salta-le-demandara-a-la-ex-minera-del-altiplano-una-millonaria-deuda-por-regalias-impagas.

90 "Paro en Livent Minera del Altiplano S.A.," PrensaObrera.com, March 29, 2020, https://prensaobrera.com/sindicales/paro-en-livent-minera-del-altiplano-s-a/.

91 Carlos Guzmán, "Protocolo de Consulta Indígena en Salinas Grandes," Presentation with Clemente Flores at II Jornada por la Defensa del Agua y Feria del Medio Ambiente y el Buen Vivir, October 7, 2017, San Pedro de Atacama, transcribed by Ramón Balcázar and translated by Language Divas.

92 Orocobre, "Olaroz Lithium Facility," https://www.orocobre.com/operations/salar-de-olaroz/ (accessed January 15, 2021).

93 Subsecretaría de Desarrollo Minero, Secretaría de Política Minera, Ministerio de Producción y Trabajo, Presidencia de la Nación, "Argentina: Advanced Lithium Projects in Salars." Environmental Justice Atlas, "Explotación de Litio en el Salar de Olaroz-Cauchari, Argentina," last updated January 29, 2019, https://ejatlas.org/conflict/mineria-de-litio-en-el-salar-de-olaroz-cauchari-argentina.

94 Mining Data Online, "Mining Data Solutions: Cachauri-Olaroz Project," https://miningdataonline.com/property/3036/Cauchari-Olaroz-Project.aspx (accessed Jan. 1, 2021).

95 On the Argentine side of the Puna, the preferred Indigenous category is Pueblo Atacama rather than Atacameño. Jerez Henríquez, "Impacto Socioambiental de La Extracción de Litio."

96 Ibid. Barandiarán, "Lithium and Development Imaginaries," 387.

97 Felix M. Dorn and Fernando Ruiz Peyré, "Lithium as a Strategic Resource: Geopolitics, Industrialization, and Mining in Argentina," *Journal of Latin American Geography* 19, no. 4 (2020:) 68–90, https://digitalcommons.lsu.edu/jlag/vol19/iss4/5/. Jerez Henríquez, "Impacto Socioambiental de La Extracción de Litio," 34–35. Environmental Justice Atlas, "Explotación de Litio en el Salar de Olaroz-Cauchari."

98 Jerez Henríquez, "Impacto Socioambiental de La Extracción de Litio." Environmental Justice Atlas, "Explotación de Litio En El Salar de Olaroz-Cauchari." Barandiarán, "Lithium and Development Imaginaries," 387.

99 Jerez Henríquez, "Impacto Socioambiental de La Extracción de Litio."

100 Comunidades de la Cuenca de Salinas Grandes y Laguna de Guayatayoc, *Kachi Yupi: Huellas de la Sal*, August 22, 2015, 13, https://cl.boell.org/sites/default/files/protocolo_final.pdf, translated by Amanda Maxwell and Language Divas.

101 These 33 communities include Tambillo, Cochagaste, Casabindo, Santa Ana de la Puna, San Francisco de Alfarcito, Rinconadilla, Santuario de Tres Pozos, Abralaite, Agua de Castilla, Río Grande, Quera, Agua Caliente de la Puna, San Miguel de Colorado, El Moreno, El Angosto, Lipán, Aguas Blancas, Cianzo, Barrancas, Santa Ana de Abralaite, Quebraleña, Sayate Oeste, Agua Chica Ronque, Aguilar Chica and Pabellón, all on the Jujuy side of the area; and Cobres, Cerro Negro, Rangel, Esquina de Guardia, Tipán, Casa Colorada, Matancillas, and Esquinas Blancas on the Salta side. Government resources say the mine is entirely owned by Pluspetrol, but on its website Dajin Resources lists itself as maintaining 49 percent, demonstrating the complicated relationships among the companies themselves. See Jerez Henríquez, "Impacto Socioambiental de La Extracción de Litio," 33; and Subsecretaría de Desarrollo Minero, Secretaría de Política Minera, Ministerio de Producción y Trabajo, Presidencia de la Nación, "Argentina: Advanced Lithium Projects in Salars."

102 Subsecretaría de Desarrollo Minero, Secretaría de Política Minera, Ministerio de Producción y Trabajo, Presidencia de la Nación, "Argentina: Advanced Lithium Projects in Salars."

103 Hernán Schiaffini, "Litio, Llamas y Sal en la Puna Argentina," *Revista de la Carrera de Sociología* 3, no. 3 (2013): 121–36, https://publicaciones.sociales.uba.ar/index.php/entramadosyperspectivas/article/view/152; Jerez Henríquez, "Impacto Socioambiental de La Extracción de Litio." Comunidades de la Cuenca de Salinas Grandes y Laguna de Guayatayoc, *Kachi Yupi—Huellas de la Sal*.

104 Centro de Información Judicial, "Se Realizó en la Corte Audiencia Pública por el Otorgamiento de Permisos Para la Explotación de Litio y Borato en Jujuy," March 28, 2012, http://www.cij.gov.ar/nota-8848-Se- realizo-en- la- Corte- audiencia- publica-por- elotorgamiento-de-permisos-para-la-explotacion-de-litio-y-borato-en-Jujuy.html.

105 See also Article 75, Section 17 of the Argentine Constitution regarding Indigenous rights to preliminary consultation: Constitución de la Nación Argentina, Ley Nº 24.430, December 15, 1994, http://servicios.infoleg.gob.ar/infolegInternet/anexos/0-4999/804/norma.htm.

106 Comunidades de la Cuenca de Salinas Grandes y Laguna de Guayatayoc, *Kachi Yupi: Huellas de la Sal.*

107 Fundación Ambiente y Recursos Naturales (FARN), "Piden a la Corte Suprema que se Respete el Derecho a un Ambiente Sano—FARN," December 8, 2019, https://farn.org.ar/archives/27368. Comunidades de la Cuenca de Salinas Grandes y Laguna de Guayatayoc, *Kachi Yupi: Huellas de la Sal.*

108 For industry and chemical engineering perspectives on debates over water availability impacts due to brine extraction, see Ejeian, Mojtaba, Alexander Grant, Ho Kyong Shon, and Amir Razmjou. "Is Lithium Brine Water?" *Desalination* 518 (December 15, 2021): 115169. https://doi.org/10.1016/j.desal.2021.115169; Alex Grant et al., "Is Lithium Brine Water? Anti-Webinar Summary & Conclusions," Jade Cove Partners, June 2020, https://www.jadecove.com/research/islithiumbrinewaterantiwebinar.

109 National Oceanic and Atmospheric Administration, "Why Is the Ocean Salty?" National Ocean Service, https://oceanservice.noaa.gov/facts/whysalty.html (accessed June 1, 2021).

110 Silvia Matteucci, "Ecorregión Puna." See also: Bárbara Jerez Henríquez, Sergio Uribe Sierra, and Ramón Morales Balcázar, eds., *Salares Andinos: Ecología de Saberes por la Protección de Nuestros Salares y Humedales* (Santiago: Fundación Tantí, 2021).

111 From the Spanish colonial era and into the 20th century, authorities argued that because the desert was empty and arid, Indigenous Peoples living there could be erased or marginalized. This underlies the modern and contemporary formation of an Atacameño ethnopolitical movement. See Manuel Mendez, Manuel Prieto, and Milton Godoy, "Production of Subterranean Resources in the Atacama Desert: 19th and Early 20th Century Mining/Water Extraction in the Taltal District, Northern Chile," *Political Geography* 81 (August 2020): 102194, https://doi.org/10.1016/j.polgeo.2020.102194; Hans Gundermann K., "Inicios de Siglo en San Pedro de Atacama: Procesos, Actores e Imaginarios en Una Localidad Andina," *Chungara: Revista de Antropología Chilena* 36, no. 1 (January 2004): 221–40, https://doi.org/10.4067/S0717-73562004000100007; Héctor Morales Morgado, "Génesis, Formación y Desarrollo del Movimiento Atacameño (Norte de Chile)," *Estudios Atacameños* 1 (December 2013): 110–28, https://doi.org/10.4067/S0718-10432014000300007; and Camila Bustos, "La Producción de 'Etnomercancías' en el Contexto Turístico Atacameño," *Revista Líder* 25 (2014): 9–31, https://fdocuments.ec/document/la-produccin-de-aoeetnomercanc-contexto-ceder-turismo-desarrolladas-por.html.

112 Carolina A. Contado et al., "Atacama Database: A Platform of the Microbiome Diversity of the Atacama Desert," *Antonie Van Leeuwenhoek* 113 (February 2020): 185–95, https://doi.org/10.1007/s10482-019-01328-x. Cristina Dorador et al., "Diversity of *Bacteroidetes* in High-Altitude Saline Evaporitic Basins in Northern Chile," *Journal of Geophysical Research: Biogeosciences* 114, no. G2 (June 2009), https://doi.org/10.1029/2008JG000837. Cristina Dorador et al., "Cyanobacterial Diversity in Salar de Huasco, a High-Altitude Saline Wetland in Northern Chile: An Example of Geographical Dispersion?," *FEMS Microbiology Ecology* 64, no. 3 (June 2008): 419–32, https://academic.oup.com/femsec/article/64/3/419/472874. Cristina Dorador et al., "Unique Clusters of Archaea in Salar de Huasco, an Athalassohaline Evaporitic Basin of the Chilean Altiplano," *FEMS Microbiology Ecology* 73, no. 2 (August 2010): 291–302, https://doi.org/10.1111/j.1574-6941.2010.00891.x. Cristina Dorador et al., "Bacterial and Archaeal Diversity in High Altitude Wetlands of the Chilean Altiplano," *Fundamental and Applied Limnology/Archiv für Hydrobiologie* 182, no. 2 (February 2013): 135–59, https://www.researchgate.net/publication/236946365_Bacterial_and_archaeal_diversity_in_high_altitude_wetlands_of_the_Chilean_Altiplano. Vera Thiel et al., "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 Microbiology Ecology* 74, no. 3 (December 2010): 510–22, https://doi.org/10.1111/j.1574-6941.2010.00966.x. Ingrid Garcés, "El Salar de Maricunga al Banquillo de los Acusados," *Le Monde Diplomatique*, February 13, 2019, https://www.lemondediplomatique.cl/El-salar-de-Maricunga-al-banquillo.html.

113 Eduardo Brondízio, Sandra Díaz, and Josef Settele, eds., *Global Assessment Report on Biodiversity and Ecosystem Services*, Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), May 2019, https://zenodo.org/record/3831674#.YSf3gohKiUk.

114 Yery Marambio-Alfaro et al., "The Salt Flats Fighter: Agonistic Survival of *Liolaemus fabiani* in the Salar de Atacama," PeerJ Preprints 5: e2891v1, March 26, 2017, https://doi.org/10.7287/peerj.preprints.2891v1. Yery Marambio-Alfaro and Jaime Troncoso-Palacios, "A New Species of *Liolaemus* of the *L. Nigromaculatus* Group (Iguania: Liolaemidae) from Atacama Region, Chile," *Basic and Applied Herpetology* 28 (October 2014): 65–77, https://zookeys.pensoft.net/article/6011/; Gonzalo Gajardo and Stella Redón, "Andean Hypersaline Lakes in the Atacama Desert, Northern Chile: Between Lithium Exploitation and Unique Biodiversity Conservation," *Conservation Science and Practice* 1, no. 9 (September 2019): 94, https://doi.org/10.1111/csp2.94. Ashley Stumvoll, "Shift to Renewable Energy Could Have Biodiversity Cost, Researchers Caution," *Mongabay Environmental News*, June 18, 2019, https://news.mongabay.com/2019/06/shift-to-renewable-energy-could-have-biodiversity-cost-researchers-caution/.

115 J. A. Hribljan et al., "Carbon Storage and Long-Term Rate of Accumulation in High-Altitude Andean Peatlands of Bolivia," *Mires and Peat* 15, art. 12 (2014): 1–14, https://www.fs.usda.gov/treesearch/pubs/53712.

116 Verónica Molina et al., "Greenhouse Gases and Biogeochemical Diel Fluctuations in a High-Altitude Wetland," *Science of the Total Environment* 768 (May 2021): 144370, https://doi.org/10.1016/j.scitotenv.2020.144370. Verónica Molina et al., "Distribution of Greenhouse Gases in Hyper-Arid and Arid Areas of Northern Chile and the Contribution of the High Altitude Wetland Microbiome (Salar de Huasco, Chile)," *Antonie van Leeuwenhoek* 111, no. 8 (2018): 1421–32, https://doi.org/10.1007/s10482-018-1078-9.

117 Carolina F. Cubillos et al., "Microbial Communities From the World's Largest Lithium Reserve, Salar de Atacama, Chile: Life at High LiCl Concentrations," *Journal of Geophysical Research: Biogeosciences* 123, no. 12 (December 2018): 3668–81, https://doi.org/10.1029/2018JG004621.

118 Cristina Dorador et al., "Microbial Community Composition and Trophic Role Along a Marked Salinity Gradient in Laguna Puilar, Salar de Atacama, Chile," *Antonie Van Leeuwenhoek* 111, no. 8 (May 2018): 1361–74, https://doi.org/10.1007/s10482-018-1091-z.

119 Universidad de Chile, *Informe País: Estado del Medio Ambiente en Chile, Comparación 1999–2015*, December 2016, https://www.uchile.cl/publicaciones/129607/informe-pais-estado-del-medio-ambiente-en-chile-1999-2015.

120 Javiera Barandiarán, "Assessing 30 Years of Neoliberal Environmental Management in Chile: Effective, Democratic or Neither?" in *The Oxford Handbook of Comparative Environmental Politics*, edited by Jeannie Sowers, Stacy D. VanDeveer, and Erika Weinthal, (Oxford, England: Oxford University Press, 2021).

121 Heubl, "Lithium Firms Depleting Vital Water Supplies."

122 Ingrid Garcés, "Salar de Surire un Ecosistema Altoandino en Peligro, Frente a Escenario del Cambio Climático," *Nexo Revista Científica* 24, no. 1 (2011): 43–49. Ingrid Garcés and Gabriel Álvarez, "Implicancias del Cambio Climático Sobre la Biodiversidad del Salar de Aguas Calientes I, Chile," Centro de Información de Recursos Naturales, Ministerio de Agricultura, http://bibliotecadigital.ciren.cl/bitstream/handle/123456789/26026/HUM2-0125.pdf?sequence=1&isAllowed=y (accessed June 1, 2021). Ingrid Garcés et al., "Relevancia del Salar de Atacama Frente al Escenario Económico," Project: Hidrología Salar Atacama, May 2017, https://www.researchgate.net/publication/325542217_Relevancia_del_Salar_de_Atacama_frente_al_escenario_Economico. Nicholas Casey, "Climate Change Claims a Lake, and an Identity," *New York Times*, July 7, 2016, http://www.nytimes.com/interactive/2016/07/07/world/americas/bolivia-climate-change-lake-poopo.html. Babidge et al., "'That's the Problem with That Lake.'"

123 Rob Nixon, *Slow Violence and the Environmentalism of the Poor* (Cambridge: Harvard University Press, 2011).

124 Andrea E. Becerra et al., *A New Course: Managing Drought and Downpours in the Santiago Metropolitan Region,* NRDC, 2019, https://www.nrdc.org/sites/default/files/new-course-managing-drought-downpours-santiago-report.pdf. Paulo Urrutia, "Escasez Hídrica: ¿Cambio Climático o Sobreexplotación?," *El Mostrador*, June 30, 2019, https://www.elmostrador.cl/destacado/2019/06/30/escasez-hidrica-cambio-climatico-o-sobreexplotacion/. Amnesty International, "Chile: Authorities Must Protect Rodrigo Mundaca and Other Environmental Defenders," accessed February 3, 2020, https://www.amnesty.ie/chile-authorities-must-protect-rodrigo-mundaca-environmental-defenders/.

125 Bonilla, "Estudio de Caso Sobre la Gobernanza Del Litio en Chile."

126 Ministerio de Medio Ambiente, "Humedales del Norte de Chile: Riqueza Patrimonial y Científica," July 20, 2016, https://mma.gob.cl/humedales-del-norte-de-chile-riqueza-patrimonial-y-cientifica/.

127 Minería Chilena, "Litio: Una Fuente de Energía."

128 International Rights of Nature Tribunal, "Launch of the Verdict 5th International Rights of Nature Tribunal," press release, January 9, 2020, https://therightsofnature.org/wp-content/uploads/2020/01/Press-Release-Tribunal-Chile-January-2020.pdf.

129 The R. P. Gustavo Le Paige Archaeological Museum in San Pedro states that archaeologists have found arrowheads or "*colas de pescado*" to hunt large animals that have been extinct for 12,500 years. See also UNESCO World Heritage Centre, "San Pedro de Atacama," https://whc.unesco.org/en/tentativelists/1191/ (accessed June 1, 2021).

130 Manuel Prieto, "Privatizing Water in the Chilean Andes: The Case of Las Vegas de Chiu-Chiu," *Mountain Research and Development* 35, no. 3 (2015): 220–29, http://dx.doi.org/10.1659/MRD-JOURNAL-D-14-00033.1. Manuel Prieto, "Practicing *Costumbres* and the Decommodification of Nature: The Chilean Water Markets and the Atacameño People," *Geoforum* 77 (December 2016): 28–39, https://www.sciencedirect.com/science/article/abs/pii/S0016718516302299?via%3Dihub. Kate J. Neville and Glen Coulthard, "Transformative Water Relations: Indigenous Interventions in Global Political Economies," *Global Environmental Politics* 19, no. 3 (August 2019): 1–15, https://direct.mit.edu/glep/article/19/3/1/14964/Transformative-Water-Relations-Indigenous.

131 Carlos Lugo and José Moncada, "Una Aproximación al Conocimiento de la Diversidad y Multifuncionalidad de las Chacras Andinas," in *Sembrando Vida y Cultura. Las Chacras Como Espacios Multifuncionales En Comunidades Indígenas Andinas*, (Ibarra, Ecuador: Editorial Universidad Técnica del Norte (UTN), 2018) 12–35.

132 Isabel Sepúlveda Rivera et al., "Aguas, Riego y Cultivos: Cambios y Permanencias en los Ayllus de San Pedro de Atacama," *Estudios Atacameños*, no. 51 (December 2015): 185–206, https://doi.org/10.4067/S0718-10432015000200012.

133 Ministerio de Obras Públicas, Dirección General de Aguas, "Resolución 3: Declara el Agotamiento de la Cuenca del Río Vilama y sus afluentes, Provincia de El Loa, Región de Antofagasta," June 2017, https://www.leychile.cl/Navegar?idNorma=1103421. Ministerio de Obras Públicas, Dirección General de Aguas, "Resolución 44: Declara el Agotamiento de Cuenca del Río San Pedro y Sus Afluentes, Provincia de El Loa, Región de Antofagasta," July 2016, https://www.leychile.cl/Navegar?idNorma=1092006.

134 Prieto, "Privatizing Water in the Chilean Andes."

135 Ministerio de Obras Públicas, Dirección General de Aguas, "Resolución 13: Declara Como 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," August 2018, https://www. leychile.cl/Navegar?idNorma=1121804&idVersion=2018-08-16.

136 Babidge and Bolados, "Neoextractivism and Indigenous Water Ritual."

137 Ramón Morales Balcázar, "Minera Escondida/BHP BIliton, un 'Buen Vecino' en el Salar de Atacama..." *Observatorio de Salares*, January 14, 2020, https://observatoriosalares.wordpress.com/2020/01/14/minera-escondida-bhp-billiton-un-buen-vecino-en-el-salar-de-atacama/. Data from Babidge and Bolados, "Neoextractivism and Indigenous Water Ritual."

138 Ministerio de Obras Públicas, Dirección General de Aguas, "Resolución 13: Declara Como 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," August 2018, https://www.leychile.cl/Navegar?idNorma=1121804&idVersion=2018-08-16.

139 Grant et al., "Is Lithium Brine Water?"

140 Volkswagen, "Fact-Finding Expedition to the Lithium Desert of Chile," March 11, 2020, https://www.volkswagenag.com/en/news/stories/2020/03/fact-finding-expedition-to-the-lithium-desert-of-chile.html# . Ellen Lenny-Pessagno, "Dialogue and Shared Value in the Salar de Atacama: Governance and Environmental Sustainability," presented at "The Green Economy and South America's Lithium Triangle," Inter-American Development Bank, Washington, D.C., January 23, 2020.

141 Amphos 21, *Modelo Hidrológico Consolidado Cuenca Salar de Atacama. Estudio de Modelos Hidrológicos Conceptuales Integrados Para los Salares de Atacama, Maricunga y Pedernales. Etapa III Informe Final*, Chile, 2018, https://www.amphos21.com/publicaciones/#. J. Salas et al., "Hidrogeología del Sistema Lagunar del Margen Este del Salar de Atacama (Chile)," *Boletín Geológico y Minero* 121, no. 4 (2010): 357–72, https://www.researchgate.net/publication/288622658_Hydrogeology_of_the_lacustrine_system_of_the_Eastern_Margin_of_the_Salar_the_Atacama_Chile. Wenjuan Liu et al, "Spatiotemporal Patterns of Lithium Mining And Environmental Degradation in the Atacama Salt Flat, Chile," *International Journal of Applied Earth Observation and Geoinformation* 80, no. 12 (2019): 145–56, https://doi.org/10.1016/j.jag.2019.04.016. Lee Ann Munk et al., "Hydrogeologic and Geochemical Distinctions in Freshwater-Brine Systems of an Andean Salar." *Geochemistry, Geophysics, Geosystems* 22, no. 3 (2021). https://doi.org/10.1029/2020GC009345. Also, see Lilly G. Corenthal, "Regional Groundwater Flow and Accumulation of a Massive Evaporite Deposit at the Margin of the Chilean Altiplano," *Geophys. Res. Lett.* 43, no. 15 (August 2016): 8017–25, https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2016GL070076; Martin Grosjean and Heinz Veit, "Water Resources in the Arid Mountains of the Atacama Desert (Northern Chile): Past Climate Changes and Modern Conflicts," In: Huber U.M., Bugmann H.K.M., Reasoner M.A. (eds) *Global Change and Mountain Regions. Advances in Global Change Research, vol 23*, Springer, Dordrecht, (2005), https://doi.org/10.1007/1-4020-3508-X_10; Ramón Arevena, "Isotope Hydrology and Geochemistry of Northern Chile Groundwaters," *Bull. Inst. Fr. Études Andines* 24, no. 3 (1995): 495–503; and Diego Frau et al. "Hydroclimatological Patterns and Limnological Characteristics of Unique Wetland Systems on the Argentine High Andean Plateau." *Hydrology* 8, no. 4 (November 2021): 164. https://doi.org/10.3390/hydrology8040164.

142 M. A. Marazuela et al., "Hydrodynamics of Salt Flat Basins: The Salar de Atacama Example," *Science of the Total Environment* 651, part 1 (February 2019): 668–83, DOI: 10.1016/j.scitotenv.2018.09.190. Lee Ann Munk et al., "Hydrogeologic and Geochemical Distinctions in Freshwater-Brine Systems of an Andean Salar." *Geochemistry, Geophysics, Geosystems* 22, no. 3 (2021), https://doi.org/10.1029/2020GC009345.

143 Reuters, "Chile Files Arbitration Suit Against Albemarle Over Lithium Royalties—Newspaper," February 21, 2021, https://www.reuters.com/article/chile-lithium-albemarle-idUSL1N2KR076. Dave Sherwood, "Exclusive: Lithium Giant Albemarle Slams Chile Over 'Unjust' Withholding of Atacama Study," Reuters, March 4, 2021, https://www.reuters.com/article/us-chile-lithium-albemarle-exclusive-idUSKBN2AW2AB.

144 Ingrid Garcés and Gabriel Álvarez, "Water Mining and Extractivism of the Salar de Atacama, Chile," in *WIT Transactions on Ecology and the Environment,* J. Casares Long, ed., 245 (2020): 189–99, Southampton: WIT Press. DOI: 10.2495/EID200181. Thea Riofrancos, "What Green Costs," *Logic*, no. 9, December 7, 2019, https://logicmag.io/nature/what-green-costs/.

145 Heubl, "Lithium Firms Depleting Vital Water Supplies."

146 Patricia Araya, Coordinadora de Incidencia de FIMA, "III Seminario Internacional: 'Boom Del Litio y Extractivismo del Litio en los Salares Andinos,'" conference presentation, Fiscalía del Medio Ambiente, Copiapó, June 7, 2019.

147 Sherwood, "Exclusive: Top lithium Miner Seeks to Monitor."

148 Ibid.

149 Universidad de Chile, *Informe País: Estado del Medio Ambiente en Chile*.

150 Ibid.

151 Ramón Morales Balcázar, "Minera Escondida/BHP BIliton." Javiera Martínez and Cristian Olmos, "El Desastre de Antofagasta Minerals," *Diario Universidad de Chile*, May 19, 2020, https://radio.uchile.cl/2020/05/19/el-desastre-de-antofagasta-minerals/.

152 Dominique Hervé, *Justicia Ambiental y Recursos Naturales* (Santiago: Ediciones Universitarias de Valparaíso, 2015).

153 Sally Babidge, "Sustaining Ignorance: The Uncertainties of Groundwater and Its Extraction in the Salar de Atacama, Northern Chile," *Journal of the Royal Anthropological Institute* 25, no. 1 (March 2019): 83–102, https://doi.org/10.1111/1467-9655.12965.

154 Beatriz Bustos-Gallardo, Bridge, and Prieto, "Harvesting Lithium."

155 Servicio Agrícola y Ganadero (SAG), "Consolidado Ecocidio 'Salar de Punta Negra' por 'Minera Escondida-BHP Billiton,'" 2015, https://www.camara.cl/verDoc.aspx?prmID=45120&prmTIPO=DOCUMENTOCOMISION. C. Zárate, F. Fernández, and A. Vásquez, "Derechos de Agua: El Impacto de Minera Escondida en el Salar de Atacama," *El Mostrador*, June 28, 2018, https://www.elmostrador.cl/noticias/opinion/columnas/2018/06/28/derechos-de-agua-el-impacto-de-minera-escondida-en-el-salar-de-atacama/.

156 Patricio Soto, "Primer Tribunal Ambiental Acoge Reclamación de Asociación de Coposa en Contra del Programa de Cumplimiento de Minera Collahuasi," Primer Tribunal Ambiental, April 14, 2020, https://www2.1ta.cl/primer-tribunal-ambiental-acoge-a-tramite-demanda-por-dano-ambiental-en-contra-de-minera-escondida/.

157 "Denuncia Crimen Ambiental de Minera Escondida en Salar de Punta Negra," *El Acontecer*, February 10, 2016, https://www.elacontecer.cl/index.php/u-s/item/578-denuncia-crimen-ambiental-de-minera-escondida-en-salar-de-punta-negra-video. Also in Servicio Agrícola y Ganadero, "Consolidado: Ecocidio 'Salar de Punta Negra.'"

158 Andrés Pozo, "SMA Levanta Cargo Contra Minera Escondida Por Impacto Sobre Recurso Hídrico," *Diario Financiero*, July 31, 2020, http://www.df.cl/noticias/empresas/mineria/sma-levanta-cargo-contra-minera-escondida-por-impacto-sobre-recurso/2020-07-31/103631.html.

159 Michelle Carrere, "In Chile, a prickly coalition tries to bring a salt flat back to life," Mongabay, August 17, 2021, https://www.mining.com/web/chile-launches-tender-value-added-lithium-projects/.

160 Data from Chile's 2017 census: Biblioteca del Congreso Nacional de Chile, "San Pedro de Atacama, Reporte Comunal 2020," https://www.bcn.cl/siit/reportescomunales/comunas_v.html?anno=2020&idcom=2203 (accesssed June 1, 2021).

161 Ramón Balcázar, personal communication with Karen Luza, Indigenous water defender and secretary at CAPRA (Comité de Agua Potable Rural de San Pedro de Atacama), 2019.

162 Lesley Muñoz Rivera, "Tierras si, extractivismo no!" Presentation at Parallel COP organized by the Sociedad Civil por la Acción Climática, December 4, 2019, Santiago, Chile, transcribed by Bianca Delgado and translated by Amanda Maxwell and Language Divas.

163 Servicio de Evaluación Ambiental, "Estudio de Impacto Ambiental 'Proyecto Blanco,'" September 14, 2018, https://infofirma.sea.gob.cl/DocumentosSEA/MostrarDocumento?docId=63/ee/fcec836b803648c845234fa52e369e800d23; Codelco, "Codelco y Minera Salar Blanco suscriben acuerdo para estudiar el desarrollo conjunto de proyecto de litio en Maricunga," August 1, 2019, https://www.codelco.com/codelco-y-minera-salar-blanco-suscriben-acuerdo-para-estudiar-el/prontus_codelco/2019-08-01/085134.html; Patricia San Juan, "Codelco Se Anima Con El Litio: Suscribe Acuerdo Con Minera Salar Blanco Para Estudiar Proyecto En El Salar de Maricunga," *La Tercera*, August 1, 2019, sec. Pulso. https://www.latercera.com/pulso/noticia/codelco-salar-blanco-suscriben-acuerdo-estudiar-proyecto-litio-salar-maricunga/763105/.

164 "Information Memorandum: Maricunga Project," Corporate presentation – Bearing Lithium, May 2020, http://www.bearinglithium.com/_literature_236726/Corporate_Presentation.

165 *Bloomberg*, "Minera Salar Blanco Receives Environmental Approval for the Maricunga Lithium Project," February 5, 2020. https://www.bloomberg.com/press-releases/2020-02-05/minera-salar-blanco-receives-environmental-approval-for-the-maricunga-lithium-project.

166 Presentation by Lesley Muñoz and Elena Rivera Cardoso, President of Comunidad Colla de la Comuna de Copiapó, June 10, 2020, Conversatorio: "Las Falsas Soluciones para Enfrentar la Crisis Climática," Red por los Ríos Libres. http://www.youtube.com/watch?v=SesLWMQ_F34.

167 Presentation by Lesley Muñoz and Elena Rivera Cardoso, President of Comunidad Colla de la Comuna de Copiapó, June 10, 2020, Conversatorio: "Las Falsas Soluciones para Enfrentar la Crisis Climática," Red por los Ríos Libres. http://www.youtube.com/watch?v=SesLWMQ_F34.

168 Ingrid Garcés, "El Salar de Maricunga al Banquillo de Los Acusados," 2019.

169 María Gómez, "Transición energética, electromovilidad y extractivismo del litio en salares andinos de Chile, Argentina y Bolivia," Presentation at Parallel COP organized by the Sociedad Civil por la Acción Climática, December 5, 2019, Santiago, Chile, transcribed by Bianca Delgado and translated by Amanda Maxwell and Language Divas.

170 Rick Mills, "Lithium Chile, a Perfect Storm," Mining.com, May 29, 2018, https://www.mining.com/web/lithium-chile-perfect-storm/.

171 María Gómez, "Transición energética, electromovilidad y extractivismo del litio en salares andinos de Chile, Argentina y Bolivia," Presentation at Parallel COP, December 5, 2019.

172 Melissa Pistilli, "Why the Lithium Triangle Has Become a Hotbed for Mining Activity," *Investing News Network*, August 28, 2019, https://investingnews.com/innspired/lithium-chile-lithium-triangle/. Lithium Chile, "Lithium Chile Identifies 58KM2 High-Priority Target Area at Coipasa, Chile," May 7, 2018, https://www.lithiumchile.ca/news/lithium-chile-identifies-58km2-high-priority-target-area-at-coipasa-chile/.

173 Lithium Chile, "Community Approval for Lithium Chile's Exploration Program," April 29, 2019, https://www.lithiumchile.ca/news/lithium-chile-announces-community-approval-for-their-exploration-program-on-their-salar-de-coipasa-property/. Ashley Cowell, "Lithium Chile Announces Community Approval for Their Exploration Program on Their Salar de Coipasa Property," *Investing News Network*, April 23, 2019, https://investingnews.com/daily/resource-investing/battery-metals-investing/lithium-investing/lithium-chile-announces-community-approval-for-their-exploration-program-on-their-salar-de-coipasa-property/; "Lithium Chile Advances Coipasa and Turi Projects Towards Drilling," Bloomberg, September 12, 2019, https://www.bloomberg.com/press-releases/2019-09-12/lithium-chile-advances-coipasa-and-turi-projects-towards-drilling.

174 News File, "Lithium Chile Updates Coipasa Drilling Program," October 3, 2019, https://www.newsfilecorp.com/release/48480/Lithium-Chile-Updates-Coipasa-Drilling-Program.

175 "Lithium Chile Announces Completion of First Drill Hole on the Turi Property and Results from Recent Check Assays on the Laguna," *Bloomberg*, February 4, 2020, https://www.bloomberg.com/press-releases/2020-02-04/lithium-chile-announces-completion-of-first-drill-hole-on-the-turi-property-and-results-from-recent-check-assays-on-the-laguna. News File, "Lithium Chile Updates Coipasa Drilling Program." Stockhouse, "Announcement of Binding Agreement on Salar de Arizaro, Argentina & Company," May 31, 2021, https://stockhouse.com/opinion/independent-reports/2021/05/31/announcement-binding-agreement-on-salar-de-arizaro-argentina-company.

176 Peter Greim, A. A. Solomon, and Christian Breyer, "Assessment of Lithium Criticality in the Global Energy Transition and Addressing Policy Gaps in Transportation," *Nature Communications* 11, art. 4570 (2020), https://doi.org/10.1038/s41467-020-18402-y.

177 International Labour Organization, "C169—Indigenous and Tribal Peoples Convention, 1989," Article 7, https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100_INSTRUMENT_ID:312314.

178 For example, see Comunidades de la Cuenca de Salinas Grandes y Laguna de Guayatayoc, *Kachi Yupi: Huellas de la Sal*; Secretariat of the Convention on Biological Diversity, *Akwé: Kon Guidelines*, 2004, https://www.cbd.int/doc/publications/akwe-brochure-en.pdf; and Secretariat of the Convention on Biological Diversity, *The Tkarihwaié:ri Code of Ethical Conduct to Ensure Respect for the Cultural and Intellectual Heritage of Indigenous and Local Communities*, 2011, https://www.cbd.int/traditional/code.shtml.

179 United Nations General Assembly, "United Nations Declaration on the Rights of Peasants and Other People Working in Rural Areas," Annex, October 30, 2018, https://undocs.org/en/A/C.3/73/L.30.

180 Kyle Powys Whyte, "On the Role of Traditional Ecological Knowledge as a Collaborative Concept: A Philosophical Study," *Ecological Processes* 2, art. 7 (2013), https://ecologicalprocesses.springeropen.com/articles/10.1186/2192-1709-2-7.

181 Guangyu Wang et al., "Integrated Watershed Management: Evolution, Development and Emerging Trends," *Journal of Forestry Research* 27 (2016): 967–94, https://doi.org/10.1007/s11676-016-0293-3.

182 Sengupta, Somini, and Marcos Zegers. "Chile Writes a New Constitution, Confronting Climate Change Head On." *The New York Times*, December 28, 2021, sec. Climate. https://www.nytimes.com/2021/12/28/climate/chile-constitution-climate-change.html; Agencia EFE, "Chile Vive un Convulso Comienzo de la Redacción de Su Nueva Constitución," July 5, 2021, https://www.efe.com/efe/america/politica/chile-vive-un-convulso-comienzo-de-la-redaccion-su-nueva-constitucion/20000035-4578324.

183 Salares Andinos, "OPSAL Invitó a Definir Cómo Avanzar en Protección de Salares y Humedales Andinos en el Nuevo Contexto Constituyente," https://salares.org/2021/07/14/opsal-invito-a-definir-como-avanzar-en-proteccion-de-salares-y-humedales-andinos-en-el-nuevo-contexto-constituyente/ (accessed August 9, 2021).

184 Amnesty International, *Powering Change: Principles for Businesses and Governments in the Battery Value Chain,* February 4, 2021, https://www.amnesty.org/en/documents/act30/3544/2021/en/.

185 Uyanga Gankhuyag and Fabrice Gregoire, *Managing Mining for Sustainable Development: A Sourcebook*, United Nations Environment and United Nations Development Program, April 2018, http://www.undp.org/content/dam/undp/library/Sustainable%20Development/Extractives/UNDP-MMFSD-LowResolution.pdf. Earthworks, "Mining 101," https://www.earthworks.org/issues/mining/ (accessed September 18, 2020).

186 Babidge, et al., " 'That's the Problem with That Lake.' " For a list of initiatives, see Ethan N. Elkind, Patrick R. P. Heller, and Ted Lamm, "Building a Sustainable Electric Vehicle Battery Supply Chain: Frequently Asked Questions," Natural Resource Governance Institute and the Center for Law, Energy and the Environment at UC Berkeley School of Law, April 2020, 12, https://www.law.berkeley.edu/wp-content/uploads/2020/04/Building-A-Sustainable-Electric-Vehicle-Battery-Supply-Chain.pdf.

187 Manuel Prieto, "La Ecología (a)Política Del Modelo de Aguas Chileno," in *Ecología Política En Chile. Naturaleza, Propiedad, Conocimiento y Poder* Beatriz Bustos-Gallardo, Manuel Prieto, and Jonathan Barton, eds. (Santiago: Editorial Universitaria, 2015).

188 California Department of Water Resources, "Sustainable Groundwater Management Act," https://water.ca.gov/Programs/Groundwater-Management/SGMA-Groundwater-Management (accessed June 1, 2021).

189 Dave Sherwood, "Exclusive: Lithium Giants Albemarle and SQM Battle of Access to Atacama Water Study," Reuters, November 17, 2020, https://in.reuters.com/article/us-chile-lithium-albemarle-exclusive-idINKBN27X10G.

190 Norihiko Shirouzu and Paul Lienert, "Exclusive: Tesla's Secret Batteries Aim to Rework the Math for Electric Cars and the Grid," Reuters, May 14, 2020, https://www.reuters.com/article/us-autos-tesla-batteries-exclusive/exclusive-teslas-secret-batteries-aim-to-rework-the-math-for-electric-cars-and-the-grid-idUSKBN22Q1WC.

191 Charles R. Standridge and Lindsay Corneal, *Remanufacturing, Repurposing, and Recycling of Post-Vehicle-Application Lithium-Ion Batteries*, Mineta National Transit Research Consortium, June 2014, https://transweb.sjsu.edu/sites/default/files/1137-post-vehicle-Li-Ion-recycling.pdf. Ellen MacArthur Foundation Archive, "The Circular Economy in Detail," https://www.ellenmacarthurfoundation.org/explore/the-circular-economy-in-detail (accessed October 8, 2020). Dustin Mulvaney et al., "Progress Towards a Circular Economy in Materials to Decarbonize Electricity and Mobility," *Renewable and Sustainable Energy Reviews* 137 (March 2021): 110604, https://doi.org/10.1016/j.rser.2020.110604.

192 For a list of second-life battery pilot projects, see Hanjiro Ambrose, "The Second-Life of Used EV Batteries," Union of Concerned Scientists, May 27, 2020, https://blog.ucsusa.org/hanjiro-ambrose/the-second-life-of-used-ev-batteries.

193 Siqin Xiong, Junping Ji, and Xiaoming Ma, "Environmental and Economic Evaluation of Remanufacturing Lithium-Ion Batteries From Electric Vehicles," *Waste Management* 102 (February 2020): 579–86, https://doi.org/10.1016/j.wasman.2019.11.013.

194 Ibid.

195 Linda Gaines, Kirti Richa, and Jeffrey Spangenberger, "Key Issues for Li-Ion Battery Recycling," *MRS Energy & Sustainability* 5, no. 12 (2018), https://link.springer.com/article/10.1557/mre.2018.13.

196 Clare Church and Laurin Wuennenberg, "Sustainability and Second Life: The Case for Cobalt and Lithium Recycling," International Institute for Sustainable Development, March 2019, 5, https://www.iisd.org/system/files/publications/sustainability-second-life-cobalt-lithium-recycling.pdf.

197 "Battery Recycling Global Market Report 2021: COVID-19 Growth and Change," Globe Newswire, July 9, 2021, https://www.globenewswire.com/news-release/2021/07/09/2260426/0/en/Battery-Recycling-Global-Market-Report-2021-COVID-19-Growth-And-Change.html.

198 U.S. Defense Logistics Agency, "Hazardous and Recycled Waste," chapter 7 in *DLA Energy Environmental Guide for Fuel Facilities*, 2019, https://www.dla.mil/Portals/104/Documents/Energy/Publications/Environmental%20Guide%20for%20Fuel%20Facilities/Chapter7_HazardousandRecycledWaste_Mar2019.pdf?ver=2019-04-17-084152-237.

199 Elsa Dominish, Nick Florin, and Rachael Wakefield-Rann, *Reducing New Mining for Electric Vehicle Battery Metals: Responsible Sourcing Through Demand Reduction Strategies and Recycling*, prepared for Earthworks by the Institute for Sustainable Futures, April 2021, https://www.earthworks.org/cms/assets/uploads/2021/04/UTS-EV-battery-metals-sourcing-20210419-FINAL.pdf.

200 Gavin Harper et al., "Recycling Lithium-Ion Batteries From Electric Vehicles," *Nature* 575 (2019): 75–86, https://doi.org/10.1038/s41586-019-1682-5.

201 See the list of contributors in the Preface (p. 2) of John Drexhage, Tarek Keskes, and Kirsten Lori Hund, *Reuse and Recycling: Environmental Sustainability of Lithium-Ion Battery Energy Storage Systems*, Energy Sector Management Assistance Program, World Bank Group, August 2020, http://documents1.worldbank.org/curated/en/593961599738208006/pdf/Reuse-and-Recycling-Environmental-Sustainability-of-Lithium-Ion-Battery-Energy-Storage-Systems.pdf.

202 Jean Kumagai, "Lithium-Ion Battery Recycling Finally Takes Off in North America and Europe," *IEEE Spectrum*, January 5, 2021, https://spectrum.ieee.org/lithiumion-battery-recycling-finally-takes-off-in-north-america-and-europe.

203 Reuters, "China Puts Responsibility for Battery Recycling on Makers of Electric Vehicles," February 26, 2018, https://www.reuters.com/article/us-china-batteries-recycling/china-puts-responsibility-for-battery-recycling-on-makers-of-electric-vehicles-idUSKCN1GA0MG. Chris Randall, "China Releases Battery Recycling Regulations," electrive.com, November 11, 2019, https://www.electrive.com/2019/11/11/china-releases-battery-recycling-regulations/. Argus, "China Launches NEV Battery Recycling Regulations," January 6, 2020, https://www.argusmedia.com/en/news/2045403-china-launches-nev-battery-recycling-regulations.

204 Latham & Watkins LLP, "EU Commission to Adopt a Regulation on Batteries, Energy Storage, and Electric Vehicle Batteries," Lexology, June 22, 2020, https://www.lexology.com/library/detail.aspx?g=a3cf5fb1-7112-481c-8b48-c060b43d9797. Raphaël Danino-Perraud, "The Recycling of Lithium-Ion Batteries: A Strategic Pillar for the European Battery Alliance," *Études de l'Ifri*, March 2020 https://www.ifri.org/sites/default/files/atoms/files/danino_recycling_batteries_2020.pdf.

205 U.S. Department of Energy, "Energy Department Announces Battery Recycling Prize and Battery Recycling R&D Center," January 17, 2019, https://www.energy.gov/articles/energy-department-announces-battery-recycling-prize-and-battery-recycling-rd-center.

206 116th Congress, 2nd session, S. 3356: To support the Reuse and Recycling of Batteries and Critical Minerals, and for Other Purposes, February 27, 2020, https://www.congress.gov/116/bills/s3356/BILLS-116s3356is.pdf.

207 Greim, Solomon, and Breyer, "Assessment of Lithium Criticality."

208 Ken Alston et al., *Building Lithium Valley: Opportunities and Challenges Ahead for Developing California's Battery Manufacturing Ecosystem*, New Energy Nexus, September 2020, p. 15, file:///C:/Users/Owner/Downloads/TN237271_20210323T114640_Building%20Lithium%20Valley,%20New%20Energy%20Nexus.pdf.

209 Alex Grant, "Explainer: Overview of Direct Lithium Extraction (DLE) From Geothermal Brines," *Finfeed*, August 20, 2019, https://finfeed.com/features/explainer-overview-direct-lithium-extraction-dle-geothermal-brines/. Julie Chao, "Geothermal Brines Could Propoel California's Green Economy," Berkeley Lab, August 5, 2020, https://newscenter.lbl.gov/2020/08/05/geothermal-brines-could-propel-californias-green-economy/. Anmar Frangoul, "Geothermal Project in England Secures Funding to Help Pilot Lithium-Extraction Technology," CNBC, August 7, 2020, https://www.cnbc.com/2020/08/07/geothermal-project-secures-funding-to-help-pilot-lithium-extraction.html.

210 Julie Cart, "Will California's Desert be Transformed Into Lithium Valley?" *Cal Matters*, February 25, 2021, https://calmatters.org/environment/2021/02/california-desert-lithium-valley/.

211 Grant, Alex. "From Catamarca to Qinghai - The Commercial Scale DLE Operations." *Jade Cove Partners* (blog), April 2020. https://www.jadecove.com/research/fromcatamarcatoqinghai; Jun Lu et al., "Efficient Metal Ion Sieving in Rectifying Subnanochannels Enabled by Metal–Organic Frameworks," *Nature Materials* 19, (2020): 767–74, https://doi.org/10.1038/s41563-020-0634-7.

212 Alex Grant, "After the DLE Cambrian Explosion," Jade Cove Partners, enero 2022, https://www.jadecove.com/research/dlecambrianexplosion.

213 Alex Grant, "Lithium (Extraction Technology) in 2025 (Part 1 of 3)," Hot Copper, June 18, 2019, https://hotcopper.com.au/threads/good-old-fireside-chat.3718767/page-13102?post_id=39112528.

214 Andy Home, "Column: Tesla's Reluctant Commitment to Cobalt a Warning to Others," Reuters, June 23, 2020, https://www.reuters.com/article/us-tesla-cobalt-ahome/column-teslas-reluctant-commitment-to-cobalt-a-warning-to-others-andy-home-idUSKBN23U20Q.

215 "El Primer Electrocorredor de Latinoamérica Cuenta con 285 Buses 'Cero Emisión,'" *RPP Noticias*, January 20, 2020, https://rpp.pe/mundo/latinoamerica/el-primer-electrocorredor-de-latinoamerica-cuenta-con-285-buses-cero-emision-noticia-1240606?utm_source=amp&utm_medium=nota&utm_campaign=amp.

216 Julian Spector, "The 5 Most Promising Long-Duration Storage Technologies Left Standing," GTM, March 31, 2020, https://www.greentechmedia.com/articles/read/most-promising-long-duration-storage-technologies-left-standing.

217 World Commission on the Ethics of Scientific Knowledge and Technology, *The Precautionary Principle*, UNESCO, March 2005, https://unesdoc.unesco.org/ark:/48223/pf0000139578.

218 International Rights of Nature Tribunal, "Launch of the Verdict 5th International Rights of Nature Tribunal."