

Beyond scarcity and its management: Sociocultural dimensions of the water crisis in the Atacama Desert

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ABSTRACT

The depletion of freshwater sources by indiscriminate industrial actions is one of the direct causes of the current water crisis. One of the emblematic cases of this problem is the Atacama Desert, a unique hyper-arid zone in which an extensive copper industry depletes its scarce freshwater reserves. This territory, occupied for millennia by indigenous groups, is experiencing a water crisis that threatens its very subsistence. This paper uses the ethnographic method and the Water Justice framework to approach the everyday and often invisible issues of this crisis within the Mamiña community. This Quechua community holds an ambivalent position in front of the copper mine project because of its control of the water rights, the economic interests of some of their members, and the role of the Aymara minority. We suggest that researchers in this field pay more attention to the communities' internal diversity and its relations with the copper industry to understand how the water crisis is detached from its biophysical conceptions to be socioculturally constructed.

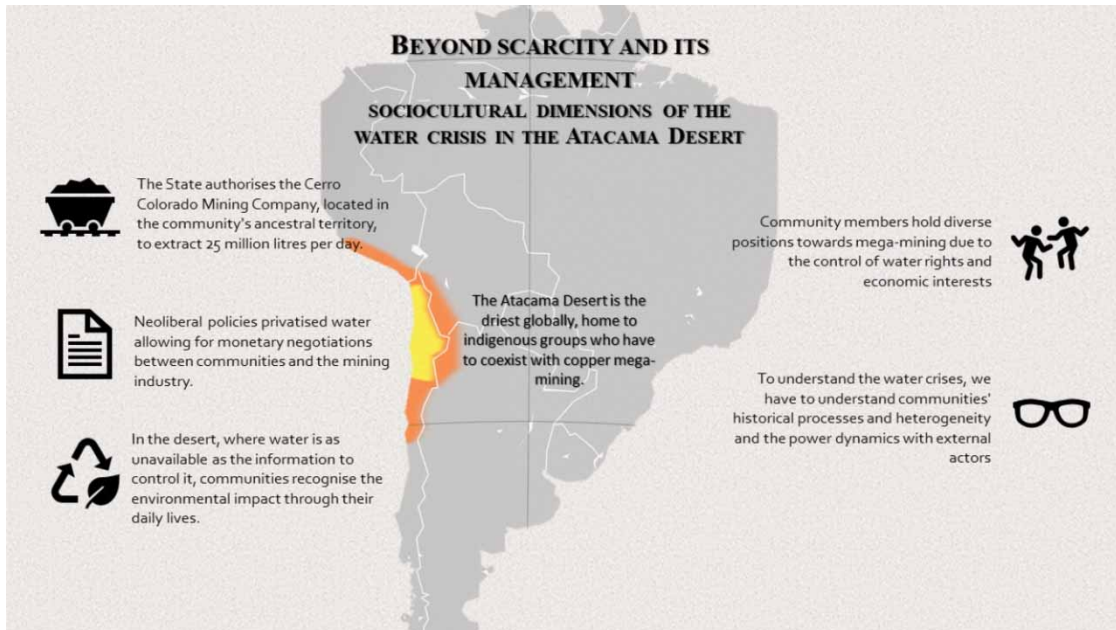
Key words: Andean, Chile, Ethnography, Extractivism, Neo-extractivism Quechua, Neoliberalism, Water crisis

HIGHLIGHTS

- The water crisis in the Atacama Desert is not only related to its natural conditions of biophysical scarcity.
- An investigative approach focused on the sociocultural dimension could better show the everyday interactions of current water problems.
- The interweaving of sociocultural practices and discourses with the conditions of the environment are key cornerstones to understanding how the water crisis is constructed.
- The hyper-arid conditions of the desert and the scarce information on indicators hide the environmental damage that occurs in it.

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GRAPHICAL ABSTRACT



1. INTRODUCTION

The depletion of freshwater sources and the ecological destruction of the so-called global water crisis is less a consequence of generalised scarcity than a manifestation of uneven power geometries (Boelens *et al.*, 2018). Water becomes scarce not in relation to its biophysical availability, but in relation to its quality, accessibility, affordability, and reliability (Cook & Bakker, 2012). There is unequal access to water and uneven water distribution across the world (Sultana, 2018). In this context, Water Justice (WJ) is a field within the political ecology of water that focuses on unequal distribution of benefits and burdens, access to and control over water, and also on efforts to build alternative water realities (Boelens *et al.*, 2018). This approach is interested in analysing how people experience water injustice, while simultaneously facing political oppression, cultural discrimination, and economic marginalisation, showing that water problems are of ecological, political, and social nature (Sultana, 2018). Boelens *et al.* (2018) argued that 'Cultural, ethnic and gender discrimination often constitute the foundation to privilege allocation of water rights to some over others' (p. 5). Accordingly, WJ situates the sociocultural dimensions together with the phenomena of the global water crisis as an articulated body (Zwarteveen & Boelens, 2011a). In this sense, the culture cannot be analysed in a biased way as it is a crucial dynamic complex without which it is not easy to move towards equity and justice.

Current examples of water injustice are those imposed by agribusiness water grabbing, hydropower and mega-hydraulic development, rural–urban transfers, water privatisation, and neo-extractive industries (Rodríguez-Labajos & Martínez-Alier, 2015). Chile, in particular, has shown significant economic growth in recent decades due to the development of a neo-extractive industry that has positioned the country as one of the leading copper producers in the world (World Bureau of Metal Statistics, 2019). However, Yáñez & Molina (2011) point out that this growth has a consequence that the environmental conflicts related to extractive industries affect water availability. As a result, some of the driest areas in the world located in Chile are

experiencing environmental degradation, conflicts, and reduced industrial productivity (Bottaro, Latta & Sola, 2014; Aitken *et al.*, 2016). In Chile, dimensions of water injustice derived from a historical privatisation process protected by the Water Code (WC) and a neoliberal state (Castro & Quiroz, 2011). These include a lack of protection for local communities' applications, the award of free and perpetual rights of use to private operators, and the lack of recognition to indigenous peoples rights (Rodríguez-Labajos & Martínez-Alier, 2015). Yáñez & Molina (2011) remark the latter issue as an important pattern of neo-extractive projects across Latin America, which often develop on indigenous lands.

The Atacama Desert is not only one of the driest areas in Chile and in the world, but it is also the centre of one of the most important reserves of mineral resources, particularly copper, lithium, and other minerals. This situation further accentuates the hyper-aridity conditions, especially considering that water allocation for mining operations is up to four times higher than domestic use in the area under study (Aitken *et al.*, 2016). From a hydrometric point of view, the desert presents more severe management problems. Most of the data from state monitoring stations are scarce, outdated, and confusing. According to a water resource observatory in the Tarapacá region, some of these reasons are that almost all these stations do not have a current historical record or do not have accurate coordinates, their level measurements are not standardised, and only a few meet the basic characteristics for proper operation (Lictevoud *et al.*, 2014). Despite this, some research centres have carried out monitoring at other stations. The results show that in the last 30 years, the principal aquifer in the region has increased its use by 1890% and that, ultimately, the Pampa del Tamarugal aquifer is overexploited (Viguier *et al.*, 2019). Definitely, there is a consensus among institutions and academics to establish that water resources in the region present a negative balance in which the level of water extraction exceeds the rate of recharge (Lictevoud & Faysse, 2018; Viguier *et al.*, 2019). In general, the waters of the Atacama Desert runoff through groundwater and are not visible. Their depletion is not easy to identify through the already desert landscape and can only be recognised when depletion occurs, or the local knowledge of human groups allows changes in their ecology to be identified (Babidge, 2021).

The link between mineral exploitation and the overexploitation of water resources in an area with natural conditions of scarcity is aggravated when witnessing that the installation of these megaprojects has been carried out in territory of ancestral use of different indigenous communities (Romero-Aravena *et al.*, 2012). Due to these characteristics, the case of the Atacama Desert, in general, has unique phenomena that have attracted the attention of several researchers (Cantillana, 2020). The literature focusing on the consequences of water dispossession of Andean indigenous peoples started the debate (Aldunate, 1985; van Kessel, 1985; Castro, 1992; Núñez & Pourrut, 1995; Hendriks, 1998). The results presented in this literature shows that neo-extractive expansion was producing water and sociocultural stress in local communities. Over time, the discussion has been strengthened by a theoretical and empirical corpus dominated by political analysis in general and socioecological analysis in particular (Gentes, 2000; Carrasco, 2009, 2016; Romero-Aravena *et al.*, 2012; Babidge, 2013, 2016, 2019; Prieto, 2015, 2016b, 2017; Bolados & Babidge, 2017; Romero-Toledo, 2018; Prieto *et al.*, 2019). The critical approaches of this literature urgently illustrate the consequences of a water crisis accentuated by neoliberal policies, neo-extractivist agendas and the almost non-existent governmental protection of affected groups.

Stepping aside from literature could broaden knowledge about the particularities of the water phenomenon and the reconfigurations it has produced at the community level. Prieto (2021) has recently shown this by analysing indigeneity as a dynamic cultural category subject to constant friction with commodification. The approach has allowed him to observe that the strategic integration of certain market games enables the re-emergence of indigenous identity to regain their access to water. Babidge (2021) has also made progress in analysing the impacts produced by the overexploitation of the water-mining binomial from the traditional local knowledge of some Likan-antay groups, especially when the socio-environmental damage is made invisible in the dryness

of the desert. Therefore, we suggest that research into the water crisis in the Atacama Desert must move away from a focus on disputes over water allocation and water rights towards communities' internal composition, economic exchanges with the mine projects, and cultural representations. In addition, a large part of these investigations on the Atacama Desert focused on ethnically homogenous communities compared to more northerly areas¹ (with exceptions, e.g., van Kessel, 1985; Romero-Aravena *et al.*, 2018; Romero-Toledo, 2018).

We contribute to this debate with ethnographic research based on a case located in an area of the Atacama Desert comparatively less studied. The research focuses on the everyday life of the actors to understand the interactions with the water crisis, based on historical, structural, and sociocultural elements and the economic interests related to the mining project. The article is structured as follows: first, we present background information on the Chilean neoliberal context. Second, we present the methodological section, then review and examine the impact of Chile's historical and structural processes on the water crisis. Finally, we discuss these effects in relation to the micro-social dimensions of the Mamiñean case, their relationship with the mining company and the sociocultural interaction that occur.

1.1. Neoliberal policies, neo-extraction of raw materials, and mining appropriation of water resources

During the military dictatorship of Pinochet (1973–1990), a neoliberal agenda² was imposed in Chile to test the new dogmas for the state and market structure. Chile had become the centre of developmentalist thinking in Latin America with the socialist government of Allende implementing nationalisation policies (nationalisation of copper mines, land reform, minimum wage, among others) (Hickel, 2017). The transformation of the country as a laboratory for neoliberal policies positioned it as a model leader, without recognising the structural consequences resulting from the privatisation of state companies and public goods (Harvey, 2005). In fact, the idea that economic aspects should always be above others, such as environmental and sociocultural ones, was built-in at different levels of society and its institutions. Under this model, in 1981, the WC came into effect (Congreso Nacional de Chile, 1981): A policy that legally denationalised water as an exclusive good for public use, simultaneously turning it into a private good (Larraín, 2006; Bauer, 2008). In the spirit of the WC, we can observe the intention to create a water market that would allow a free transaction of usufruct rights. However, it was complex to establish an informed price list that created a market, which led to the industrial grabbing of water rights (Bauer, 1997; Budds, 2004). Considering that, although the state has a free-market ideology, contradictorily, it plays a fundamental role in the allocation of the resource, protecting its concentration for large extractive industries such as mining (Prieto, 2015).

In 2019, 94% of the water used for mining processes in the area studied came from fresh groundwater sources (Cochilco, 2020). One mining company located in the area was allocated to extract 504,000 litres per hour (Dirección General de Aguas, 2021). Such concentration in water resource allocation resulted in severe consequences for different population groups and especially for indigenous communities (Romero-Aravena *et al.*, 2012). In the Atacama Desert, the registration of water rights by mining companies triggered the dispossession of water in the neighbouring indigenous communities (Budds, 2010; Prieto, 2015, 2016a). More recently, mining companies have acquired and bought in the market the right of use from indigenous and peasant communities either through payments of compensation or by installing new wells or through the regularisation of illegal loggings (Budds, 2009; Romero-Aravena *et al.*, 2012).

¹ The Atacama Desert is located across four regions (administrative division) of Chile: north to south, Arica y Parinacota, Tarapacá, Antofagasta, and Atacama.

² According to Harvey (2005), the neoliberal agenda is part of an articulated strategy of the elites to discipline and restore the parameters for abundant exploitation of diverse resources.

In 1993, an Indigenous Law was enacted in Chile ([Congreso Nacional de Chile, 1993](#)) to advance the recognition of the rights of the native population after a long history of cultural assimilation and inter-ethnic conflicts ([Bengoa, 2004](#)). Despite its enactment, the state continued with a high ethnocentric load of the national culture whose homogenising nature did not allow it to abandon multicultural denialism ([Vergara et al., 2006](#)). Unfortunately, the scant progress of this policy was accentuated by observing that the state does not recognise indigenous communities by their nature, nor by the fact that they are groups that share the same characteristics in a given territory. Thus, through this law, the legislators created the legal figure of ‘indigenous communities’ as a territorial organisation that had to fulfil certain stages to be officially recognised. For example, the formation of a directorate, popular election processes, provision of a *quorum* for participation, and the presence of a public official to guarantee the process. Therefore, the indigenous groups were forced to submit to an unknown governmental apparatus, disconnected from any customary practice and traditional socio-political organisation.

Likewise, Chile promoted the development of a neo-extractive industry without legal protection for the environment nor the indigenous rights. Only in 1994, Chile legislated on environmental protection to ensure that the nation had the right to live in a pollution-free environment, but not universally, since the law determines this ‘without prejudice to what other legal norms establish on the matter’ ([Congreso Nacional de Chile, 1994](#)). Therefore, both regulatory bodies of protection were subject to other laws that support the transactional economic model ([Bolados & Babidge, 2017](#)). Essentially, Chilean legislation is based on neoliberal dogmas of private empowerment for market supremacy. Neo-extractivism is precisely a renewed form of extractive logic that still has the structure of accumulation and dispossession as its key cornerstone through the massification of profits and the externalisation of impacts ([Gudynas, 2010](#); [Svampa, 2015](#)). Big business, such as the neo-extractive mining companies, has deepened these dogmas through scant socio-environmental and heritage protection regulations. This long history of environmental degradation is one of the most critical factors in the water crisis and its sociocultural consequences in the Atacama Desert³.

1.2. The Cerro Colorado mining company and Mamiña

During the 1980s, some of the most important transnational mega-mining projects were consolidated in the Tarapacá region, north of the Atacama Desert ([Guerrero, 1998](#)): Quebrada Blanca Mining Company (Teck), Doña Inés de Collahuasi Mining Company (Anglo American), and Cerro Colorado Mining company (BHP Billiton). The rapid installation of these megaprojects was due to the already seen neoliberal policies that sought accelerated growth. One of the main consequences of this policy was the installation of these companies in hyper-arid zones and the ancestral territories of several indigenous communities, with the complete absence of regulatory bodies to protect them. Cerro Colorado Mining Company is placed in the Mamiñeans’ traditional lands.

In 2019, the Cerro Colorado Mining Company (The Company) produced 71,700 tonnes of copper (Comisión Chilena del Cobre [[Cochilco](#)], 2020). In 2017, 93% of the water used for mining processes came from fresh groundwater sources, with the extraction of 1153 litres per second at the regional level ([Cochilco, 2018](#)). There are no disaggregated data that allow us to precisely know the exact water consumption related to this company’s production; however, from the recently cited Cochilco reports, we can establish some approximate values. In the Tarapacá Region, in 2017, 613,000 tons of copper were produced, divided into three mega-mining projects; The Company, for its part, contributed 66,200 tons. The Company, for its part, contributed 66,200 tonnes. Thus,

³ While the state has now progressed on water and environmental protection standards, it is still difficult to recognise its breakthrough without reversing the state economic development model. For example, the governmental partition related to indigenous peoples (CONADI) has a programme of funds for consultancy and purchasing water rights for indigenous groups. Some progress can also be recognised in the citizen training programmes charged by the institution’s environmental impact assessment system.

considering that in the same year, 4,159,899 litres per hour were used for the regional total and that the Company's annual production was 66,200 tonnes, this project used more than 446,400 litres of groundwater per hour (see Figure 1). In any case, this Company has extraction rights in four fresh groundwater catchments for a total of 25 million litres per day⁴. These extraction points are located 40 kilometres northeast of Mamiña. In general, the use for mining activities in the region is 17%, while 8% is for home consumption.

All this background can be seen at play in Mamiña (Figure 2), a Quechua indigenous rural village with a millenary history (Núñez, 1965; Uribe, 2006). One of its main characteristics is its thermal springs, whose outstanding therapeutic properties have been known since the 14th century. Because of this, the community has developed a territory vocation focused on productive activities derived from trips and stays at its hot springs and on complementary agriculture. These productive relationships have been based on a Quechua cosmogonic and sociocultural logic of reciprocity and respect for their ecological environment (Albó, 2000). However, they have also been subjected to constant interactions that have affected their presence: the emergence of the new borders of the nation-state, the rural to urban migration process, and in the last 40 years, extractive neoliberal policies (Romero-Toledo & Sambolín, 2019). Such phenomena, added to the hyper-arid conditions of the desert, the scarce availability of surface freshwater and groundwater (Gayo *et al.*, 2012; Lictevout & Faysse, 2018) and an open-pit copper mining project close to the village, have produced a water crisis scenario that puts in evidence reconfigurations in the sociocultural fabric of the indigenous group: negotiations, cultural contradictions and a metabolic rift with their environment.

2. METHODOLOGY

Mamiña is placed at more than 2700 meters above sea level (masl), at the beginning of the Andean foothills. It has an approximate surface of 6600 m² over an area of 2 km (Figure 3). However, the ancestral use of the territory can grow exponentially through commercial transhumance routes or caravans. Approximately 200 people live there permanently, almost 70% of them are Quechua and, to a lesser extent, Aymara, mainly grouped in extended



Fig. 1 | Annual copper production and water consumption of mega-mining in Tarapacá (2017). *Source:* Own elaboration based on Cochilco (2018, 2020).

⁴ This information can be consulted directly in the geographic information systems of the General Water Direction at www.dga.mop.gob.cl. The query must be carried out in a particular way, and there is no direct URL that makes it possible to reference it.



Fig. 2 | Mamiña is in the middle of the photograph, and the hills with residues from the mining processes emerge in the background. *Source:* Own elaboration.

families. Their main economic activities vary between services and manufacturing and complement some native activities such as agriculture or raising rabbits. Its population makes it one of the few Andean villages that still maintains a permanent activity throughout the annual cycle. There is also a high floating population derived from the hotel boom related to The Company. The Mamiñeans, as they call themselves, celebrate various indigenous and religious activities, of which the most outstanding are the festivities of the Señor de Mamiña, the Virgen del Rosario, and the carnival period. On the other hand, the most well-attended territorial and grassroots organisations correspond to the Quechua Indigenous Community, the Neighbourhood Council, and the Water Community.

The whole sociocultural emphasis of this anthropological examination of the everyday issues of the subjects of study is articulated by the ethnographic method (Taylor *et al.*, 2016; Hammersley & Atkinson, 2019). As a result, the research was qualitative with an application of the ethnographic method carried out by the first author of the manuscript. Informants were selected in accordance with different characteristics: whether they were Indigenous or not, their activity, age, leadership, usual residence, and gender to have access to the different views of the phenomena. As such, we interviewed indigenous community members, leaders, youth, adults, the elderly, men and women, employees of the mining company, among others. The first author contacted other informants through the family group that hosted him during the fieldwork. Because of the treatment of sensitive issues such as the location of the springs or the disputes and negotiations with the mining project, this recommendation from one informant to another spared us from an unfavourable reception.

The fieldwork was divided in two periods. First, an exploratory phase during August and September 2019, in which the case study was selected and the first approach with the community also took place. Although many indigenous communities share similar problems, we chose one that was close to a mining project with ongoing

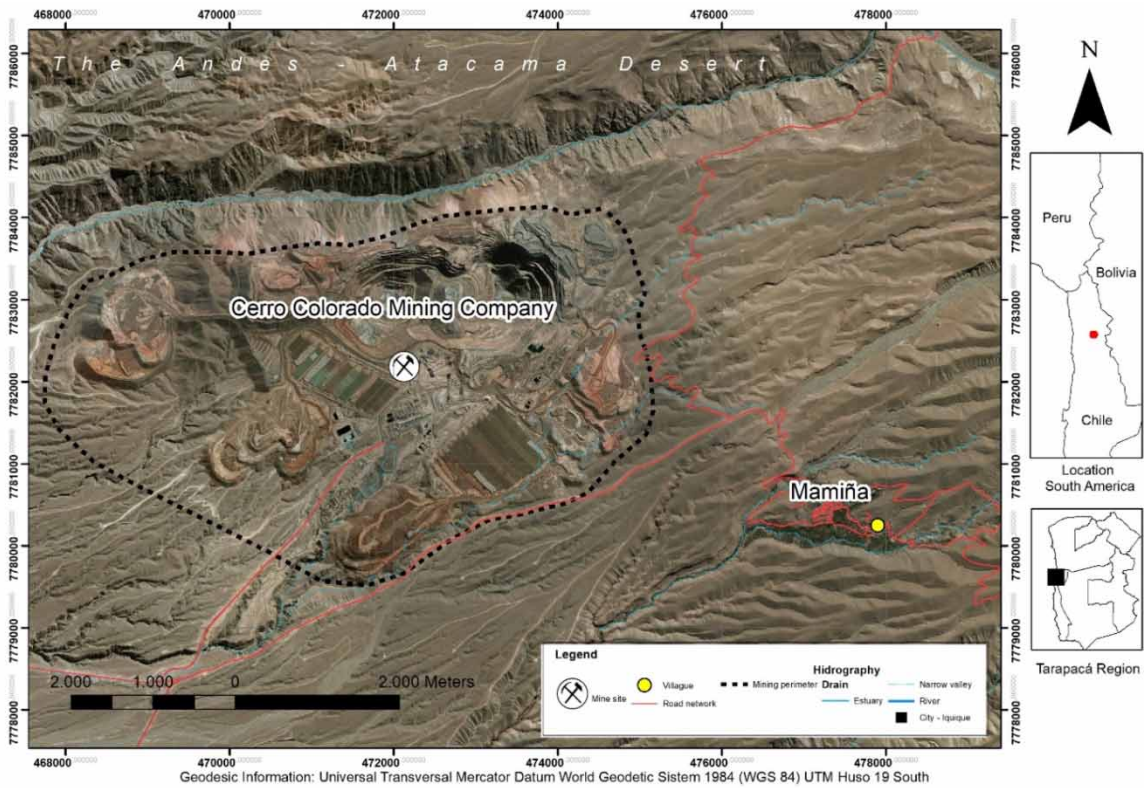


Fig. 3 | Map of the study area. *Source:* Own elaboration.

conflicts, and where the first author would be welcomed. Second, there was a phase of permanent fieldwork from January to June 2020. A series of techniques, such as semi-structured interviews and participant observation, were applied during the different field stays. In total, we conducted 32 interviews with a duration of between 40 and 130 min, without counting the informal conversations held daily. Although the global pandemic due to COVID-19 was in full swing, the sanitary confinement norms in Chile began in May. For this reason, fortunately, the consequences of the pandemic did not affect the fieldwork.

The interview scripts had three large thematic dimensions with an inductive nature to later also facilitate the analysis tasks: (1) the cultural dimension that sought to identify information regarding the interviewee ancestry, involvement in productive vernacular activities and rituals, (2) the water dimension in which we collected data regarding the community's use and management of water and the problems observed by the informants; and (3) the neo-extractivist dimension in which we collected data on the individual's perception of the community's relationship with the mining project, negotiations, disputes, and general impressions. On the other hand, participant observation was applied during the day-to-day and sustained directly with various community members. Some significant activities were related to the carnival: preparation and ornamentation of the spaces for dances and banquets, participation in traditional dances and subsequent recreational activities together with the directors of the El Progreso Society, as the leaders of the celebration are known. The first author participation in recreational bathing afternoons next to the natural and thermal springs was also revealing, at which point a

large part of the information of ontological significance about the waters emerged. Everything allowed us to simultaneously contrast and strengthen the data that were obtained during the interviews.

The information collection on site ended when the data saturation concerning the dimensions investigated and the time frame of analysis was achieved. However, it is difficult to establish a total saturation in problems of social reality that are contemporary and in process of change. Subsequently, the information was processed through the codes and subcodes created from the dimensions mentioned above (ethnic, water, and neo-extractive) and analysed with the qualitative analysis software Nvivo 11. In ethical terms, the European Investigator's Letter guidelines were followed while the written or verbal consent of the informants was always sought, and data were stored in a secure storage centre according to the Autonomous University of Barcelona's Ethics Committee procedure. It should be noted that all the names used correspond to pseudonyms, and the ages indicated are approximate.

3. THE COMMUNITY OF MAMIÑA, HISTORICAL PROCESSES, AND THE NEO-EXTRACTIVIST CONSEQUENCES

In July 1998, the Quechua indigenous community of Mamiña was established. From that moment on, the Mamiñeans began a process of ethno-historical rescue to re-establish the nexus of the practices and customs of their ancestors:

'For us to constitute as indigenous we had to do a study, but according to what they told me, those who formed the community had to carry out an anthropological and archaeological study, and from there, from that, we were registered as Quechuas in the Conadi' (Female, leader, 53 years old).

This ancestry, still unfinished, had been split at different times since the emergence of the nation-state. For example, the annexation of the Tarapacá region to the Chilean territory during the Pacific War (1879–1884) involved a process of forced Chileanisation in which nationalist groups, protected by the state, carried out violent acts against any Peruvian sociocultural expression (González, 2004). This situation also led, in part, to the demoralisation of any Andean cultural practice (Cantillana & Pizarro, 2017). Then, the rural to urban migration (1889–1952) resulted in the abandonment of the Andean town and, consequently, the reconfiguration of indigenous practices in chafe with the processes of modernity and development (Carrasco & González, 2014).⁵ All of these phenomena led to a process that Van-Kessel (2003) called the indigenous Andean cultures' holocaust in progress.

We must remember that the temporal space that we have analysed goes from the formation of the state of Chile in 1810 to the present and that, despite the bicentennial existence of the nation, indigenous peoples still do not have total constitutional recognition. For this reason, the logic of concealment and denial that underlies this entire process seems to be an unofficial policy. The partial or, in some cases, total abandonment of indigenous roots or worldview has been fostered by these ethnocidal policies (Van Kessel, 2003). Faced with this complex scenario, the inhabitants of Mamiña have managed to maintain the traditional community, now facing other more recent problems such as neoliberal policies and the neo-extractive industries.

⁵ Another process that also affected the indigenous communities of the Atacama Desert was the generalisation and virtual denomination of these groups as Aymara. The following process of ethnohistoric rescue and process of indigenous re-identification was known as 'desaymarisation'. This phenomenon is investigated in depth by Romero-Toledo & Sambolín (2019).

For a long time, agricultural and livestock activities were the basis of the Andean people's economy and the essence of their social relations. Since pre-Inca times (15th century), the geography of the Andean Area was structured based on a specialisation of the territory by ecological floors, which at different altitude levels allowed the development of various economic activities. This vertical control (Murra, 1975) also made it possible for human groups to move in order to exchange products and learn other activities through the figure of settlers. For example, the sector of the altiplano and mountain range (3800–5000 masl)⁶ was characterised by specialising in llama grazing, while in valleys and streams (2500–3500 masl), agriculture and the breeding of domesticated species were developed through corrals. In this way, Mamiña has been characterised by two vernacular economic activities; on the one hand, the raising of rabbits, the cultivation of corn and other species; and on the other, the development of self-sustaining tourism concerning its hot springs. Some informants fervently recall that past:

'Mamiña has always had, it can be said, two economic niches: One is agriculture, through the production of alfalfa, garlic, quinces, and the other is their hot springs. They acquired international fame in the nineteenth century. That is why Cardinal Caro,⁷ who had a TB [tuberculosis] came. I do not remember if it was... he got it in Italy or Santiago [Santiago de Chile], but being familiar with the benefits, and with Mamiña's fame, he asked to be transferred and be a pastor of the Mamiña church. He held that position between 1899 and 1900. He was the parish priest of Mamiña. Due to the fame that there was... for the hot spring' (Woman, 22 years old).

'Here they grew, and still a little, onion, garlic, corn, flowers are grown. The flowers are grown here of good quality and are long-lasting... well, they were. Flowers, vegetables, and more are dedicated to raising the rabbit. It is the raising of the rabbit that is what characterizes Mamiña for the spicy rabbit. So, the rabbit is raised more and [is] saleable. It is sold more for the party and everything' (Male, 72 years old).

This whole ecological relationship was fractured at various times, such as in the mercantilist invasion of the Spanish crown and the subsequent emergence of the Creole republics. Even after the annexation of the current territories in the Atacama Desert to the Chilean State, the Andean town has continued with a series of transformations that altered its sociocultural configuration (Van Kessel, 2003).⁸ This new segment of local historiography was recognised by the transformations and peasant integration linked to the industrialisation process (Gundermann & González, 1995). With the help of the analysis of the indigenous integration patterns of (Gundermann & González (2008), we can causally group these historical moments as follows: Industrialisation and the objectives of the modernising state produced a process of (1) de-ruralisation triggered by rural to urban migration, (2) new forms of production and monetary valorisation, (3) de-peasantisation by discrediting the economic relations of the Andean ecology, and (4) finally, these structural changes began the process of translocation. In this process indigenous people who had already relocated their habitual residence to urban centres temporarily returned to their villages, especially for festive cycles. One of the main economic milestones in which these four phases converged was related to the beginning of the capitalist accumulation model applied to nitrate production, extending to the establishment of neoliberalism. Figure 4 shows these transformations along with the current drivers of change that are transforming the landscape: the new extractivism and the water crisis produced by it.

⁶ The altitudes are referential and are represented in approximate values. José Maria Caro (1866–1958) was the first Chilean Archbishop and Cardinal to officiate in the country.

⁷ We use the historiographic periods at the referential level, although we must recognise that the indicated moments are much more complex. This entire time frame can be consulted in the seminal work of Van Kessel (2003).

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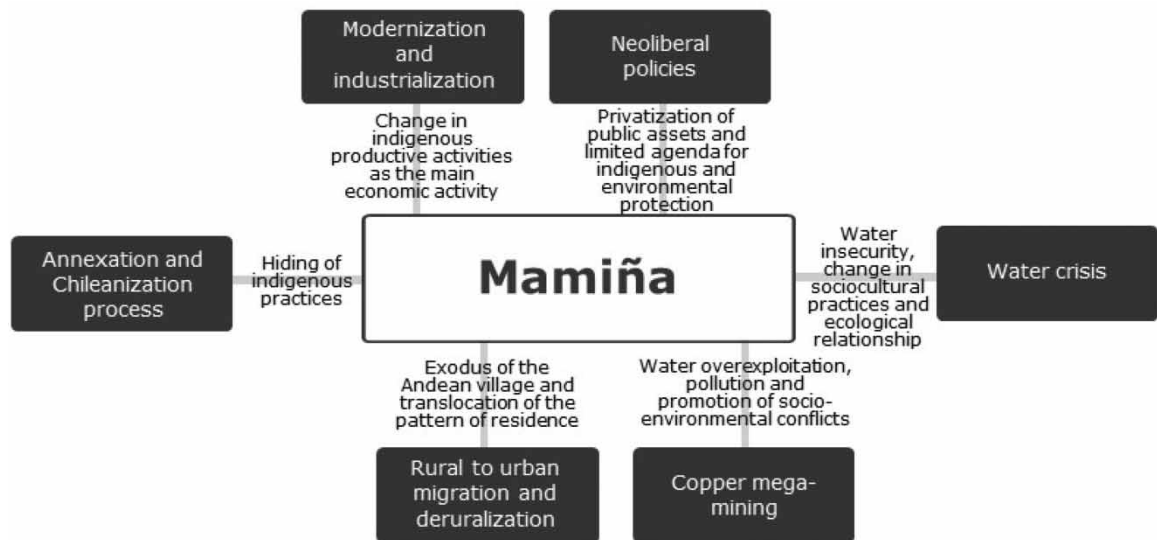


Fig. 4 | Macro-factors affecting the case of Mamiña⁹. *Source:* Own elaboration.

The new extractivism represented by the copper mining activity sharpened an already known experience in the area. This is how these companies moved into an Andean zone that, in general, had already abandoned agriculture as a main economic activity. Mamiña, unlike other nearby indigenous communities, historically complemented its vernacular economy with services associated with its hot springs. The relationship between The Company and the community evolved through time. At first, the industrial mining activity began with pre-feasibility studies accompanied by a philanthropic business relationship, which later became more complex. In these processes, environmental and indigenous laws play a fundamental role, which, even though it only grants partial protection, has led mining companies to create specialised areas for community relations. Even though these measures seem to be disguised as corporate social responsibility, they correspond to reparation programmes for the damage they cause to the socio-environmental landscape. These agreements are entered into with indigenous groups legally recognised by the state and are materialised in various ways. One of them is the direct transfer of money or community development programmes' financing (Babidge, 2013). In particular, the relationship between Cerro Colorado and the community has been described as 'difficult'. Negotiation and dispute processes resulted in mixed feelings in community members regarding possible contributions and threats from The Company: 'Yes, it has contributed to much work, but they did not see the other part; they did not think of that first. In the contamination that was going to occur, or in the water they were going to consume' (woman, 45 years old).

4. RESULT AND DISCUSSION: INTERACTION EFFECTS BETWEEN THE WATER CRISIS AND THE COMMUNITY'S SOCIOCULTURAL BACKGROUND

4.1. The Mamiñean water crisis

Even though Mamiña is in a hyper-arid area, it has hydrogeological conditions that allow it to access freshwater directly throughout the annual cycle. In the village, it is possible to find different groundwater springs used for

⁹ This flow scheme can also be used to analyse other cases in the Andean area.

domestic, agricultural and tourist purposes. These springs are managed by the Mamiñanos themselves through the Water Community, the oldest organisation and legally recognised by the state since the 1930s. This organisation is made up of a representative of the family groups whose participation is for life and can be inherited by direct consanguinity. El Tambo, due to its history and proximity, is one of the community's main springs. A household distribution network runs through this source, and there is also an accumulation pond used for agricultural and livestock activities. The community carried out both constructions, although improvements have been made through external economic aid over time. The allocation for domestic use is available freely, while the allocation for productive vernacular activities is distributed by timetable, property, and type of crop. We have not been able to obtain the exact amount of water rights held by the community through public information, and the community has requested to not disclose this data. In practice, however, we have observed consumption of the flow that in quantity and continuity is sufficient to cover domestic uses. In contrast, it is more cyclical for productive uses according to the filling of the accumulation ponds (Figure 4). On the other hand, there are no hydrometric data to know the evolution of groundwater flow. On the contrary, local knowledge has helped the community be aware of the possible impacts of water stress caused by natural and anthropogenic factors on their water reserves.

The close bond between the community and the water has been extended through generations. The Mamiñeans enjoyed an autarkic water security due to their direct and continuous access, in which diverse ontologies emerged. It is possible to recognise the symbolic vision of water-related to the Quechua worldview in which the waters represent a fraction of the *Pachamama*, that is what they call 'mother earth'. In addition to this sacramental condition firmly integrated into their discourses, there is a strong material link, reinforced in a particular way by its thermal springs that provide water for different uses:

'Water is everything, water, and land, they go hand in hand. Our community and our indigenous world are nothing without it. If they take away the water that we get from the land, if we cannot irrigate it, we cannot grow our crops. We are going to die, we are going to die ourselves as a people, we are going to disappear together with hot springs' (Male, 50 years old).

Despite having direct access to water, the quantity and continuity of the resource have been interrupted for various reasons that we will be addressing in short. Through these interruptions, Mamiñeans began to notice the biophysical dimension of the crisis, not as an endemic problem but, due to its geographical particularities, as a local issue. At the general level of the Atacama Desert, the community recognizes mining projects as the leading cause of the overconsumption of water. The resulting impacts are visible, for example, through the drying up of the gullies. Nevertheless, they do not seem to believe that these are problems that affect them directly, mainly because they believe that since they have not traded their water rights to the mining projects, their resources are not at immediate risk. However, local problems, also promoted by external actors, would be the events that raise the alarm about the conditions of the crisis: 'Here there are problems with water: One, for example, is that they [mining company] came to set up their camp here, they have many miners, and we lack water (...). Every day there is more water shortage. The spring is no longer giving water...'. (Female leader, 60 years old).

Considering the proximity of the mining project and the decades that it has been operating in the area, it was only until the arrival of these agents at the village that the community began noticing its water crisis. A few years ago, the company started demanding lodging services for its employees directly in Mamiña. The use of the village as a temporary dormitory for the company led to explosive growth in the number of hotels to meet this demand, which raised the community's alarm:

‘So, I always say that we, ourselves, are also to blame here, I have always said: the leaders, we are to blame, because we [could say] -no and no more, there is no more-. Because the waters are registered, not in the name of the [indigenous] Community but in the name of an organisation called the Water Community. The Mamiñeans are the owners of the water, so we would also have to set the rules and say: no, gentlemen. How many times have I said: -we must take care of the water-? With all this climate change, with the earthquakes, with mining, it is as if the water flow is decreasing (...) so these are signs that we must take care of the water’ (Female leader, 60 years old).

This activity caused one of the main services focused on tourists, as specific users, to shift towards the miners. This situation is the opposite of community tourism services historically offered by the group through approximately three hotels, plus the lodging services in their homes. The community is aware that, contrary to the touristic activity, the contracts signed with the mining company ensure income for prolonged periods. In this context, the current waterscape and its problems are the subjects of disputes at the micro-social level. The change in the territory vocation is due to this reason; however, most of the hotels created for the mine employees are not owned by the indigenous Quechua Mamiñeans, but by new group members, indigenous and non-indigenous people. The communitarian explanation is that most of these new subjects of the local space do not have a direct and close relationship with the ‘land’ of Mamiña and its sacred waters. In addition, the Mamiñeans are aware of the excessive consumption of water by the hotels. Despite the lack of hydrometric data to accurately know each group of consumers’ level of consumption, the company’s employees sometimes quadrupled the Mamiñean population (approximately 200 people). All of this is recounted in the following interview excerpt:

‘Although there are miners and many hotels that work with mining, those who run those hotels and earn that money are not all Mamiña. They are not directly part of the community. Or they are not from Mamiña. Let us start with that. They are people who chose to live in Mamiña because they liked the town and thought they would come for a house, then build a small farm to make a hotel. A clear example of that is Carlos. He is not from here, and with my aunt, they came here many years ago. They worked as handicrafts, and they had cattle and...all those things. After some time, it became clear that Mamiña was also a tourist place to earn money and that’s why people came. Now there is mining, and their hotel has grown to such a large scale that they no longer receive tourists. Where is the priority? -let us go to somewhere safe, where they pay you monthly (...) It is a safe bet. Imagine... about the water, there are so many people that in hours of the day almost no water course out’ (Female, 25 years old).

These events, which the community has identified as direct attacks on their water security, have been diagnosed based on day-to-day experiences. Interaction with the environment is the key cornerstone of local knowledge (Thompson *et al.*, 2020), through which people have integrated different values to measure changes in their environment. In contexts where hydrogeological data are as scarce as the resource, these sociocultural indicators are essential for identifying environmental impacts. At the local level, water availability for domestic use relativises the stress placed on the community’s water resources. This situation is associated with the temporal increase in external users, which leads to a drop in water pressure in the highest sectors of the town and occasional cuts in other areas due to a decrease in water flow. Concerning the use of water for productive activities, it has also been possible to observe a reduction in the flow rate due to the time it takes to fill the reservoirs. One of these accumulation ponds (Figure 5), for example, used to reach its maximum after 2-day intervals, and now it could take up to 4 days to fill up. During some recreational bathing days in these ponds, the Mamiñeans used to recall memories of how this place always used to have water.



Fig. 5 | Accumulation pond for productive activities. *Source:* Own elaboration.

4.2. Basis for the negotiations and the projection of the water crisis

The corporate philanthropy that the mining industry developed at the time of the first contact with the communities was crucial for establishing a bond. The Mamiñeans remember the first actions of The Company as support to the construction of roads or maintenance of community infrastructure. Searching for minerals through drilling was not new in the Atacama Desert, which had already developed an important saltpetre industry before the first half of the 20th century (Donoso, 2018; Méndez, 2021). In fact, the relationships that were established at that time with the officials of the drilling companies are recalled as collaborative, even recalling their participation in community activities such as the carnival cycle. This was a crucial issue considering that mutual aid and cooperation are the basis of social relations in the Andean communities (Montes, 1989)¹⁰. In general, the consequences of the extractive incursion in their territories were not yet visible to the community. Consequently, this link starts to break when, with the indigenous and environmental protection laws, a political reorganisation of the indigenous world began (Romero-Toledo & Sambolín, 2019). The emergence of state-recognised indigenous communities was one of these factors. This new form of organisation forced the groups to abandon the traditional logic to group it through a socio-political organisation functional to the State. The Indigenous Community of Mamiña obtained this legal recognition in 1998. This rise of new and bureaucratic indigenous communities was concomitant with the boom of the copper industry in the early 2000s (Solminihac *et al.*, 2018). Throughout this time segment, the industry moves from drilling and pre-feasibility studies to open-pit mining excavations that made

¹⁰ Support and collaboration are not understood from an essentialist point of view but from the material reciprocity of actions.

visible, on the one hand, the magnitude and extension of this new form of extraction, and on the other, its profitability. The eventual relationship produced by corporate philanthropy no longer had any cooperative support, evidencing the place of the mining company as an external agent that made occupation and usufruct of a landscape that did not belong to them.

The indigenous and environmental laws, despite their insubstantiality, made it possible for new mining projects to undergo environmental impact assessment processes, including indigenous consultation processes (Mirosevic, 2011). The consultative and non-resolutive character of these processes is a characteristic of their slight progress since there were no consequences to prevent the development of a project. Above all, considering that the consultations are held only and when they are within the project's area of interest, an impact could be generated on the indigenous landscape. Nonetheless, only for organisations recognised by the State. There was a panorama without legal protection in the indigenous territories in which mining projects had already been installed. This situation affected Mamiña as well as it probably did the entire Andean area. For example, one of the political organisations was unaware of the legal procedures to protect the few rights that the State granted them. At the same time, they confronted an industry with substantial resources and structural policies that facilitated their functioning. One leader recalled:

'I had to learn, to train myself, because they came with their professionals with strange words, and we did not understand anything. But not anymore. Now we stand strong (...) they are always one step ahead of us because they have everything, resources, they have everything' (woman, leader, 60 years old).

For this reason, the negotiation processes between the mining company and the community emerged in a context where the neoliberal structure encumbered the indigenous agency. In this regard, corporate social relations, managed mainly by the community relations area, represents the functionality of a mining company office focused on controlling socio-environmental conflicts¹¹. The negotiations for the compensation of socio-environmental damage in no case protected or respected indigenous communities. The agents of this office, who have experience and even some training in anthropology to facilitate the functionality of the contact, established different types of quasi-clientelist relationships. They contribute materially to different needs observed in the village or directly to requests from the community, having a more immediate resolution than public services. Some of these actions are very similar to the corporate philanthropy developed at the beginning of The Company, as they continued to improve community infrastructure. Some agreements were reached in the context of the Environment Qualification Resolution. The Company undertook the financing, among other, programmes for education, development, tourism, and infrastructure. The community conceives the nature of these relationships as an obligation of The Company to contribute to the territory they are damaging. This type of arrangement has been based on the most immediate needs of the Andean population. In fact, in a recent research on conflicts caused by this same mining company in other communities, monetary valuation of compensation was crucial for achieving judicial and extrajudicial settlements in which the direct beneficiary was the company itself (Romero-Toledo *et al.*, 2017; Escalona-Thomas, 2020). This company benefited both from the evasion of judicial processes and from the creation of community conflicts that diverted the agency of the indigenous groups.

Placing these antecedents in a socio-historical perspective shows in a better way that the phenomena that occur concerning neo-extractive projects are not due to immediate consequences of their operation but to transversal structural processes. Thus, at the community level, the negotiations produced conflicts between members of

¹¹ This phenomenon was analysed in depth in another case study of the Atacama Desert by Babidge (2013).

the indigenous communities due to the use and scope of the money received for this compensation. These disputes, at times, have led to the formation of other types of state-recognised indigenous organisations that operate in the same territory. The actions of suppressing community cohesion statuses and sustaining uncertainty in hydrogeological information (Babidge, 2019) would be some of the strategies of the industry to maintain control. On some occasions, communities were able to apply repertoires of direct action. For example, some forms of mobilisation have been, among others, street protests, public campaigns, lawsuits, court cases, and judicial activism (Environmental Justice Atlas, 2020). Despite these actions, the community has not been able to organise cohesively with the other communities in the area, mainly due to differences in the consultation and negotiation processes with the mining company. In particular Mamiñeans think highly about how other indigenous groups in other areas of southern Atacama have grouped. This is the case of the Council of Atacameño peoples, an organisation that brings together the Likan-antay, which has enabled them to confront injustice processes cohesively (Bolados & Babidge, 2017).

‘The first consultation caught us in the cold, as they say. The [state] did an indigenous consultation with a big guy [mining company] with all the money and we had nothing. The state sent us to carry out an indigenous consultation without resources, without anything. In other words, each community defended itself with what it had. But enough is enough. We are already prepared; we are well organised. We know how to defend ourselves. Before, people did not know what an indigenous consultation was, nor what the rights were, it caught us all off guard. Now people know, at least I know. At least I know, and I know how to get money out of them because that is what the struggle is like’ (Female leader, 65 years old).

‘Norma is very clear about it, but she does not have enough support and the other thing that exhausts her a lot is the same division that exists in the community. There was a fight there over the same mining issue. Because they want to... Norma fights for the community, but she has members of the same community on the board that wanted to negotiate directly with Cerro [Colorado], which implied the death of the valley in that scenario. So, it still exhausts her. (...) I wish we had the organisation of the Council of Atacameño Peoples’ (Female, 30 years old).

In their disputes over control and usufruct of territory, these unequally saturated relationships of power and control reflect the beginning of the relationship between the mining project and the indigenous communities. Despite this complex panorama, a stigma has been erected at the regional level for those communities that negotiate with mining projects, being labelled as ‘sell-out communities’ even within the indigenous population. This situation contributes to identity self-questioning but has also allowed the community members to analyse the processes and contexts of the dispute. This fact was recurrent in the interviews and conversations during the fieldwork. The informants narratively remembered the processes of affectation, evoking state vulnerability, and the lack of environmental policies that did not allow them to learn about mining’ consequences until it was already fully operational: ‘They told me: -no, yes, Mamiña was sold. But when I was born, the mining company was already installed. The mining companies were there long before. My parents had no idea what to do until it was already installed and operating...there were no laws or anything’ (Male, 23 years old). Therefore, the environmental degradation caused in conjunction with the deterioration of the common goods are a consequence that, in no case, should be imputed to these local collective actors.

Finally, the expectations shared by Mamiñeans in the face of the crisis are not very encouraging:

‘I do not visualise Mamiña in 20 years more, I do not feel it, I do not see it. That is to say, I do not visualise it because I believe that the mining company is coming with more strength. It is coming with a second project

more extensive than the one we have, than the one it has now. The hotels are preparing for that, they are expanding, and it will be more of a crisis than what we have now, more critical' (Male former leader, 66 years old).

5. FINAL CONSIDERATIONS

The water crisis is a direct cause of the depletion of water sources (International Conference on Water & the Environment, 1992). This has spread the idea that a water crisis only exists when water is exhausted. However, the case of the Atacama Desert in general, and that of Mamiña in particular, shows how the water crisis is socio-culturally constructed in a hyper-arid area with natural problems of water availability. The Mamiñean have faced an invisible crisis, living next to a mega-mining project with intensive water use and deficient public hydrogeological data. Water becomes scarce in the Atacama Desert by its accelerated depletion by industrial activities. Yet, in Mamiña its crisis is not brought about directly by these issues but by the actions that derive from its overexploitation. For the Mamiñeans, water grabbing by external agents was not the main trigger for the conflicts and the crisis, as it has been in other cases in the Atacama Desert (e.g., Budds, 2010; Prieto, 2015; Babidge, 2019; Prieto *et al.*, 2019). In fact, by not trading, leasing, or selling their water resources to The Company, they assumed they were unburdened by from the impacts of overexploitation for years. This situation strengthened the feeling of collective property. Water injustice here has not become manifest through large or violent conflicts but as Boelens *et al.*, (2018) pointed out it has occurred in less visible ways. WJ highlights these minus evident issues that are better understood from a situated and everyday examination, especially when there are scenarios with overpowering structures such as neo-extractive activities (Zwarteveen & Boelens, 2011b). In Mamiña, the disruptions of water security constitute the principal cause through which, beyond hydrogeological projections, the existence of the crisis is represented. The context of the water crisis as a phenomenon is complex, especially when depicting that their interactions differ in a same socioecological area.

The sociocultural and productive combinations resulting from the water crisis have directly affected the daily life processes of the desert inhabitants. They have redefined their cultural patterns for subsistence in a society highly focused on commodification and individual capitalisation of goods and resources. This phenomenon has also produced simultaneous actions of negotiation and dispute for the control of water and territory, both among its inhabitants and between the inhabitants and external agents. Such resistance processes also allow us to observe contradictions linked to the perception of water as a vital element or exploitable resource. The fact that the Mamiñeans have not achieved cohesion to eventually face the crisis is also related to the trickery of neo-extractivism and reductionist laws. This has taken place internally, owing to the differences between who is a Mamiñean and who is not, and external conditions such as the *divide et impera* strategies applied by The Company in the context of the negotiations. In fact, the leaders think highly of the organisation achieved in the southern part of the Atacama Desert by the Council of Atacameño Peoples (Bolados & Babidge, 2017; Babidge, 2021). Apparently, in the study area, the centuries-old policies of cultural negationist and the top-down imposition of new forms of organisation for the indigenous world have had more intricate repercussions. Nevertheless, the indigenous people, and human groups in general, do not constitute static units but interact with the factors of their environment to integrate or resist them according to their individual and collective experiences. In contrast to what Prieto (2021) observed among other inhabitants of the Atacama Desert who, mobilised by the dispossession of their water, have used the resurgence of indigenous identity to contradict the mercantile logics of overexploitation and commodification of nature; in Mamiña we see how some kind of water security forged a scenario of tranquillity and momentarily made the water crises invisible. The adverse environmental effects of this whole web are also invisible through poor hydrological information. Babidge (2021), as in Mamiña, analysed in other areas of the Atacama how, through ecological relationships, desert

dwellers understand and signify the dryness of their desert areas. In the case of Turi, where there is also an extractive company, hydrogeological data are scarce and often highly technical, yet these communities resist the scarcity of information and water technicalities (Babidge, 2021). Further on, the investigation of the crisis should pay attention to its identification and likewise recognise the processes that complexify the interaction that communities can have with it.

The water crisis should be articulated with the intersections of economics, politics, and history: A model based on the contributions of the WJ, whose application should be from a global and situated approach for the investigation of contexts in crisis. In the case of Mamiña, the crisis is one of the latest problems to affect the study area. Not only has it endured a problem of governance but also a major structural and historical problem, which has kept going on since the beginning of the republic. The debate on water use and management in Chile has emphasised the consequences of the neoliberal agenda and has empirically questioned the contradictions of Chilean governance (Cantillana, 2020). This debate must now move towards the particularities of the crisis to contribute to water security frameworks. In Mamiña, a series of values at diverse levels that are disruptive face each other. For example, the indigenous water values are different from the neoliberal values. However, both are in constant competition within the indigenous communities: on the one hand, the cosmogonic questions and on the other, the pragmatic questions linked to the survival of the groups. Going deeper into this problem is key to broadening the debate on the water crisis since restoring this link would eventually help possible integrated management of the crisis.

Finally, despite Chile's progress in socio-environmental protection policies, its prevailing economic model continues to be applied and is protected by an existing constitution. Exacerbating the importance of private property renders insubstantial any legal instrument focused on the common social welfare. The country is currently undergoing a constitutional process that might initiate a political process to reverse this situation, beginning by ending the private water model. We suggest the assembly members guarantee water resources as a common good for public use and secure natural sources of surface and underground freshwater for domestic consumption and the traditional sociocultural activities of indigenous groups. We also suggest that the main starting point would be the constitutional recognition of indigenous groups, their territory and self-determination. To move away from any indigenous essentialism, constituents should consider that indigenous groups constitute dynamic entities able to incorporate minorities and manage local resources. It is well known that Chile is a coastal country where mining is the main economic activity, which could facilitate the implementation of sustainable alternatives to ensure these water-intensive processes. One of them could be the mandatory use of desalinated water for industrial activities. On the other hand, it is crucial to consider the sociocultural dimension of environmental decisions to manage the negative perception of these alternatives on the use of desalinated water and thus avoid what has happened recently in some dry areas of the country (Villar-Navascués & Fragkou, 2021). In this case, it was expected that the use of desalinated water would be for industrial processes, but finally, the administration destined it for human consumption.

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DATA AVAILABILITY STATEMENT

Data cannot be made publicly available; readers should contact the corresponding author for details.

CONFLICT OF INTEREST

The authors declare there is no conflict.

REFERENCES

- Aitken, D., Rivera, D., Godoy-Faúndez, A. & Holzapfel, E. (2016). Water scarcity and the impact of the mining and agricultural sectors in Chile. *Sustainability* 8(2), 128. doi:10.3390/su8020128.
- Albó, X. (2000). Aymaras entre Bolivia, Perú y Chile (Aymaras people between Bolivia, Peru, and Chile). *Estudios Atacameños* (19), 43–74. doi:10.22199/S07181043.2000.0019.00003.
- Aldunate, C. (1985). Deseccación de las Vegas de Turi (Drainage of Vegas de Turi). *Chungara Revista de Antropología Chilena* 14, 135–139.
- Babidge, S. (2013). ‘Socios’: the contested morality of ‘partnerships’ in indigenous community–mining company relations, northern Chile. *Journal of Latin American & Caribbean Anthropology* 18(2), 274–293. doi:10.1111/jlca.12020.
- Babidge, S. (2016). Contested value and an ethics of resources: water, mining and indigenous people in the Atacama Desert, Chile. *The Australian Journal of Anthropology* 27(1), 84–103. doi:10.1111/taja.12139.
- Babidge, S. (2019). Sustaining ignorance: the uncertainties of groundwater and its extraction in the Salar de Atacama, northern Chile. *Journal of the Royal Anthropological Institute* 25(1), 83–102. doi:10.1111/1467-9655.12965.
- Babidge, S. (2021). Seeing water: slow resistance and the material enigma of extractive effects on society and ecology. *Hau: Journal of Ethnographic Theory* 11(2), 395–411. doi:10.1086/715788.
- Bauer, C. (1997). Bringing water markets down to earth: the political economy of water rights in Chile, 1976–1995. *World Development* 25(5), 639–656.
- Bauer, C. (2008). The experience of Chilean water markets. In: Bauer, C. (ed.). *Expo Zaragoza: Water Economics and Financing*. Expo Zaragoza, Zaragoza, pp. 1–11.
- Bengoa, J. (2004). *La memoria olvidada (Forgotten Memory)*. Comisión Bicentenario, Santiago de Chile.
- Boelens, R., Perreault, T. & Vos, J. (2018). *Water Justice*. Cambridge University Press, Cambridge.
- Bolados, P. & Babidge, S. (2017). Ritualidad y extractivismo. La limpieza de canales y las disputas por el agua en el Salar de Atacama – norte de Chile (Rituality and extractivism. The cleaning of canals and disputes over water in the Salar de Atacama – northern Chile). *Estudios atacameños* (54), 207–216. doi:10.4067/S0718-10432016005000026.
- Bottaro, L., Latta, A. & Sola, M. (2014). La politización del agua en los conflictos por la megaminería: Discursos y resistencias en Chile y Argentina (The politicisation of water in mega-mining conflicts: discourses and resistance in Chile and Argentina). *Revista Europea de Estudios Latinoamericanos y del Caribe* (97), 97–115. doi:10.2307/23972442.
- Budds, J. (2004). Power, nature and neoliberalism: the political ecology of water in Chile. *Singapore Journal of Tropical Geography* 25(3), 322–342.
- Budds, J. (2009). Contested H₂O: science, policy and politics in water resources management in Chile. *Geoforum* 40(3), 418–430. doi:10.1016/j.geoforum.2008.12.008.
- Budds, J. (2010). Water rights, mining and indigenous groups in Chile’s Atacama. In: Boelens, R., Getches, D. & Guevara, J. (eds). *Out of the Mainstream: Water Rights, Politics and Identity*. Earthscan, London, pp. 197–211.
- Cantillana, R. (2020). Los estudios del agua en Chile: revisión y perspectivas críticas (Water research in Chile: review and critical perspectives). *Tecnología y Ciencias del Agua* 11(6), 61–93. doi:10.24850/j-tyca-2020-06-03.
- Cantillana, R. & Pizarro, E. (2017). Chanavaya o Puerto Inglés: su pasado histórico en el ciclo productivo del guano en el Norte Grande de Chile (Chanavaya or Puerto Inglés: its historical past in the guano production cycle in the North of Chile). In: Pizarro, E. (ed.). *Tránsitos Historiográficos. Arica y su hinterland (siglos XVI-XX)*. Ediciones Universidad de Tarapacá, Arica, pp. 105–120.
- Carrasco, A. (2009). Estrategias de resistencia indígena frente al desarrollo minero. La comunidad de Likantatay ante un posible traslado forzoso (Strategies of indigenous resistance to mining development. The Likantatay community in the face of a possible forced relocation). *Estudios Atacameños* 38, 75–92.

- Carrasco, A. (2016). A biography of water in Atacama, Chile: two indigenous community responses to the extractive encroachments of mining. *Journal of Latin American and Caribbean Anthropology* 21(1), 130–150. doi:10.1111/jlca.12175.
- Carrasco, A. M. & González, H. (2014). Movilidad poblacional y procesos de articulación rural-urbano entre los aymara del norte de Chile (Population mobility and processes of rural-urban articulation among the Aymara people of northern Chile). *Si Somos Americanos* 14(2), 217–231. doi:10.4067/s0719-09482014000200009.
- Castro, M. (1992). *Cultura hídrica: un caso en Chile (Water Culture: A Case in Chile)*. Oficina Regional de Cultura para América Latina y el Caribe – ORCAL, La Habana.
- Castro, M. & Quiroz, L. (2011). ‘La crisis del agua en Chile: «el futuro de Chile requiere una nueva política de agua» (Chile’s future requires a new water policy)’. In: Boelens, R., Cremers, L. & Zwartveen, M. (eds). *Justicia hídrica. Acumulación, conflicto y acción social*. Instituto de Estudios Peruanos, Fondo Editorial PUCP, Lima, pp. 225–240.
- Cook, C. & Bakker, K. (2012). Water security: debating an emerging paradigm. *Global Environmental Change* 22(1), 94–102. doi:10.1016/j.gloenvcha.2011.10.011.
- Donoso, C. (2018). Los albores de la industria salitrera en Tarapacá (The beginnings of the saltpetre industry in Tarapacá). *Chungará (Arica)* 50(3), 459–470. doi:10.4067/S0717-73562018005001402.
- Escalona-Thomas, D. (2020). La negociación en los conflictos ambientales y su implicancia en el desarrollo local: caso de la comunidad aymara de Cancosa (Negotiation in environmental conflicts and their implications for local development: the case of the Aymara community of Cancosa). *Diálogo andino* (61), 81–91. doi:10.4067/s0719-26812020000100081.
- Gayo, E. M., Latorre, C., Jordan, T. E., Nester, P. L., Estay, S. A., Ojeda, K. F. & Santoro, C. M. (2012). Late quaternary hydrological and ecological changes in the hyperarid core of the northern Atacama Desert (~21 °S). *Earth-Science Reviews* 113(3), 120–140. https://doi.org/10.1016/j.earscirev.2012.04.003.
- Gentes, I. (2000). Culturas étnicas en conflicto (Ethnic cultures in conflict). *Revista Américas* 16(4), 7–50.
- González, S. (2004). *El dios cautivo. Las Ligas Patrióticas en la chilenización compulsiva de Tarapacá (1910–1922) (The Captive God. The Patriotic Leagues in the Compulsive Chileanisation of Tarapacá (1910–1922))*. LOM Ediciones, Santiago de Chile.
- Gudynas, E. (2010). *The new Extractivism of the Twenty-First Century: Ten Urgent Theses About Extractivism in Relation to Current South American Progressivism*. Center for International Policy, Washington, DC.
- Guerrero, V. (1998). Minería y asentamientos humanos (Mining and human settlements). *Revista de Ciencias Sociales* 8, 15–31.
- Gundermann, H. & González, H. (1995). Tierra, agua y sociedad atacameña, un escenario cambiante (Land, water and Atacameñean society, a changing stage). In: Pourrut, P. & Núñez, L. (eds). *Agua, ocupación del espacio y economía campesina en la región atacameña: aspectos dinámicos*. UCN-Orstom, Antofagasta.
- Gundermann, H. & González, H. (2008). Pautas de integración regional, migración, movilidad y redes sociales en los pueblos indígenas en Chile (Patterns of regional integration, migration, mobility and social networks in indigenous peoples in Chile). *Universum* 1 (23), 82–115. https://doi.org/10.4067/S0718-23762008000100006.
- Hammersley, M. & Atkinson, P. (2019). *Ethnography. Principles in Practice*, 4th edn. Routledge, London.
- Harvey, D. (2005). *A Brief History of Neoliberalism*. Oxford University Press, Oxford.
- Hendriks, J. (1998). Water as private property: notes on the case of Chile. In: Boelens, R. & Dávila, G. (eds). *Searching for Equity: Conceptions of Justice and Equity in Peasant Irrigation*. Van Gorcum, Assen, pp. 297–309.
- Hickel, J. (2017). *The Divide: A Brief Guide to Global Inequality and its Solutions*. Penguin Random House, London.
- Larraín, S. (2006). El agua en Chile: entre los derechos humanos y las reglas del mercado (Water in Chile: between human rights and market rules). *Polis Revista Latinoamericana* 14, 1–11.
- Licteuvout, E. & Faysse, N. (2018). ‘A doubly invisible aquifer: hydrogeological studies and actors’ strategies in the Pampa del Tamarugal Aquifer, Northern Chile’. *Water Alternatives* 11(3), 592–606.
- Méndez, M. (2021). Genealogy of mining territories in the Atacama Desert: the production of modern waterscapes in Tarapacá region, northern Chile (1853–1924). *Extractive Industries and Society* 8(1), 111–122. doi:10.1016/j.exis.2020.05.003.
- Mirosevic, C. (2011). La participación ciudadana en el procedimiento de evaluación de impacto ambiental y las reformas introducidas por la Ley N° 20.417 (Citizen participation in the environmental impact assessment procedure and the reforms introduced by Law No 20.417). *Revista de derecho (Valparaíso)* (36), 281–323. doi:10.4067/S0718-68512011000100008.
- Montes, Á. (1989). *Simbolismo y poder (Symbolism and Power)*. Anthropos, Barcelona.
- Murra, J. (1975). *Formaciones económicas y políticas del mundo andino (Economic and Political Formations of the Andean World)*. IEP, Lima.

- Núñez, L. (1965). Prospección arqueológica en el norte de Chile (Archaeological prospection in northern Chile). *Estudios Arqueológicos* 1, 9–35.
- Núñez, L. & Pourrut, P. (1995). *Agua, ocupación del espacio y economía campesina en la región atacameña (Water, Occupation of Space and Peasant Economy in the Atacameño Region)*. Universidad Católica del Norte, Antofagasta.
- Prieto, M. (2015). Privatizing water in the Chilean Andes: the case of Las Vegas de Chiu-Chiu. *Mountain Research and Development* 35(3), 220–229. doi:10.1659/MRD-JOURNAL-D-14-00033.1.
- Prieto, M. (2016a). Bringing water markets down to Chile's Atacama Desert. *Water International* 41(2), 191–212. doi:10.1080/02508060.2015.1107400.
- Prieto, M. (2016b). Practicing costumbres and the decommodification of nature: the Chilean water markets and the Atacameño people. *Geoforum* 77, 28–39. doi:10.1016/j.geoforum.2016.10.004.
- Prieto, M. (2017). El Riego que el Mercado no Quiere Ver: Historia del Despojo Hídrico en las Comunidades de Lasana y Chiu-Chiu (Desierto de Atacama, Chile) (The irrigation that the market does not want to see). *Journal of Latin American Geography* 16(2), 69–91. doi:10.1353/lag.2017.0022.
- Prieto, M. (2021). Indigenous resurgence, identity politics, and the anticommodification of nature: the Chilean water market and the Atacameño people. *Annals of the American Association of Geographers*, 1–18. In press. doi:10.1080/24694452.2021.1937036.
- Prieto, M., Salazar, D. & Valenzuela, M. (2019). The dispossession of the San Pedro de Inacaliri river: political ecology, extractivism and archaeology. *The Extractive Industries and Society*, 1–11. In press. doi:10.1016/j.exis.2019.02.004.
- Rodríguez-Labajos, B. & Martínez-Alier, J. (2015). Political ecology of water conflicts. *WIREs Water* 2(5), 537–558. doi:10.1002/wat2.1092.
- Romero-Aravena, H., Méndez, M. & Smith, P. (2012). Mining development and environmental injustice in the Atacama Desert of Northern Chile. *Environmental Justice* 7(2), 70–76. doi:10.1089/env.2011.0017.
- Romero-Aravena, H., Romero-Toledo, H. & Opazo, D. (2018). Topoclimatología cultural y ciclos hidrosociales de las comunidades andinas chilenas (Cultural topoclimatology and hydro-social cycles in Chilean Andean communities). *Cuadernos de Geografía: Revista Colombiana de Geografía* 27(2), 242–261. doi:10.15446/rcdg.v27n2.66599.
- Romero-Toledo, H. (2018). Agua, extractivismo y etno-territorialidades: los aymara y los mapuche en Chile (Water, extractivism and ethno-territorialities: the Aymara and the Mapuche in Chile). In: Romero-Toledo, H. & Ulloa, A. (eds). *Agua y disputas territoriales en Chile y Colombia*. Universidad Nacional de Colombia, Facultad de Ciencias Humanas, Departamento de Geografía, Bogotá, pp. 57–84.
- Romero-Toledo, H. & Sambolín, A. (2019). Indigeneidad y territorio: los aymaras y quechuas en el Norte de Chile (Indigeneity and territory: the Aymara and Quechua in Northern Chile). *Scripta Nova* 23(611), 1–32.
- Romero-Toledo, H., Videla, A. & Gutiérrez, F. (2017). Explorando conflictos entre comunidades indígenas y la industria minera en Chile: las transformaciones socioambientales de la región de Tarapacá y el caso de Lagunillas (Exploring conflicts between indigenous communities and the mining industry in Chile). *Estudios Atacameños* 55, 231–250.
- Solminihaç, H. D., Gonzales, L. E. & Cerda, R. (2018). Copper mining productivity: lessons from Chile. *Journal of Policy Modeling* 40(1), 182–193. doi:10.1016/j.jpolmod.2017.09.001.
- Sultana, F. (2018). Water justice: why it matters and how to achieve it. *Water International* 43(4), 483–493. doi:10.1080/02508060.2018.1458272.
- Svampa, M. (2015). Commodities consensus: neoextractivism and enclosure of the commons in Latin America. *South Atlantic Quarterly* 114(1), 65–82. doi:10.1215/00382876-2831290.
- Taylor, S., Bogdan, R. & DeVault, M. (2016). *Introduction to Qualitative Research Methods: A Guidebook and Resource*, 4th edn. Wiley, New York.
- Thompson, K., Lantz, T. & Ban, N. (2020). A review of indigenous knowledge and participation in environmental monitoring. *Ecology and Society* 25(2), 10.
- Uribe, M. (2006). Acerca de complejidad, desigualdad social y el complejo cultural Pica-Tarapacá en los Andes Centro-Sur (1000–1450 DC) (On complexity, social inequality and the Pica-Tarapacá cultural complex in the Central-Southern Andes (1000–1450 AD)). *Estudios atacameños* (31), 91–114. doi:10.4067/S0718-10432006000100007.
- van Kessel, J. (1985). La lucha por el agua en Tarapacá; la visión andina (The struggle for water in Tarapacá; the Andean vision). *Chungara. Revista de Antropología Chilena* 14, 141–155.
- Van Kessel, J. (2003). *Holocausto al progreso: los aymaras de Tarapacá (Holocaust of Progress: the Aymara of Tarapacá)*, 4th edn. IECTA, Iquique.

- Vergara, I., Gundermann, H. & Foerster, R. (2006). Legalidad y legitimidad: ley indígena, Estado chileno y pueblos originarios (1989–2004) (Legality and legitimacy: indigenous Law, the Chilean State and Indigenous peoples (1989–2004)). *Estudios sociológicos* 24(71), 331–361.
- Viguié, B., Jourde, H., Leonardi, V., Daniele, L., Batiot-Guilhe, C., Favreau, G. & De Montety, V. (2019). Water table variations in the hyperarid Atacama Desert: role of the increasing groundwater extraction in the pampa del tamarugal (Northern Chile). *Journal of Arid Environments* 168, 9–16. <https://doi.org/10.1016/j.jaridenv.2019.05.007>.
- Villar-Navascués, R. A. & Fragkou, M. C. (2021). Managing water scarcity futures: identifying factors influencing water quality, risk perception and daily practices in urban environments after the introduction of desalination. *Water* 13(19), 1–15. doi:10.3390/w13192738.
- Yáñez, N. & Molina, R. (2011). *Las aguas indígenas en Chile (Indigenous Waters in Chile)*. LOM Ediciones, Santiago de Chile.
- Zwarteveen, M. & Boelens, R. (2011a). Justicia hídrica: algunas reflexiones (Water justice: some reflections). In: Boelens, R., Cremers, L. & Zwarteeven, M. (eds). *Justicia Hídrica. Acumulación, Conflicto y Acción Social*. Instituto de Estudios Peruanos, Fondo Editorial PUCP, CBC, Lima, pp. 455–468.
- Zwarteveen, M. & Boelens, R. (2011). La investigación interdisciplinaria referente a la temática de “justicia hídrica (Interdisciplinary research on the theme of “water justice”. Conceptual approaches)”. Unas aproximaciones conceptuales. In: Boelens, R., Cremers, L. & Zwarteeven, M. (eds). *Justicia Hídrica. Acumulación, Conflicto y Acción Social*. Instituto de Estudios Peruanos, Fondo Editorial PUCP, CBC, Lima, pp. 29–58.

Reports, Resolutions, and Laws

- Cochilco (2018). *Consumo de agua en la minería del cobre al 2017 (Water Consumption in Copper Mining in 2017)*. Gobierno de Chile, Santiago de Chile.
- Cochilco (2020). *Yearbook: Copper and Other Mineral Statistics 2000–2019*. Gobierno de Chile, Santiago de Chile.
- Congreso Nacional de Chile (1981). *Código de Aguas (Water Code)*. Biblioteca del Congreso Nacional, Santiago de Chile, Chile.
- Congreso Nacional de Chile (1993). *Ley No. 19.253 (Ley Indígena): Establece normas sobre protección, fomento y desarrollo de los indígenas, y crea la Corporación Nacional de Desarrollo Indígena: CONADI*. Biblioteca del Congreso Nacional, Santiago de Chile, Chile.
- Congreso Nacional de Chile (1994). *Ley sobre bases generales del medio ambiente (Environmental Law)*. Biblioteca del Congreso Nacional, Santiago de Chile.
- Dirección General de Aguas (2021). *Derechos de aprovechamiento de aguas registrados en DGA (Water use Rights)*. Available at: https://dga.mop.gob.cl/productosyservicios/derechos_historicos/Paginas/default.aspx (accessed 4 April 2021).
- Environmental Justice Atlas (2020). *Cerro Colorado Mining Company, Chile, Environmental Justice Atlas*. Available at: <https://ejatlas.org/conflict/cerro-colorado-chile#> (accessed 10 July 2021).
- International Conference on Water and the Environment (1992). *The Dublin Statement on Water and Sustainable Development*. Available at: <http://www.un-documents.net/h2o-dub.htm> (accessed 10 March 2018).
- Lictevout, E., Payano, R., Cordoba, D., Amaro, S., Herrera, V. & Arancibia, F. (2014). *Diagnóstico y análisis crítico de la red de monitoreo de los recursos hídricos de la región de Tarapacá (Diagnosis and Critical Analysis of the Water Resources Monitoring Network in the Tarapacá Region)*. CIDERH – Universidad Arturo Prat, Iquique.
- World Bureau of Metal Statistics (2019). *Database*. Available at: <https://www.world-bureau.com/searchlink.htm> (accessed 10 September 2020).

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