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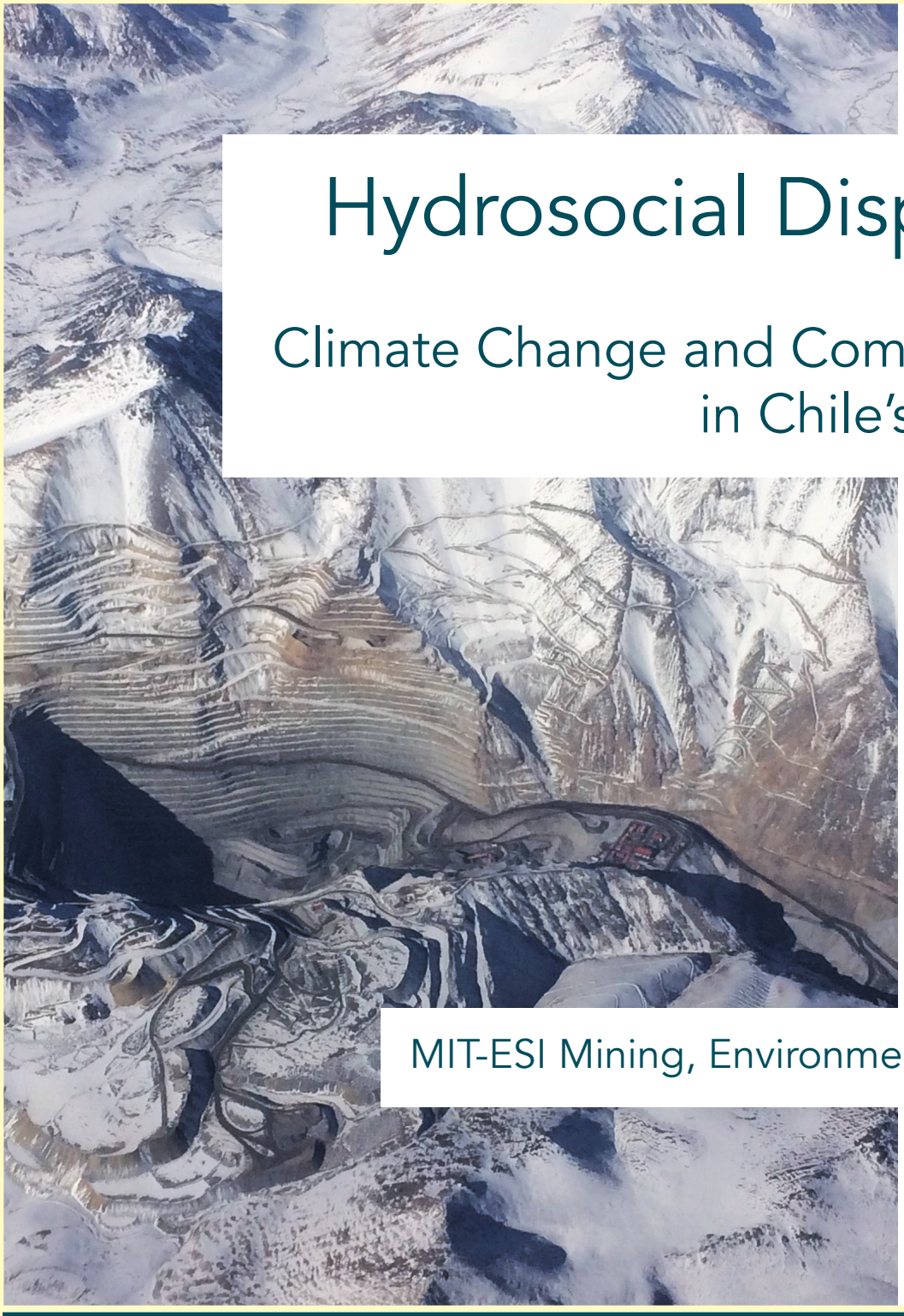

Hydrosocial Displacements

Climate Change and Community Relations in Chile's Mining Regions

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Massachusetts Institute of Technology

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Summary

In response to climate change and widespread social conflict over water resources, mining companies in Chile are expanding collaboration with local communities and investing in desalination to permit the use of seawater in operations. This project examined three questions related to these emerging trends:

1. How does collaboration among communities, companies, and policymakers affect the management of water resources and hydrosocial conflict?
2. How and why has desalination been employed to resolve conflicts, and with what effect?
3. How does this collaboration and technological development differ between mining projects directed by state-owned and private companies?

These questions were analyzed through fieldwork conducted between September 2017 and November 2018 in Santiago and three case study sites in Chile that have experienced recent conflict over water resources: communities near BHP's Escondida Mine, Antofagasta Minerals' Los Pelambres Mine, and CODELCO's Andina Mine. Methods included semi-structured interviews with twenty-four national-level experts in Santiago; participant observation and semi-structured interviews with fifty-five participants representing communities, mining companies, and government in the case study sites; and focus groups in each site and Santiago.

[a] This working paper is an executive summary of a dissertation submitted to the Clark University Graduate School of Geography in June 2020. For a complete discussion of relevant and cited literature, research methods, findings, and conclusions, please see the full dissertation: Odell, S. D. (2020). Hydrosocial displacements: Climate change and community relations in Chile's mining regions. Dissertation submitted to Clark University, Graduate School of Geography. ProQuest Dissertations & Theses Global (28000622).

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Results indicate that rather than resolving conflict over water, the community relations strategies analyzed often move sources of harm downstream and to more vulnerable regions—a process referred to as "hydrosocial displacements." Within this framework, interacting geographical, technical, economic, and political factors constrain the range of responses proposed to address conflict over water, while downstream dynamics and relations of power predict the nature of the displacements they produce.

The expanded use of desalinated seawater is not projected to reduce the mining industry's reliance on continental water supplies at a national scale, but rather, permit an increase in mining production, which is likely to exacerbate or create new socio-environmental harms. With regard to differences between state-owned and private companies, a general perception emerged among participants that CODELCO performs worse than private companies on localized socio-environmental issues and community relations in the regions in which it operates. However, results suggest that public vs. private ownership is less important to the outcomes of water conflict than the dynamics of hydrosocial displacements. These findings offer important implications for communities, government, and mining companies in Chile and globally seeking to address conflicts over water in the context of climate change.

Research Implications

- ***For scholarship:***
  - As the impacts of climate change and mining converge, water harms tend to flow downstream and/or from more powerful to less powerful communities.
  - More research is needed on the intersecting impacts of climate change and mining on vulnerable communities.
- ***For mine-community relations:***
  - Solutions to water conflict must consider long-term consequences throughout and beyond a watershed to avoid creating new harms in new places.
  - This requires cooperation within and between diverse communities affected by the broad footprint of each mine, including in both highland and coastal regions.
  - In order to collaborate effectively with communities, mining companies and government officials must be willing to accept local rejection of extraction proposals.
- ***For development:***
  - The pursuit of economic development and social equity at a national scale must not ignore localized environmental and social harms in mining regions that produce national wealth.
  - Desalination of seawater is unlikely to resolve pre-existing socio-environmental harms if it does not reduce the use of freshwater resources.

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1 Background

Copper production in Chile increased by 8 percent between 2009 and 2018, contributing to a 9 percent increase in the consumption of continental water supplies—such as rivers and aquifers—by the industry over the same period (COCHILCO, 2020, tables 1.1, 1.2, and 32). While mines in and around the Atacama Desert in the north of the country have always operated under arid conditions, the Central Region experienced new water constraints due to an unprecedented "mega drought" beginning in 2010 (Garreaud et al., 2020).

These dynamics have contributed to the emergence of conflicts over water between local communities and mining companies. Though particularly prominent in Chile,[1] such conflicts are not unique to the country. The Environmental Justice Atlas, which tracks socio-environmental conflict at a global scale, has identified 519 cases of conflict related to mining with impact on water worldwide (Temper et al., 2015). Concerns of this nature are "hydrosocial"—that is, they are not only affected by environmental and technical aspects of water, as the more common term, "hydrological," would imply, but political and economic ones as well (Budds et al., 2014).

Mining companies have undertaken two new interventions to respond to these conflicts. First, they have committed to expanding collaboration to understand and more directly address local communities' hydrosocial concerns. This method differs from a more traditional approach to community relations—corporate social responsibility (CSR)—in which companies compensate communities for harms, such as through the construction of a school or stadium. Second, they have invested billions of dollars in desalination plants that allow them to use seawater in operations.

This research project investigated three main questions related to these emerging trends. First, how and why has collaboration been employed to address hydrosocial conflict in mining regions, and with what affect. Second, how has desalination been used in this regard, and with effect. Third, do these dynamics of hydrosocial conflict and responses differ between state-owned (CODELCO) and private firms, and if so, how.

2 Research Methods

I examined these questions using qualitative research methods. In contrast to quantitative methods, which employ physical measurements to obtain numerical results, qualitative research analyzes language or text to understand social structures and individual experiences (see Winchester and Rofe, 2010). Fieldwork took place between September 2017 and November 2018 among national-level stakeholders in Santiago and local-level stakeholders in three case study sites that have experienced recent conflict over water between a large-scale copper operation and local communities: the Escondida Mine (Antofagasta Region), Los Pelambres Mine (Coquimbo Region), and Andina Mine (Valparaíso Region). The specific circumstances of each case study site enabled me to examine the research questions across factors, including

[1] For a broader discussion of social conflict in Chile, see Delamaza et al., 2016.

the reason for, or source of, hydrosocial conflict; presence or lack of a desalination plant; and mine ownership (private vs. public). See Figure 1 for a summary comparison of the three field sites at the time of fieldwork. In addition, the fieldwork in Santiago enabled me to examine hydrosocial concerns from national and international perspectives.

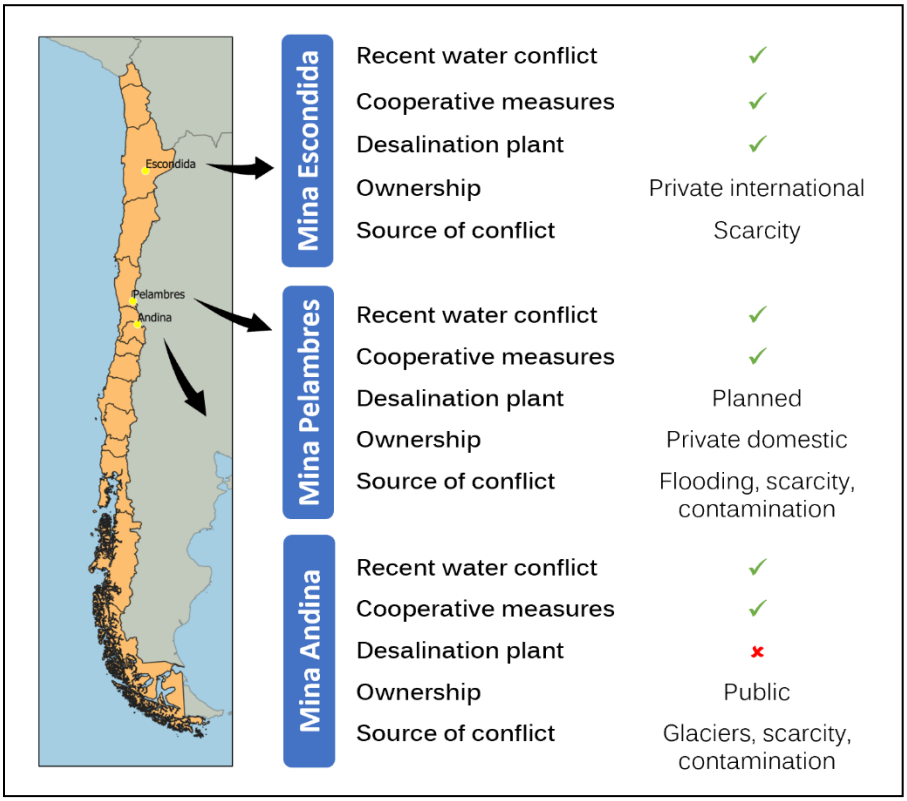

Figure 1. Summary of the three case study sites at the time of fieldwork. Source for map country and regional boundary lines: DIVA-GIS, 2011.

Across the case study sites, I employed three main research methods:

- Semi-structured interviews with national-level experts working on mining and/or water issues representing government, civil society, and mining companies in Santiago.
- Semi-structured interviews in each field site among local stakeholders representing communities, government, and the mining company.
- After the majority of the first two methods was complete, I wrote a summary of preliminary conclusions of the project, then conducted focus groups in each field site and among national-level stakeholders to request reactions to and feedback on them.

I selected participants using purposive sampling methods, including criterion, snowball, and opportunistic techniques (see Bradshaw and Stratford, 2010). Specifically, a key priority across methods was to access a diversity of perspectives within and between each stakeholder group (government, private sector, and civil society), and spatially within each field site (including both valley/highland and coastal regions affected by mining operations). See Table 1 for a summary of research methods and participants.

Table 1: *Summary of Research Methods and Participants.*[2]

Method	Private Sector	Government	Civil Society	Total
1. Santiago interviewees[3]	8	6	10	24
2. Field site interviewees	15	13	27	55
3. Focus groups	2	2	6	10

	Valley/Highland	Coast	N/A	Total
Field site interviewees	35	13	7	55

3 Results

Research results are presented here by their relevance to the three main topics investigated in this project: 1) the reasons for and impacts of increased collaboration and 2) the expansion of desalination operations in mining regions, and 3) whether and how these dynamics differ between CODELCO and private companies.

3.1 Collaboration

Figure 2 summarizes the results of two questions asked of national-level research participants in Santiago regarding hydrosocial conflict (left) and collaboration (right). A majority of respondents across stakeholder groups perceive conflict over water to have increased in mining regions over the last decade. A majority of respondents overall also perceive collaboration to have increased in the last decade, though this is driven largely by private sector respondents, with high levels of government and civil society respondents expressing uncertainty.

These results among national-level stakeholders offer context for the case study analysis at the time of fieldwork. The Escondida mine, operated by the private Australian company BHP, faced major protests over water scarcity from indigenous Atacameño (Likan Antai) communities in 2007. In recent years, it has expanded community relations, including by creating an indigenous affairs team and hiring community relations staff with training in the social sciences. In 2018, it inaugurated one of the largest desalination plants in Latin America, with the explicit objective of reducing its dependence on continental water supplies.

[2] Note that though some participants in this research project agreed to be on the record, in most cases throughout this paper, I have anonymized participation to protect the identities of those who requested confidentiality. Exceptions include those who agreed to be on the record and for whom listing their position or affiliation adds important information to the analysis.

[3] Three national-level participants were also included in the case study interviews because of the participants' in-depth knowledge of a particular case.

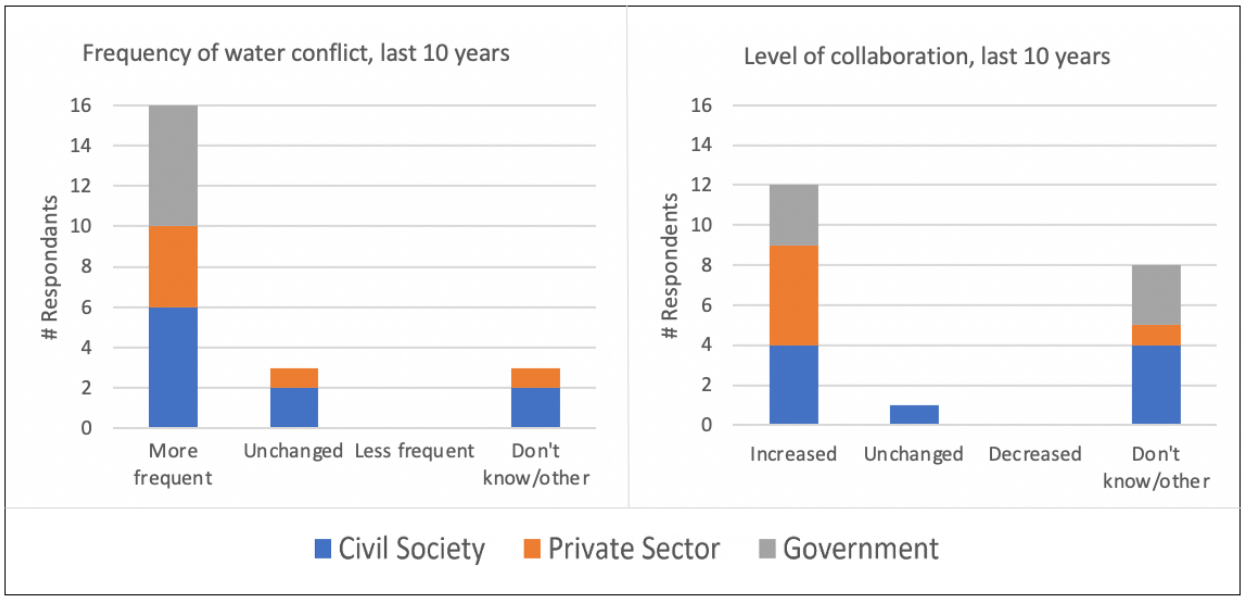

Figure 2. Perceptions of water conflict and collaboration in mining regions among national-level stakeholders in Santiago.

Los Pelambres mine, operated by the private Chilean company Antofagasta Minerals, has faced community protest over its tailings dams since the early 2000s. In response to community concern, dams proposed for sites near the mine itself were instead constructed further downstream above the small community of Caimanes, giving rise to new protests and legal challenges. In a separate conflict in 2015, protestors in the Salamanca Commune blocked roads to the mine's operation to demonstrate concern over water scarcity. In response to these hydrosocial conflicts, the company launched a new community outreach program and agreed to build a desalination plant.

Finally, the Andina mine, operated by the state-owned company CODELCO, faced public protests and pushback from local elected officials in the Metropolitan and Valparaíso regions over the impacts on glaciers of a 2013 proposal, known as Andina-244, that would have nearly tripled production. In response, CODELCO withdrew the proposal and replaced it with one that would avoid glaciers and maintain existing production levels.

A key difference between the three sites at the time of fieldwork was thus that Andina withdrew its production proposal in response to community protest, while Los Pelambres and Escondida still carried out their production objectives—including expansion. For example, Escondida's desalination plant enabled the mine to add a third concentrator that increased production by 52 percent, "…giving the operation copper processing capacity more than any other mine" (BHP, 2016, 2013, English)[4]. Similarly, Los Pelambres' desalination plant is part of an infrastructural development project that will allow it to expand annual production of the mine by 15 percent (Antofagasta Minerals, 2019).

[4] All quotations have been translated from Spanish, unless otherwise noted.

Beyond the inherent socio-environmental impacts of the mine expansions, the community relations efforts in the Escondida and Los Pelambres cases have contributed to divisions within and between communities. For example, one research participant in the Los Vilos Commune, the coastal area hosting Los Pelambres' El Mauro tailings dam and the proposed desalination plant, stated:

> So today, a concern has arisen in this commune of Los Vilos because…[protest] movements are created above [near the mine], and a solution to the side. This is like saying, I have a problem in my house, but the neighbors have the solution. [So as a result], you have the desalination plant and the El Mauro tailings dam in Los Vilos.

In other words, the interviewee asserted that Los Pelambres had responded to community concerns near the mine, but that this had resulted in a transfer of socio-environmental harms downstream to the coastal region.

In the Escondida case, BHP sought to extend a water license expiring in 2019 in the Monturaqui aquifer. According to an environmental advisor working in the region, two of five Atacameño communities in the area—including the one nearest and most directly impacted by the mine, Peine—did not want "to negotiate… But [BHP] continued negotiating with the other communities… So Peine and Toconao didn't want it at that time, and the other three did accept it. And that led to conflict. Because the other communities said, how can you accept this if I don't want it?" (As discussed below, BHP has dropped the Monturaqui plan since the end of fieldwork for this project.) In addition, interviews in the coastal communities of Coloso and Mejillones indicate concern over the potential impacts of the desalination operation and its energy plant in areas that already host substantial industrial infrastructure.

3.2 Desalination

Figure 3 summarizes the perceptions of national-level stakeholders on the question of whether the use of desalinated water in mining operations reduces tensions over water supplies. A majority of respondents answered in the affirmative, with high percentages among government and the private sector in particular, but less certainty among civil society participants.

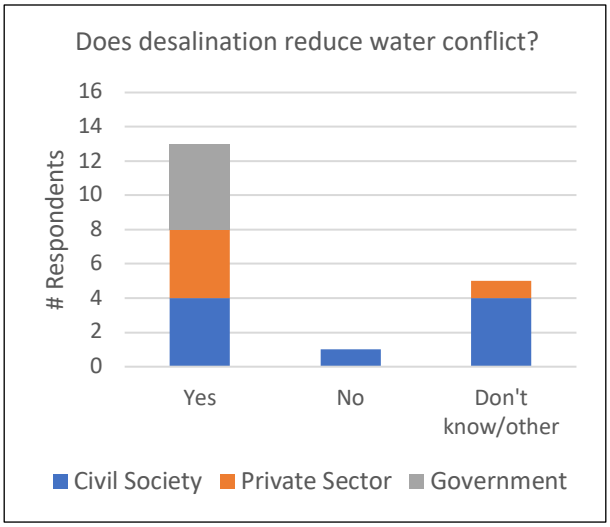

Figure 3. Perceptions of whether desalination operations reduce tensions over water in mining regions, national-level stakeholders.

Data from the Copper Commission of the Chilean Ministry of Mining (Comisión Chilena de Cobre, COCHILCO) offer statistical insight into the impact of desalination on continental water use nationwide, as shown in Figure 4. The graph on the left indicates that the mining industry's use of seawater—including both desalinated and brackish water—has grown rapidly in the past decade, from 3 percent of the total in 2009 to 23 percent in 2018, and from 1 percent to 12 percent for desalinated seawater specifically. Mining operations have also increased their capacity to use recirculated water in their operations by 77% between 2011[5] and 2018 (COCHILCO, 2020). Yet this increase in the use of alternative sources has not resulted in a reduction in the use of continental water, such as rivers and groundwater. Instead, continental water use also grew by 9 percent between 2009-2018.

The figure on the right indicates that these trends are projected to continue, with the use of seawater expanding by 230 percent between 2018 and 2029, and continental water use still increasing by 12 percent. COCHILCO also estimates that Chile's copper production will increase by 28 percent from 2017-2029 (Montes Prunes and Cantallopts, 2018a, p. 11). Overall, the demand for water in the industry is projected to increase faster than copper production, due to both declining ore grades and a shift from mining copper oxides to sulfides, which tend to occur deeper within mineral deposits and can require approximately four times the amount of water to process (Dixon, 2013; Montes Prunes and Cantallopts, 2018a). Because of this, the industry would require an increased supply of water only to maintain current levels of production, let alone increasing production as projected.

[5] The first year for which data were available.

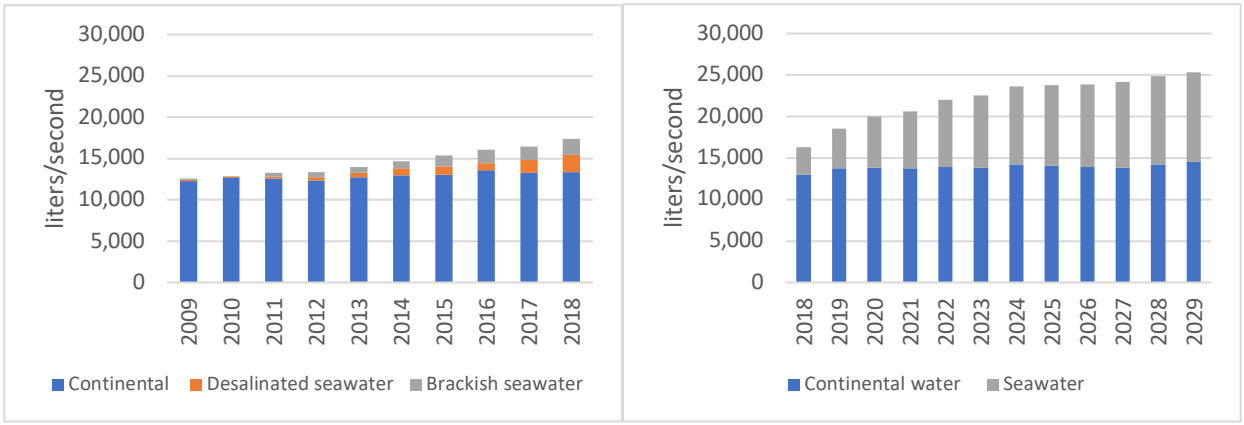

Figure 4. Left: Consumption of water in the copper mining industry, Chile, 2009-2018 (liters/second). Recycled water is not included in this figure. Data source: COCHILCO, 2020, p. 32. See also Montes Prunes and Cantallopts, 2018b, p. 4. ***Right: Projected continental and seawater use in Chile's copper mining industry, 2018-2029.*** Data source: Montes Prunes and Cantallopts, 2018a, p. 12.

The case studies demonstrate differences between individual mining operations with regard to the impacts of desalination on continental water use. In the Escondida case, BHP initially intended its desalination plant to enable the mine to wean itself off continental water supplies altogether by 2030 (BHP, 2018). However, since the end of fieldwork, the mine has increased its production of desalinated water, enabling it to end extraction from high Andean aquifers sooner, including by withdrawing the Monturaqui plan discussed above (BHP, 2020). In the Los Pelambres case, interviews indicated that the desalination plant planned at the time of fieldwork was intended to be turned on and off as needed, but would not function to return continental water rights to communities. Since fieldwork concluded, however, Los Pelambres has released a new proposal to increase the production of the desalination plant, which would allow the mine to cease extraction from the Choapa River by 2025 (Antofagasta Minerals, 2020). The Andina case had no plans for a desalination plant at the time of fieldwork.

Figure 5 indicates that these differences in the use of desalination across the three field sites may be at least partially explained by physical geography. The graph shows water used by large-scale mining, by region, as a percentage of total water use in each of Chile's regions beginning with O'Higgins and moving north to Tarapacá (left vertical axis), as well as the total amount of seawater used by the mining industry in each region (right vertical axis). At the time the data was collected, the Atacama and Antofagasta regions were the only ones in which seawater was being employed by the mining industry, and these regions also had two of the three highest percentages of water used. This supports the intuitive hypothesis that mining companies in regions in which the industry uses a higher percentage of scarcer water resources are more likely to use seawater in their operations.

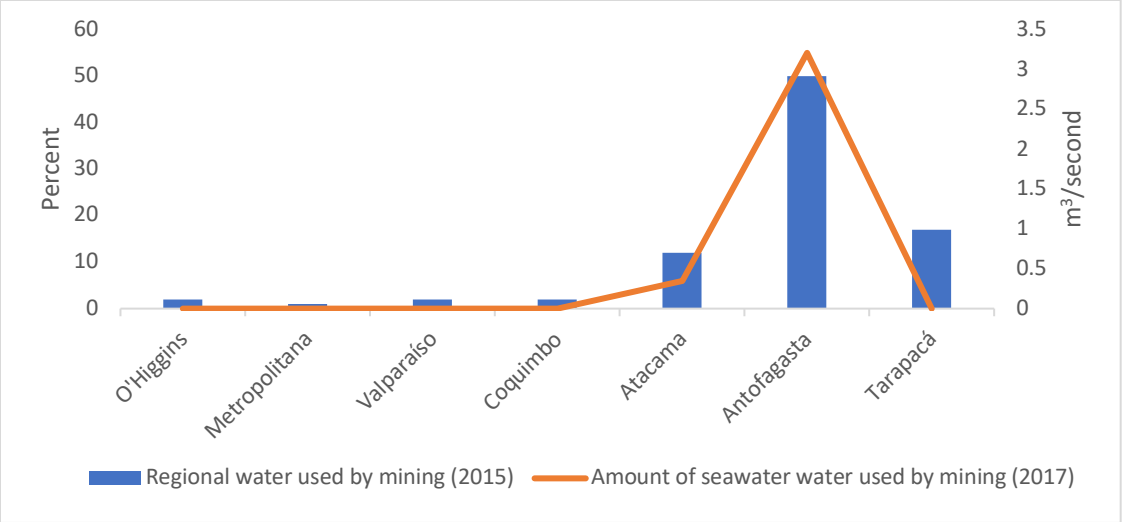

Figure 5. Percent of water used by the mining industry (left axis) and amount of seawater used by the mining industry (right axis), by region. Data source: Consejo Minero, 2019. Note that seawater used includes both desalinated and brackish water.

However, it is important to note that scarcity depends not only on how much water is available, but also how much is used, and by whom. In the Escondida case, the president of Peine asserted that the Salar de Punta Negra, used by Escondida "for almost 20 years…is now dried up" (see also Babidge, 2015, p. 75). In addition, since the end of fieldwork, the Chilean government's Superintendent of the Environment opened a case against Escondida for over-extracting from wells in the Tilopozo sector (SMA, 2020). Declining availability of freshwater supplies due to possible overuse may have thus necessitated a switch to desalination for continued operation (and expansion) to be possible.

Though public protest of desalination operations was not evident in the field sites during fieldwork, concern over the long-term impacts of desalination did emerge from interviews in both the highlands and coastal regions. The president of Coloso, where Escondida's desalination plant is located, reported that members of his community had not at that point noticed negative effects from it on their fishing, although they travel several hours to arrive at their fishing grounds. At the same time, he noted concern over the potential for marine impacts from the operation:

> And now…they add this desalination plant that [processes] lots of liters per second…and returns all that salt to the sea…Logically, that is going to cause an impact, right? Because it isn't normal. It isn't normal. But those are the costs, they say, of a developing country—it creates jobs, and that's what they're talking about at the global level.

The quotation highlights a sense that emerged from fieldwork that stakeholders are concerned over the potential impacts of desalination, but the highly technical nature of desalination and ocean dynamics prevents public stakeholders from identifying them. In addition, the comment suggests concern over the potential for a "zona de sacrificio" (sacrificial zone) dynamic, through which harms to the interviewee's community were seen as a cost accepted for broader national and international development objectives.

3.3 Comparison of CODELCO and Private Companies

Figure 6 displays Chilean copper production from 1960 to the present, divided between public and private operations. The data demonstrates that a sharp increase in private production beginning in the 1990s has led that sector to far surpass public production since then. Nevertheless, CODELCO remains the world's largest copper mining company. This public-private divide in production in Chile raises the question of how mine ownership affects conflict over water. In the case of the field sites for this project, does CODELCO's decision to cancel the Andina-244 project, in contrast to Escondida's and Los Pelambres' maintenance of expansion objectives, indicate a higher commitment to local public concerns?

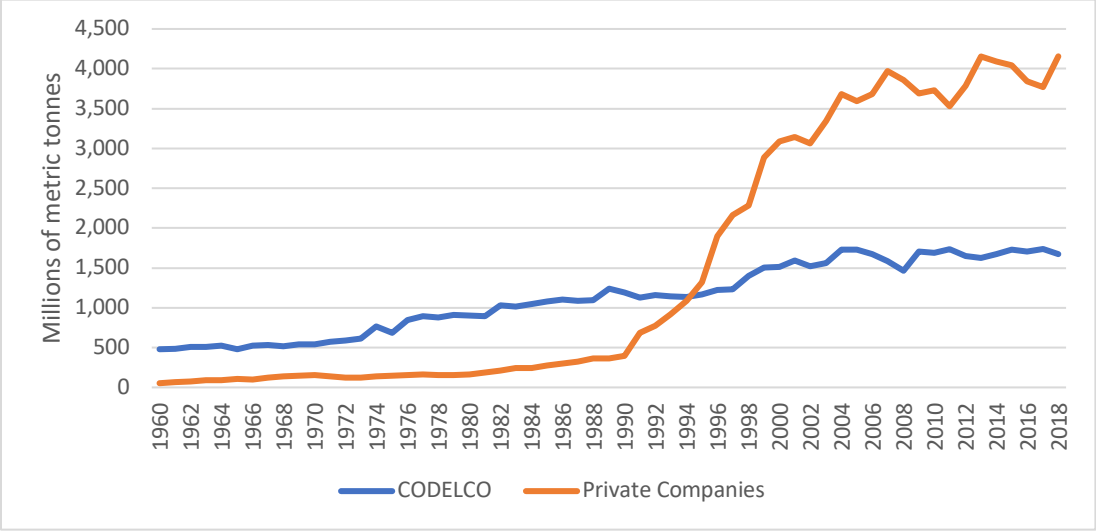

Figure 6. Chile copper production, by mine owner (millions of metric tonnes). Data source: COCHILCO (2019b).

Figure 7 shows the results of an interview question among national-level stakeholders on whether collaboration or conflict dynamics differ between public and private companies. A majority of respondents perceive them to indeed be different. It is interesting to note, however, that four of the six government respondents stated they are not.

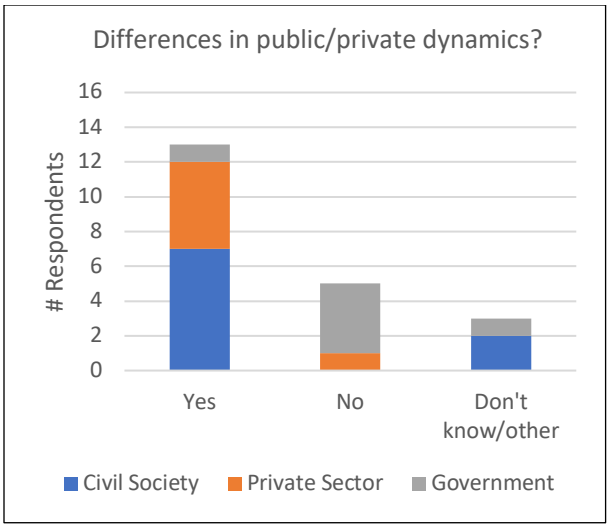

Figure 7. Perceptions of whether there are differences in collaboration or conflict dynamics between public and private companies, national-level stakeholders.

Combining Santiago interviews with those in the field sites, especially the Andina case, a general perception emerged that CODELCO performs worse than private companies with regard to collaboration and conflict dynamics with communities. Three main reasons were given to explain this difference:

- ***Flexibility to spend:*** In this line of reasoning, given legal restrictions as a state-owned company, CODELCO cannot simply spend money in local communities to respond to concerns, as private companies are able and even incentivized to do via tax exemptions.
- ***CODELCO as the sueldo de Chile:*** This point is based on the premise that CODELCO's profits accrue to the state, while those of private companies accrue to private investors. From 1994 to 2018, CODELCO contributed an average of 7.6 percent of Chile's annual public fiscal revenue, with a peak of 21.9 percent in 2006 (COCHILCO, 2019b, Tabla 30.1 and 30.2; and 2011, Tabla 32.1). In contrast, the ten largest private companies[6] contributed a total of only 4.1 percent over the same period, with a peak of 14.0 percent in 2007 (Ibid). These dynamics may contribute to a sense that public harms by CODELCO in individual sites may be justified because it is for the good of the country as a whole. This may increase the risk of zona de sacrificio dynamics in communities that host state-owned operations in particular.
- ***The role of Social License to Operate and international pressure:*** Related to the previous point, a perception emerged that as a state-owned company accruing public profits, CODELCO possesses a natural social license to operate (SLO). In contrast, private firms—especially international ones—are perceived as guests who must justify why their extraction of national wealth is publicly permissible. In addition, international

[6] Specifically, this group refers to a "Group of the ten large copper companies that had subscribed [to] a Decree Law 600 Foreign Direct Investment Contract in 2001 and were the largest copper producers at that time. These companies accounted for 90% of private sector mining production and the bulk of mining taxation from this sector" (COCHILCO, 2019b, Tabla 30.1, English).

> firms may be under greater pressure in their countries of origin and from global activist networks to maintain high standards of conduct.

Given these perceptions that CODELCO performs worse than private companies on community relations, the question remains of why it was the only one of the three cases to respond to community protest by withdrawing its expansion plans. Evidence from fieldwork indicates several key factors. First, nearly tripling the mine's production created substantial technical and financial challenges for the company. Second, in addition to longstanding impacts and concern raised by mayors in the Valparaíso Region, the Andina-244 project would have affected the Metropolitan Region (RM), and drew the ire in particular of the wealthy Lo Barnechea Commune. As the population, economic, and political centers of the country, protests in these regions had a particularly forceful impact on the project.

Third, the main hydrosocial impacts of the Andina-244 project would have been on glaciers, which have become a flashpoint of public protests in the country due to pre-existing risk to them due to climate change. A quote from the president of the Lo Barnechea Commune Neighborhood Board (Unión Comunal de Juntas de Vecinos de Lo Barnechea) underscores this point:

> ...[B]efore, people didn't know that water from glaciers was...the water that is going to give us life. And it isn't even for us – it is for future generations...But climate change is evident—the people know it, they live it, they see it – especially those of us who live in the foothills...It used to snow here... So since everything changed...the people say, no, what we have to protect, at a minimum, if we want to continue living on this planet, is water. And where is the water? In the glaciers. We have to protect them.

In this sense, the Andina case draws comparison with the Pascua-Lama mining project (see Kronenberg, 2013; Urkidi, 2010), which was also successfully rejected by the public due largely to concerns over impacts on glaciers.

4 Discussion

The Los Pelambres and Escondida cases indicate that rather than resolving sources of hydrosocial conflict, new community relations strategies and investment in desalination may instead transform and move harms to other communities. In contrast, the Andina case indicates that sources of conflict may be withdrawn in response to community protest. Across all three cases, these outcomes depend upon complex interactions between a series of related social and environmental factors. I propose a theoretical framework, "hydrosocial displacements," to explain these factors and their role in whether, how, and where a source of hydrosocial conflict is transformed, moved, or abandoned.

Figure 8 presents a conceptual diagram of hydrosocial displacements. In this framing, the intersecting impacts of climate change and mining function as stressors on water supplies, causing impacts such as contamination, scarcity, flooding, and damage to glaciers. These harms become sources of social conflict between mining companies and communities. Fixes proposed to address these sources of conflict, as well as how and where they are implemented, depend

upon four key factors: 1) geographical constraints, 2) technical, economic, and political constraints, 3) downstream dynamics, and 4) relations of power. The first two of these factors represent constraints on what fixes can be implemented, while the latter two represent dynamics that predict whether, how, and where the fixes will be implemented, and whom they will affect. Unless the source of conflict—such as a mine expansion proposal—is abandoned altogether, hydrosocial fixes will tend to result in new stressors that produce further rounds of conflict.

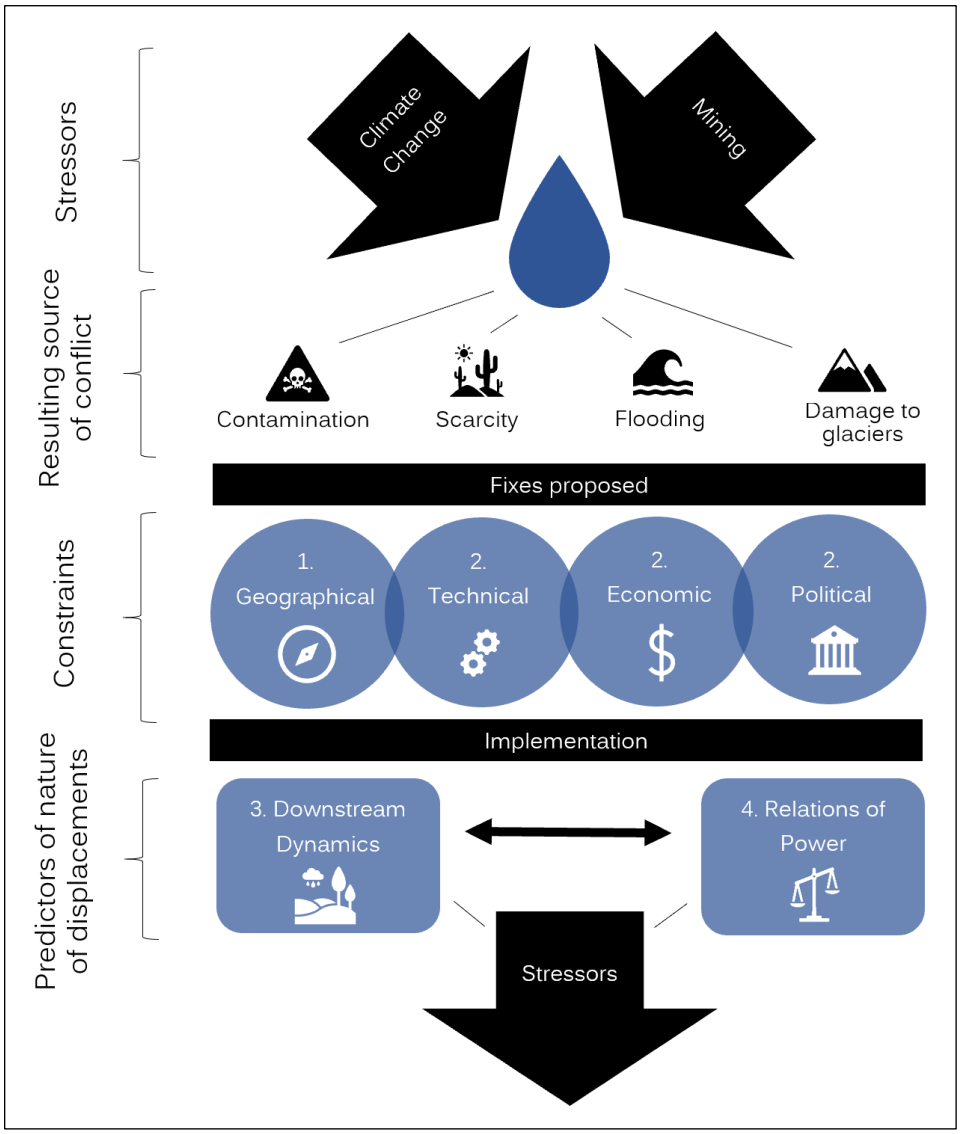

Figure 8. Conceptual diagram of hydrosocial displacements. Whether, how and where a source of hydrosocial conflict transforms and moves is based on four key factors (numbers in the figure), which in turn, are situated within broader socio-environmental dynamics. That is, stressors, such as climate change or mining, affect water resources, creating sources of social conflict. Fixes proposed to address this conflict and how they are implemented depend upon inter-related geographical, technical, economic, and political constraints. Such fixes generally result in a transformation and/or movement of the source of conflict to other sites and populations. The nature of these displacements—including who is affected by them and how—depends upon downstream dynamics and relations of power. The displacements tend to create new stressors that may result in new rounds of conflict.

This framing of hydrosocial displacements helps to explain the outcomes of conflict over water in the three field sites. In the Escondida case, geographical constraints and overuse that limit the supply of water, as well as the high technical and financial capacity of BHP and the political optimism surrounding desalination in Chile, have resulted in the investment in large-scale desalination there as a fix to hydrosocial conflict. The adoption of desalination inherently moves socio-environmental impacts of water extraction downstream toward the coast to Coloso and Mejillones, though long-standing relations of power that result in socio-environmental harms to indigenous communities leave risks of harms to Atacameño populations (see Prieto et al., 2019).[7]

In the Los Pelambres case, protests against proposed tailings dams near the more populated regions near the mine were resolved by building a dam further downstream above a less populated (and less powerful) community, resulting in new rounds of conflict. Similarly, concerns over water scarcity in the Salamanca Commune resulted in an agreement by the company to build a desalination plant in Los Vilos.

Finally, the Andina case is the only one of the three in which hydrosocial conflict actually led the mining company to withdraw its expanded production plans. This was due in part to the geographical factor of the presence of glaciers in the proposed mine site, as well as technical and financial constraints to such a large expansion. But it was also due to the high levels of political and economic power possessed by protesting communities in the Metropolitan and Valparaíso Regions.

5 Conclusions

With regard to the three main questions of this project, results and analysis indicate that:

1. *New efforts by mining companies to collaborate with local populations* are an improvement on past community relations methods. However, as currently practiced, they often result in division within and between communities, exacerbate power imbalances between companies and communities, and can lead to a transference of harms to more vulnerable populations.
2. *Desalination of seawater* has eased hydrosocial tensions in mining regions in specific case study sites. However, at a national scale, it is not projected to reduce use of continental water by the mining industry, instead permitting an expansion of copper production. In addition, concerns remain over the long-term impacts of the operations on coastal populations.
3. In general, s*tate and privately owned mining companies* are perceived to respond differently to water conflict, with CODELCO perceived as less effective in addressing community concerns. However, public and private companies are both subject to

[7] See also Bustos-Gallardo et al. (2021) for discussion of emerging trends in the lithium industry that intersect with copper mining to affect Atacameño communities.

similar geographical, social, and technical factors that likely have greater effects on the outcomes of hydrosocial conflict.

Across these three questions, the framework of hydrosocial displacements demonstrates that geographical constraints; technical, economic, and political factors; downstream dynamics; and relations of power determine whether, how, and where collaboration and desalination are deployed, and with what effect.

These findings hold important implications for communities, government officials, mining companies, and scholars with interest in water in mining regions, within three key themes, as follows.

5.1 Implications for Scholarship

This research underscores a point long made by political ecologists and hydrosocial scholars: water cannot be fully understood from only a physical (or environmental) perspective; scholarship must also consider how the resource is situated within economic and political contexts (see, for example, Budds et al., 2014). In addition, the project demonstrates that climate change and mining are converging to impact water resources and the human populations that depend upon them, and indicates that these concerns are unlikely to be resolved by current adaptive mechanisms such as desalination that function simply to maintain current production and consumption patterns (see also Fragkou and McEvoy, 2016; Swyngedouw, 2013). As climate change advances and mining production expands, greater research is needed on how the impacts of both may intersect in vulnerable communities.

5.2 Implications for Community Relations

The three case studies of this project demonstrate that communities have been successful in pushing mining companies to take local concerns seriously. However, current measures deployed to respond to these concerns tend to result in greater divisions within and between the communities. Intentionally or not, mining companies' new collaborative mechanisms may thus result in a 'divide and conquer' dynamic that increases the power of the corporation relative to a fractured civil society, enabling the mining company to move forward with its production objectives despite opposition. This is particularly concerning in indigenous communities with pre-existing histories of exploitation and cases where existing or potential *zonas de sacrificio* become the recipients of additional harms to address the concerns of other areas.

These observations point to the benefit of expanded communication across communities affected by a mining operation, rather than more common one-on-one negotiations between the mine and individual communities.[8] Such engagement may take the form of regional sessions that bring representatives of disparate communities affected by a mine together to discuss concerns and solutions. In some cases, this has long been done among nearby

[8] See Devenin (2021) for an analysis of broad collaborative community development programs taking place in the Antofagasta region.

communities, but less frequently at a scale that includes both highland and coastal communities affected by the same operation.

Communities could benefit from placing such collaboration as a high priority for their relations with companies to ensure that their negotiating power is not divided by solutions that fix problems for one community but harm another. The mining industry would also benefit from supporting this type of communication. In the short-term, it may result in more difficult negotiations about how and where to address community concerns, but in the long-term, it can enable permanent solutions rather than simply kicking the can of social conflict down the road, requiring further rounds of negotiation and investment in the future. It must be recognized too, however, that such engagement should not simply be an exercise to ensure community approval of a mining operation. Rather, a fundamental principle of engagement must be that companies and government officials accept those instances in which communities reject project proposals, as in the Andina case.

These types of collaborative measures may require external support to enable community members to afford the transportation and labor costs needed to meet with sometimes distant peer communities, such as government funding during project approval processes. Grassroots actors have also demonstrated, however, the power of online communication technologies to muster support for causes from diverse actors across distances.

5.3 Implications for Development

Across the three field sites, discussions with participants over the specific topics of water and mining often led naturally to reflections on broader questions of development. For example, the interviewee in Coloso cited above stated that the presumed impacts of Escondida's new desalination plant "are the costs, they say, of a developing country." In Ventanas, where CODELCO smelts ore from Andina and other industrial operations fill the coastline, a fisherman pointed to an impoverished pocket of local residences and said that this is the part of development they do not tell you about. And in Salamanca, the manager of an irrigation institution noted the arrival of the Pelambres mine had brought financial benefit to the community that had been used on consumer goods. But she questioned whether this had actually improved quality of life, and what is the real value of money. What, she asked, will remain after the mine is used up besides a hole and some CSR projects? "Do we have better health? No... Do we have better education? No. So what have we gotten in the end? More money."

These quotations represent a questioning of the economic development model that has driven Chile's political and economic trajectory—as well as broader conceptions of development globally. This model views economic growth as the objective, and increased quality of life based on consumptive capacity as the benefit. Chile's success in achieving these goals has led international institutions to hold it up as a model for other countries. A core fuel fed to this development model has been copper—an ever-growing extractive operation whose profits can filter through the economy to enable the growth of other sectors, thus leading to employment, higher wages, domestic consumption, and further growth.

But these participants whose communities have borne the negative impacts of mining operations questioned whether the improvements to quality of life obtained through this model were worth the costs, and even whether they were really improvements. These questions have become all the more relevant since the conclusion of fieldwork for this project, as Chile has been shaken by massive public mobilizations over issues of equity, leading to a new constitutional convention.

As countries endowed with natural resources across the globe consider their economic and political futures in the midst and wake of the COVID-19 pandemic, such questions over mining and the nature of development will be crucial, as policymakers may look to expanded mining revenues to pay for new government programs. This may be especially true in Chile as it undergoes the process of rewriting the national constitution. This research project indicates the need to consider not only the national benefits of such programs, but also local perspectives of how they will impact the communities most directly affected by extractive industries.

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