Thirsty Country: State, Water, and the "War on Drought" in Chile in the 1960s❧

Fernando Purcell
Pontificia Universidad Católica de Chile

https://doi.org/10.7440/histcrit85.2022.05
Received: November 26, 2021 / Accepted: March 25, 2022 / Modified: May 9, 2022

How to cite: Purcell, Fernando. "Thirsty Country: State, Water, and the 'War on Drought' in Chile in the 1960s". *Historia Crítica*, n.° 85 (2022): 99-121. https://doi.org/10.7440/histcrit85.2022.05

Abstract. Objective/Context: This paper studies the role of the Chilean state during the great drought of 1967-1969 as a mediator between human beings and nature. Institutional adaptations and the effort to improve the infrastructure were elements of continuity with respect to previous droughts, but there were novelties as well, such as attempts to pursue weather modification and the artificial melting of glaciers. The support of technologies and scientists operating from peripheral state institutions was essential for these purposes. All the above took place in the context of the Cold War when the predominant environmental imaginaries made human intervention look favorable and necessary for the modernization of countries. **Methodology:** Diverse primary sources were used, such as ministerial documents, decrees, bulletins, and reports of different state institutions that allowed understanding the logic of state management during the water crisis. Similarly, research in national and international press helped identify how imaginaries about the environment were expressed and disseminated publicly, which tended to validate novel efforts to control nature. **Originality:** This is an original study for Latin America, which addresses the early appearance of science and technology in the efforts of what today would be known as geoengineering: mainly through the observation of new actors, which expanded the traditional forms of mediation between humans and nature, led by the state, concerning climate crises. **Conclusions:** In the 1960s, optimism grew for the human capacity to control and manipulate water resources by appealing to ways other than those previously known, associated with infrastructure development. Expert knowledge was placed at the service of peripheral institutions of the state to promote these changes with lasting consequences. The human desire to control nature at all costs was validated, which helps explain the temporal projection of experiments with artificial rain and glacier control to the present day in Chile.

Keywords: Chile, drought, Latin America, nature, science, state, technology, water.

País sediento: Estado, agua y la "guerra contra la sequía" en Chile en la década de 1960

Resumen. Objetivo/Contexto: en el artículo se estudia el papel del estado chileno en la gran sequía de 1967-1969, como mediador entre los seres humanos y naturaleza. Las adaptaciones institucionales y el esfuerzo por mejorar la infraestructura fueron elementos de continuidad con respecto a sequías anteriores, pero hubo novedades, como los intentos por modificar el tiempo atmosférico y el derretimiento artificial de glaciares con el apoyo de tecnologías y científicos que operaron desde instituciones periféricas del Estado. Todo lo anterior se dio en el contexto de la Guerra Fría, cuando los imaginarios ambientales predominantes hacían ver la intervención humana como algo favorable y necesario para la modernización de los países. **Metodología:** se recurre a distintos tipos de fuentes primarias como documentos ministeriales, decretos, boletines e informes de distintas instituciones estatales que permiten comprender las lógicas del manejo estatal

❧ This publication is the result of the research project Fondecyt Regular N. 1170055, financed by the State of Chile.

de la crisis hídrica. Junto con ello, se privilegió el uso de prensa nacional e internacional, para comprender cómo se expresaron y difundieron imaginarios sobre el medioambiente que tendieron a validar los novedosos esfuerzos por controlar la naturaleza. **Originalidad:** se trata de un estudio original para América Latina, que aborda la temprana aparición de la ciencia y tecnología en esfuerzos propios de lo que hoy se conoce como geoingeniería: en especial por la observación de nuevos actores, que ampliaron las formas tradicionales de mediación entre seres humanos y naturaleza, protagonizadas por el Estado a propósito de crisis climáticas. **Conclusiones**: en la década de 1960 creció el optimismo por la capacidad humana para controlar y manipular recursos hídricos apelando a formas distintas de las conocidas hasta entonces, asociadas al desarrollo de infraestructura. El conocimiento experto se puso al servicio de instituciones periféricas del Estado, desde donde se impulsaron estos cambios con consecuencias duraderas. Se validó el afán humano por controlar la naturaleza a toda costa, lo que ayuda a explicar la proyección temporal de experimentos con lluvia artificial y control de glaciares hasta nuestros días en Chile.

Palabras clave: agua, América Latina, Chile, ciencia, estado, naturaleza, sequía, tecnología.

País sedento: Estado, água e "guerra contra a seca" no Chile na década de 1960

Resumo. Objetivo/contexto: neste artigo, é estudado o papel do Estado chileno na grande seca de 1967-1969, como mediador entre os seres humanos e a natureza. As adaptações institucionais e o esforço para melhorar a infraestrutura foram elementos de continuidade em comparação a secas anteriores, mas houve novidades, como as tentativas para modificar o tempo atmosférico e o derretimento artificial de glaciares com o apoio de tecnologias e cientistas que operaram de instituições periféricas do Estado. Tudo isso ocorreu no contexto da Guerra Fria, quando os imaginários ambientais predominantes faziam ver a intervenção humana como algo favorável e necessário para modernizar os países. **Metodologia:** recorre-se a diferentes fontes primárias, como documentos ministeriais, decretos, boletins e relatórios de diversas instituições estatais que permitem compreender as lógicas da gestão estatal da crise hídrica. Além disso, foi privilegiado o uso da imprensa nacional e internacional para compreender como foram expressos e difundidos imaginários sobre o meio ambiente que tenderam a validar os novos esforços para controlar a natureza. **Originalidade:** trata-se de um estudo original para a América Latina, que aborda o precoce surgimento da ciência e da tecnologia em esforços próprios do que hoje é conhecido como geoengenharia: em especial pela observação de novos atores que ampliaram as formas tradicionais de mediação entre seres humanos e natureza, protagonizadas pelo Estado devido a crises climáticas. **Conclusões:** na década de 1960, cresceu o otimismo pela capacidade humana para controlar e manipular recursos hídricos apelando a formas diferentes das conhecidas até então, associadas ao desenvolvimento da infraestrutura. O conhecimento especializado se colocou a serviço de instituições periféricas do Estado, a partir de onde foram impulsionadas mudanças com consequências duradouras. Foi validado o anseio humano por controlar a natureza a todo custo, o que ajuda a explicar a projeção temporal de experiências com chuva artificial e controle de glaciares até os nossos dias no Chile.

Palavras-chave: água, América Latina, Estado, Chile, ciência, seca, tecnologia, natureza.

Introduction

The Chilean press and different printed media outlets coined the term "silent earthquake" or "dry earthquake" to refer to the great drought of 1967-1969, a stealthy disaster that was among the most devastating ones of the twentieth century, surpassed in scale only by the one in 1924-1925.[1] The "silent earthquake," with its most critical effects felt in 1968, caused a precipitation deficit of over 80% in the central Valparaiso and O'Higgins regions, with similar levels in the national capital of Santiago and a spatial extension ranging from the Atacama region in the north to the Bio Bio region in the south, with over 800 miles of longitudinal surface affected.[2] Thousands of animals died, fruit crops were severely affected, and water scarcity prevented regular access to water for a significant percentage of the population, all of which forced the implementation of water and electricity savings and rationing campaigns, given that the energy matrix was heavily dependent on hydroelectric generation.

This work aims to study how the Chilean state and society have managed large-scale water crises in the past. It is of particular value in the context of the great drought Chile has experienced for over a decade and in the framework of ongoing efforts to model potential future scenarios in the context of climate change. In this context, the historiographic exercise can contribute to giving credit and prominence to human agency and the impact of human action on droughts. This modeling can consider cultural practices in the human-nature relationship, decisions on scientific experimentation related to the climate, or actions by multiple actors—state and non-state—which must be analyzed considering the close connection between the human and the natural world.[3]

This article analyzes the state's capacities and strategies to address the water crisis through institutional, technological, and political tools, which helps elucidate its role in the configuration of core ideas regarding the relationship between human beings and the environment. The central argument of this work is that the state attempted to position itself as the great mediator of relations between humans and nature to confront the drought, favoring institutional and technical actions while tending to set aside sociopolitical sensitivities that would involve the citizenry in efforts, except in the case of water and electricity rationing, where Chilean population had to join in by following state guidelines rather than generating proposals. This was reinforced by a growing confidence in the human ability to alter nature and especially in the state's capacity to do so, which was globally sustained by technical knowledge and scientific and technological progress. However, although those who used science and technology to combat the drought did so from state institutions, their agendas, interests, and ways of working were shaped not by definitions

1 ENDESA, "La sequía: un terremoto silencioso," *Boletín* 1, n.º 163 (1968): 4-5; "Analizan medidas tomadas contra el terremoto seco," *La Nación*, October 16, 1968, 6; "La sequía: una catástrofe sigilosa," *La Nación*, October 20, 1968, 12; "1968 Chile, a la hora del balance. El terremoto seco de 1968," *La Nación*, December 31, 1968, 3.

2 Hans Schneider Singer and Orlando Peña Álvarez, "Un aporte al estudio de la sequía en Chile," *Revista Geográfica* 83 (1975): 114, https://www.jstor.org/stable/40992289; Pablo Camus and Fabián Jaksic, *Clima y Sociedad. El fenómeno El Niño y la Niña en la Historia de Chile* (Santiago de Chile: Instituto de Geografía UC, 2022), 75-126.

3 Mark Carey, Michel Baraer, Bryan G. Mark, Adam French, Jeffrey Bury, Kenneth R. Young, and Jeffrey McKenzie, "Toward Hydro-Social Modeling: Merging Human Variables and the Social Sciences with Climate-Glacier Runoff Models (Santa River, Peru)," *Journal of Hydrology* 518 (2014): 60-70, doi https://doi.org/10.1016/j.jhydrol.2013.11.006

received from central state ministries but rather by professional and technical challenges. As highlighted in the work edited by Andra Chastain and Tim Lorek, "beneath the conflicts waged by diplomats and militaries, the Latin American Cold War was conducted by experts," including engineers, scientists, and agronomists, who stand out clearly in critical circumstances like the drought that affected Chile in the 1960s. Nevertheless, these experts and their identities were fundamentally shaped by challenges faced during their professional and personal careers.[4] Thus, the mediating role that the state wanted to assume in the relationship between human beings and nature was strongly influenced by the emergence of scientists and technologists who collaborated strongly with the state but put their own mark on drought mitigation efforts by reinforcing imaginaries that validated ideas favoring the manipulation and control of nature. By connecting human, environmental, and scientific-technological aspects around a drought to new actors in peripheral state institutions, this article contributes to Latin American historiography on scientific-technological approaches to the environment.[5]

It is important to note that this historical analysis, in which water plays a central role, adheres to recognizing the existence of a "hydrosocial cycle." The classical scientific view of the water cycle is left aside, which tends to be represented considering the water flow in the hydrosphere, paying attention to the cyclical alteration of water molecules and their change of state from evaporation to precipitation after condensation. Instead, here we emphasize the ongoing mediation of human agents in this cycle under the concept of hydrosocial cycle, which considers the social nature involved in these flows and the role of water in them.[6] Water does not just evaporate to then condense and precipitate again to feed lakes and rivers that once again expose the water to a new evaporation process. Humans have tried to manipulate and use water resources for centuries, taking actions and implementing policies while using power and technologies to manage and control water. As Jaime Linton has noted, social processes and practices are directly involved in every instance concerning water. The author reminds us that each of these instances is saturated with ideas, meanings, values, and a socially assigned potential.[7] Applying these concepts to the case of Chile in 1968, it can be affirmed that the Chilean state played a fundamental role in the hydrosocial cycle. Ideological motivations, values, and ideas were behind the decisions made or supported to fight the water crisis, which were expressed in diverse ways and materialized in concrete policies

4 Andra B. Chastain and Timothy W. Lorek, "Introduction," in *Itineraries of Expertise: Science, Technology and the Environment in Latin America's Long Cold War*, edited by Andra B. Chastain and Timothy W. Lorek (Pittsburgh: Pittsburgh University Press, 2020), 3.

5 Michael Lemon and Eden Medina, "Technology in an Expanded Field: A Review of History of Technology Scholarship on Latin America in Selected English-Language Journals," in *Beyond Imported Magic. Essays on Science, Technology and Society in Latin America*, edited by Eden Medina, Ivan da Costa Marques, and Christina Holmes (Cambridge: The MIT Press, 2014), 111-136. An excellent work that considers the relationship between engineers, water, and the state is Mikael D. Wolfe, *Watering the Revolution. An Environmental and Technological History of Agrarian Reform in Mexico* (Durham: Duke University Press, 2017). See also Mark Carey, *In the Shadow of Melting Glaciers. Climate Change and Andean Society* (Oxford: Oxford University Press, 2010) and Tore Olson, *Reformers and the Remaking of the US and Mexican Countryside* (Princeton: Princeton University Press, 2017), 159-190.

6 Jamie Linton and Jessica Budds, "The hydrosocial cycle: Defining and mobilizing a relational-dialectical approach to water," *Geoforum* 57 (2014), 170, doi https://doi.org/10.1016/j.geoforum.2013.10.008

7 Linton and Budds, "The hydrosocial cycle," 4-5; Jessica Budds, "Contested H2O: Science, Policy, and Politics in Water Resources Management in Chile," *Geoforum* 40, n.º 3 (2009): 418-430, doi 10.1016/j.geoforum.2008.12.008

related to water—either at an institutional level or related to scientific and technological development. All this justifies the use of this theoretical analysis framework to understand the Chilean drought in the late 1960s.

This article is based on contemporaneous national and local press, institutional bulletins, ministerial documents from government agencies, and decrees and technical publications on environmental issues. As a whole, these sources provide an overview of the public debate on the drought, as well as the actions of the state within the framework of the water crisis.

The first section addresses the conceptual framework from which the state approached the drought, revealing the predominance of an environmental imaginary that changed during the Cold War and established a much sharper separation between human beings and nature. This led the state to "battle" antagonistically with nature and articulate actions to alleviate the crisis. The second section analyzes institutional responses to the crisis, which, despite their traditional approach, took place in a decade marked by reformist attempts and institutional changes aimed at overcoming underdevelopment. The final part of the article examines technological efforts based on international scientific experimentation that sought to reverse the effects of the drought. The generation of artificial rain, which was explored before the drought and gained momentum after 1968, was one of these experiments. The intentional melting of glaciers was another development. In both cases, new actors linked to the state played a leading role.

1. The war on drought

The way that the Chilean state, experts, and scientists dealt with the problem of drought from the discourse perspective is interesting. The press from the period is plagued with statements that reveal the idea of a direct confrontation, a battle against nature, rather than a relationship of coexistence or an overlap between human beings and the natural world. Faced with the crisis, ideas that assumed a categorical separation between the two worlds prevailed, in which human beings had to fight to avoid being vanquished by the attacks of nature. There are several examples, like an article in the state-owned newspaper *La Nación* entitled "Lucha racional contra la sequía" ("Rational Struggle Against Drought"), which responded to the interests of the Government, stating that the "implacable calamity" of the drought had been "confronted by the Government, determined not to allow itself to be dominated by the blind force of a hostile nature, nor by the discouragement with which weak spirits abandon the struggle when they believe that their strength is not enough to overcome the evil."[8] Even the Army "declared war on the drought," as the same newspaper reported, mobilizing to fight against nature, and thus military forces dedicated themselves to the task of drilling deep wells, in addition to engaging in water control and distribution efforts and patrolling hydrographic basins to prevent water theft.[9] The military personnel who participated in governmental commissions expressed their concern and willingness to confront the effects of the drought with determination, without sparing resources, and they described the drought as "the worst calamity

8 "Lucha racional contra la sequía," *La Nación*, August 12, 1968, 3.

9 "Declarada la Guerra en Paz contra la Sequía," *La Nación*, February 7, 1968, 2.

to affect the country for the last 200 years," in the words of Colonel Orlando Jorquera, who participated in government commissions on the drought and called to fight against it energetically.[10]

Since agrarian reform was the axis of urgent structural reforms, the need for water resources was even more acute. The right-wing government of Jorge Alessandri (1958-1964) had initiated a timid process of agrarian reform in 1962 by taking over lands that belonged to the state and had no major irrigation possibilities. The agrarian reform of Eduardo Frei Montalva (1964-1970) deepened the process and initiated policies of expropriation of privately-owned properties during the drought. Hence, water was the fundamental factor that sustained the principal structural reform of the entire decade, which was further intensified with the beginning of Salvador Allende's socialist government (1970-1973).

In the context of the drought, the so-called National Drought Commission implemented rationing campaigns, as happens in war or critical situations: "The drinking water we care for TODAY will be of use for us TOMORROW," was one of the campaign slogans published in the most important newspapers of national circulation, accompanied by "Gotita" ("Droplet"), a sensual feminine figure with a miniskirt whose head was a drop of water. Interestingly, the Commission added a powerful message associated with the campaign, which mixed practical, historical, patriotic, and environmental elements. The call was "to care for each drop of water as if it were a treasure." The drought was described as "the greatest of the last 101 years," and a request was made to make an effort for the good of Chile, claiming, ultimately, that with this national crusade, "we will be helping to win this veritable battle against nature."[11]

This defiant attitude toward nature in the Chilean case is not an exception. There are several contemporary examples worldwide where drought was perceived and characterized in a similar way. Rebecca Jones reminds us that Australia has shown a historical tendency to describe the struggle against drought as a war: "drought was an alien intruder to be eliminated. 'Battle,' 'fight,' 'war,' and 'victim' are some of the words which have characterised descriptions of drought."[12] Jones complements the above with a situation also experienced in Chile: the use of war metaphors associated with the drought led it to be considered an enemy to be overcome, which was done with aggressive measures and plans to reverse the effects of the climate phenomenon.[13]

One can argue that, in Chile, the predominant perception of drought was a war scenario. Humans fought against nature, and the state played a leading role in the generation of strategies and the use of "weapons" or policies to defeat the implacable enemy. However, unprecedented actors collaborated with the state in these matters. Among the "arms" used by the Chilean state to fight the effects of the drought, institutional adjustments and technical infrastructure development can be mentioned, along with the support of technologies to modify the weather or its effects and the intervention of glaciers. Behind this type of measures—and especially those circumscribed to the scientific-technological sphere—scaffolds located in environmental imaginaries validated the control and industrialization of nature, something that became especially relevant

10 "Perdidas 'irreparables' está causando la sequía," *El Día*, July 12, 1968, 4.

11 "¡Por favor salvemos el agua!," *El Mercurio*, August 1, 1968, 22.

12 Rebecca Jones, *Slow Catastrophes. Living with Drought in Australia* (Clayton: Monash University Publishing, 2017), 171.

13 Jones, *Slow Catastrophes,* 172.

during the Cold War.[14] The most significant projects for the transformation of nature focused on water resource management and especially on interventions that impacted river basins.[15]

2. Institutional adaptations and infrastructure

One of the strategies of the Chilean state to fight the drought involved institutional adaptation that address the political-administrative and management challenges related to the drought. This came in a broader context of institutional transformations throughout the 1960s when the state took responsibility for major development challenges. The era of global planning, as historian Mario Góngora called it, brought about changes that led to the creation of the National Planning Office, which was later to become a ministry, and institutions tasked with reforms, such as the Agrarian Reform Corporation (CORA) and the Agricultural Development Institute (INDAP). The agricultural sector was a priority, given the significant efforts to implement an agrarian reform without historical precedents, which was the focus of the institutional adaptation attempts before the drought. This happened because Chile was not self-sufficient in food supplies, despite its great agricultural potential, which made it more expensive for a predominantly poor population mass to access certain products.

Thus, it should come as no surprise that the first important institutional response by the state was to issue a Decree to establish a Drought Advisory and Coordinating Commission on June 13, 1968. It is noteworthy that the Decree's "whereas" points—which corresponded to the justification of its creation—allude to the fact that "this prolonged drought is primarily harming the agricultural and livestock lands of the regions referred to." The members of the Commission included representatives of the Ministries of Defense, Interior, Public Works, and Transport, in addition to the Santiago Intendant (Metropolitan Region Executive, equivalent to a governor). Its functions were initially restricted to agricultural matters, for which it had to "obtain all the information related to the drought affecting the country" and "evaluate its damages and consequences," in addition to providing support for the director of the Agricultural and Livestock Service. The ultimate purpose of the Commission was to advise the Ministry of Agriculture, with its meetings being held in the Ministry's offices.

Shortly after, the Advisory Commission suggested that all the municipalities between the provinces of Atacama, Coquimbo, Aconcagua, Valparaíso, Santiago, O'Higgins, Colchagua, Curicó, Talca, Maule, Linares, and Ñuble be declared in a state of emergency, which happened in early July. At the same time, a superior instance was created, called the High Commission, which the press dubbed the National Drought Commission. Reporting directly to the President of the Republic, it was composed of the ministers of the Interior, Economy, Defense, Finance, and Public Works, in addition to representatives of the Central Bank, the Bank of the State, and the Production Development Corporation (CORFO). Its tasks included "promoting the recovery of affected regions in all aspects, such as drinking water, electric power, agriculture, animal husbandry, and supplies for the population." Nevertheless, beyond its broad range of action, the central concern

14 Paul Josephson, *Industrialized Nature. Brute Force Technology and the Transformation of the Natural World* (Washington: Island Press, 2002), 1-14.

15 Richard Tucker, "Containing Communism by Impounding Rivers: American Strategic Interests and the Global Spread of High Dams in the Early Cold War," in *Environmental Histories of the Cold War*, edited by John McNeill and Corina R. Unger (New York: Cambridge University Press-German Historical Institute, 2010), 139.

continued to be agricultural productivity, which is why the position of the Executive Coordinator was held by Agriculture Undersecretary Carlos Figueroa.[16]

The National Commission coordinated a series of measures focused on guaranteeing or optimizing irrigation water with infrastructure improvements. Thus, instructions were given to operators to condition and clean up the canals, deep wells were drilled, and a commission was established to intervene the rivers; similarly, credit lines were arranged to import water pumps and guarantee forage for livestock. Given that a significant proportion of the country's electricity grid depended on the availability of water for hydroelectric generation, the National Drought Commission also implemented electricity generation and rationing policies.

Several weeks later, in August 1968, the Minister of Interior Edmundo Pérez Zujovic proposed to the President the possibility of establishing a Ministry in Campaign to address the needs created by the drought to deal with the problem of water and electricity shortages.[17] In the context of this debate, an editorial in *El Mercurio* supported the idea not only to alleviate the impact of the drought domestically but above all because it was a disaster "that will have an impact on employment and production, with foreseeable political and social consequences." At the same time, it called for the active mobilization of "the entire state machinery" as the calamity "is not far from the political-administrative action imposed by modern warfare." This justified the support for creating a Ministry with "a senior authority that orders the formulation of a plan of attack, citizen mobilization, and economic adaptation to the efforts required."[18] The problem was that citizen mobilization was conceived in a limited way, assigning it a reactive role in terms of rationing policies but without active involvement in other areas.

The Minister of Interior's proposal was not confirmed in practice. Nevertheless, the National Commission was gradually empowered, reinforcing the decision to privilege institutional adaptations focused on agriculture and livestock, consistent with the needs and context of the time. In the so-called era of global planning, state technocracy began to be dominated by economists, to the detriment of engineers, who had predominated in previous decades.[19] Not that their influence disappeared completely, but engineering efforts were not accompanied by institutional adaptations that would allow them to channel their demands beyond what the Ministry of Public Works permitted. In contrast, economists gained space, especially considering that agrarian reform was one of the most emblematic reform processes of the 1960s.

The Agrarian Reform was really set into motion under the Eduardo Frei Montalva administration (1964-1970) as part of a search for social justice and economic modernization. As historian Heidi Tinsman has noted, land distribution sought to increase agricultural production to become a self-sufficient country, an indispensable requirement to minimize the impact of foreign debt and strengthen industrialization, all of which would lay the foundations for improving the quality of

16 "Decreto de creación Comisión Asesora y Coordinadora para la Sequía," Santiago, June 13, 1968, Archivo Nacional de la Administración (ARNAD), Fondo Ministerio de Agricultura, vol. 1773.

17 "Creación de Ministerio para Enfrentar Sequía," *El Mercurio*, August 9, 1968, 1 and 22.

18 "Autoridad para enfrentar la sequía," *El Mercurio*, August 10, 1968, 3.

19 Patricio Silva, *En el nombre de la razón. Tecnócratas y política en Chile* (Santiago de Chile: Ediciones Universidad Diego Portales, 2010), 129-138.

life for the entire country.[20] Thus, the drought not only put a given year's production at risk but also the structure of a bigger plan and an extremely controversial reform launched a year earlier. Hence the institutional framework assigned a central role to agricultural and livestock issues above other considerations. Even the first signs of the water crisis, in 1967, led the Ministry of Agriculture to issue a series of public calamity decrees aimed at channeling economic assistance to geographic regions affected by the drought and strengthen the framework of the Agrarian Reform.[21]

The possibility of creating a Ministry of Water was also discussed at length, which came in the context of the so-called International Hydrological Decade. However, the flexibility to establish a new institutional framework was limited to the period of drought, and the opportunity to create a centralized institutional structure for water resource management was missed. Water continued to be a sectoral issue in which three essential needs operated: water availability for human consumption, agricultural use, and electricity generation. As the drought was addressed, a single institution focused on supply for agricultural production was also in charge of coordinating efforts to guarantee the other two needs. However, like so often before, the state did not conceive the drought as a comprehensive social problem. The Chilean state's definition of water-related needs and problems primarily had to do with productivity, which made sense in the context of the developmental efforts carried out at the time.

The option was consistent with previous discourses. The best example was Chile's position at the international conference "Water for Peace," held in New York in 1967. Jaime Donoso R. of the CORFO spoke about the country's water resources, dividing them into geographic regions and providing statistics associated with the five principal ones.[22] The CORFO report was clear about its priorities when defining "water-related needs and problems." The first challenge was agriculture due to the low productivity and stagnation of the sector in the previous decade. Thus, the report highlighted the difficulty of "expanding the country's area under irrigation and enhancing the productivity of what is currently irrigated."[23] An estimated 1.4 million hectares were irrigated at the time, with the potential of reaching 2.5 million hectares, which posed the challenge of building reservoirs and making better use of groundwater for "a comprehensive use of water in every basin."[24] The second need was industry and mining. The report began by stating that the state did not have an agency specifically in charge of water usage for industrial purposes. There were concerns about supplying industry in the city of Santiago. The third need was drinking water. The state agency responsible for this aspect was the Ministry of Public Works' Sanitary Works Department for cities over 1,000 inhabitants and the Ministry of Health's Rural Sanitation Service for towns between 200 and 1,000 inhabitants. The big problem was that, even before the drought, there were 800,000 people with only indirect supply from public taps, water distribution in trucks, or other sources.[25]

---

20 Heidi Tinsman, *La tierra para el que la trabaja. Género, sexualidad y movimientos campesinos en la Reforma Agraria chilena* (Santiago de Chile: Lom-Centro de Investigaciones Diego Barros Arana, 2009), 94-101.

21 "Decreto de creación Comisión Asesora y Coordinadora para la Sequía," Santiago, June 13, 1968, ARNAD, Ministerio de Agricultura, vol. 1767. See also "Decreto de Calamidad Pública para Provincias de Coquimbo, Aconcagua y Valparaíso," Santiago, June 13, 1968, ARNAD, Ministerio de Agricultura, vol. 1767.

22 Jaime Donoso R., *Chile y sus recursos hidráulicos* (Santiago de Chile, CORFO, 1967), 8-10.

23 Donoso R., *Chile y sus recursos hidráulicos*, 20.

24 Donoso R., *Chile y sus recursos hidráulicos*, 22.

25 Donoso R., *Chile y sus recursos hidráulicos*, 26.

The fourth need was hydroelectric resources, and the main concern focused on growing consumption by the population.[26]

To find a solution to the problem created by the drought, the state's main emphasis was on taking advantage of the catastrophe to invest in what the public debate called preventive infrastructure. This debate was compelling and stressed the need to implement measures based on technical criteria, not just political ones.

Generally, there was a consensus regarding the importance of infrastructure to overcome the crisis, though not regarding the national origin of technical recommendations. There was a significant level of technological nationalism in some opinions expressed in the context of the drought. Israeli Water Commissioner Menachem Kantor visited the country in December 1968. After spending three weeks in Chile, he submitted a report to the Minister of Agriculture Hugo Trivelli, establishing that only 20% of the existing waters in river sources were effectively used for irrigation. He stressed that, beyond evaporation or seepage into groundwater, there were significant deficiencies in the irrigation water transportation systems, which generated huge losses. He also called for modernizing the Chilean agriculture's irrigation systems, in addition to suggesting the use of groundwater.[27] His recommendations led to immediate reactions from different well-known Chilean engineers.

In this context, a letter by civil engineer Carlos Llona deserves attention. A distinguished hydraulic engineer with 57 years of experience in water distribution and a university professor, he addressed a letter to Carlos Correa Valdés, organizer of the National Agricultural Society's conference "Irrigation, Water, and Drought," and made the following comment on foreign technicians the government brought to Chile:

> We cannot conclude this brief review on the practical matters of improving irrigation without saying two words of commentary on the alleged lessons learned in this area of national activity from foreign technicians who come voluntarily or, even more discouraging, were brought in by the national government for the price of gold, surely with very good intentions, but, in general, with total futility.

Llona explained further that Chile had unique conditions and that the foreigners visited the country "with total ignorance of the comprehensive problem, yet even so intend to teach us lessons." His opinion was complemented by engineer Eugenio Lobo Parga, who affirmed that these foreigners were totally ignorant of the country's topography and water reality."[28]

Llona concluded by saying:

> [I]t is essential to create an atmosphere that convinces the supreme government and the country as a whole that our irrigation technicians do not need foreign lessons to resolve the problems, that we are perfectly capable of studying and resolving them, which usually cannot be done for lack of money. This must be clearly stated, in addition to saying that these funds in hard cash

26 Donoso R., *Chile y sus recursos hidráulicos*, 28.

27 "80 por ciento del agua de riego se pierde en Chile," *La Nación*, December 17, 1968, 2.

28 Carlos Llona, "La buena aplicación del agua," *Revista Chilena de Ingenieros y Anales del Instituto de Ingenieros* 340 (1969): 9-11.

> paid to these useless technicians would be put to far better use helping national technicians and institutions that dedicate themselves to the study of irrigation in Chile.[29]

In general terms, it can be argued that the Chilean state showed a significant capacity to adapt to diverse circumstances during the drought since it was able to create new ad-hoc institutions and mobilize a series of infrastructure resources to overcome the situation. However, there were limitations to this phenomenon since the government addressed the crisis and its impact essentially from an economic and productive perspective. Furthermore, the primary focus was on agriculture. There was no interest in seeing the drought as a phenomenon with a generalized impact on society, as a comprehensive crisis. This fact explains the predominance of institutional strategies that placed far more emphasis on technical and agricultural matters over social ones, even though, at the same time, the Frei Montalva government had been involved in a popular mobilization campaign without precedents in Chilean history.

The state did not open social spaces for the public to design, activate, or participate in different types of campaigns associated with the drought, except for cases in which communities occasionally helped with projects, such as laying pipes for drinking water.[30] Why did the state, which in other issues strived to give prominence to the people, exclude them from cooperation in the fight against this natural disaster? The answer has to do with the state not conceiving the drought as a socio-cultural problem but rather one that was essentially sectoral (agricultural) and, to a large extent, economic-productive, despite the profound social history underlying every drought, as Mike Davis affirms.[31]

Droughts continued to be seen as passing phenomena or exceptional situations that could be addressed with specific and limited measures and did not endure over time. There was no capacity to reverse the situation Rafael Elizalde Mac-Clure called attention to in 1970, when he complained that the administration of Chilean water resources was distributed among many state agencies, like the Ministry of Public Works' Irrigation, Waters, and Planning departments and the Production Development Corporation. Elizalde Mac-Clure pointed out that this disparity in water management and the consequent lack of coordination had led to "the creation of a confusing, variable, and at times contradictory water policy that has naturally been unable to be as effective as the circumstances require." Hence the 1968 drought prompted some people to propose the creation of a Ministry of Water and Irrigation to administer the Water Code, among other things.[32] This institutional scenario led to creating—under the auspices of the Agrarian Reform—the General Water Board under the Ministry of Public Works, whose mission was "to study and plan natural water resources for their better use and benefit the national economy."[33]

---

29 Llona, "La buena aplicación del agua," 11.

30 "Abastecimiento de agua en Santiago está asegurado con embalse de 'El Yeso,'" *La Nación*, September 14, 1968, 3.

31 Mike Davis, *Late Victorian Holocausts. El Niño Famines and the Making of the Third World* (London: Verso, 2017), 21. For the case of Brazil, see Eve E. Buckley, *Technocrats and the Politics of Drought and Development in Twentieth-Century Brazil* (Chapel Hill: University of North Carolina University Press, 2017).

32 Rafael Elizalde Mac-Clure, *La sobrevivencia de Chile* (Santiago de Chile: Ministerio de Agricultura, Servicio Agrícola y Ganadero, 1970), 244.

33 Elizalde Mac-Clure, *La sobrevivencia de Chile*, 244.

But beyond the importance of this measure, it did not resolve the structural problem of water management that accompanies us to this day.

Institutional adjustments and efforts to develop infrastructure were part of known reactions to droughts, regardless of their success or historical projection. The evidence indicates that they responded to a common pattern.[34] However, the first great Chilean drought in the Cold War period brought certain developments associated with the Chilean state's support for science and technology to "fight" the drought. This is associated with drives and initiatives that gained significant strength in Latin America during the Cold War and which were, at times, strongly intertwined with the political-ideological contingency and needs.

3. Science and technology at the service of the fight against drought

One of the novel characteristics of this drought was the leading role played by science and technology as instruments for developing solutions to water scarcity. Until then, the Chilean state had relied on administrative measures, special decrees to generate economic support, sporadic institutional adaptations, or the construction of water infrastructures. At the end of the 1960s, the state relied on people linked to science and technology to overcome the climatic catastrophe. These new actors did not always operate from the heart of the ministries and the central administration but from "peripheral" state institutions, such as the state-owned electric company ENDESA, the Universidad del Norte, the Air Force, or regional agricultural development institutions. In addition, there was a significant amount of "personal entrepreneurship" on the part of actors and scientists who were willing to propose and collaborate with these entities. Together, they contributed to strengthening the imaginaries they conceived as durable and feasible, regardless of whether they were supported by actions in a particular climatic and historical context.[35] Efforts to generate artificial rain and melt glaciers in the 1960s exemplify this tendency.

3.1. The generation of artificial rain

In Chile, significant attempts were made to produce artificial rain, which were possible years after the company General Electric concluded based on a series of experiments in 1946 that rain could be produced artificially under specific conditions. They discovered that by "seeding" certain types of clouds with dry ice crystals, the moisture could crystallize, concentrate, and precipitate in the form of rain. The experiments were led by Irving Langmuir and Vincent J. Schaefer, under contract with the US National Defense Research Council, and quickly imitated and improved in different parts of the world.[36]

---

34 Pablo Camus and Fabián Jaksic, "La gran sequía de 1968: efectos sociopolíticos y crisis de la democracia en Chile", *Revista de Historia* (Concepción) 28, n.º 2 (2021): 271-293, doi: http://dx.doi.org/10.29393/rh28-34gspf20034; Nicolás López, "Un terremoto silencioso. Sequía y crisis social en el campo chileno, 1967-1969," *Seminario Simon Collier 2017* (Santiago: Instituto de Historia UC, 2017), 99-127.

35 Sheila Jasanoff, "Future Imperfect: Science, Technology, and the Imaginations of Modernity," in *Dreamscapes of Modernity. Sociotechnical Imaginaries and the Fabrication of Power*, edited by Sheila Jasanoff and Sang-Hyun Kim (Chicago: The University of Chicago Press, 2015), 1-33.

36 James R. Fleming, *Fixing the Sky. The Checkered History of Weather and Climate Control* (New York: Columbia University Press, 2010).

The state's interest in these practices started in 1962 in the context of an alliance between the Ministry of Agriculture and E. Bowen, an Australian scientist who worked for the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia.[37] Bowen drafted a report for the ministry on the possibility of creating an experimental artificial rain program, which was the basis and inspiration for the Experimental Weather Modification (META, for its Spanish acronym) project. Bowen had become a leading figure in research on and experimentation with artificial rain after he started studying the physics of how rainfalls were formed in 1946. As he was to say in a later interview, he embarked on a large-scale research program after finding out about the experiments conducted in the United States using dry ice.[38] Bowen's team discovered that the composition of silver iodide crystals was similar to that of dry ice, which allowed artificial rain projects to be employed far more effectively.[39] Bowen's work at CSIRO focused on New South Wales and the western part of Victoria in Australia, but he also worked internationally in Israel, Chile, South Korea, Peru, and Rhodesia.[40]

The report drafted by Bowen for Chile on the feasibility of using artificial rain generation techniques for the arid north elicited enthusiasm in José Cristoffanini, who years later would prepare a specific project at the Ministry of Agriculture's request. Cristoffanini's proposal led to the creation of the META project.[41] Cristoffanini was an agronomist, a pilot, and a resident of Arica, on the far north of the country, one of the driest areas in the world. In addition to collaborating with the Ministry of Agriculture's High Council for Agricultural Development, he was to become director of the Center for Ecological Research at the state Universidad del Norte, where he promoted the META project and later sought US cooperation.

The project was formalized in 1966, before the great drought of the late 1960s, by an agreement reached with the Ministry of Agriculture and subsequently ratified by the Ministry of Defense.[42] However, Cristoffanini had been seeking to implement it since 1965.[43] It is interesting that Cristoffanini presented himself as the person responsible for the project and its absolute ideologue at the press conference announcing the project. At the time, the local press highlighted that "the project was gradually created in his mind when, faced with the drought phenomenon annihilating the inner regions of Arica, the Department Governor started to put pressure on agricultural engineers to prepare the evacuation of livestock and even people toward more favored sectors."[44]

The Tripartite Agreement signed in Arica was based on a series of previous assumptions and scopes. It was published in its entirety during its formalization in June 1967, but there were significant institutional precedents in 1966. It is important to highlight that the Arica Project was a special initiative within the broader META program. In fact, in the context of signing the agreement document in Arica, reports affirmed that its experiments would be extended to La Serena, a city

37 David Erickson and Oscar Badilla, "Cloud seeding in Chile," *Journal of Weather Modification* 14, n.º 1 (1982): 48.

38 "Australia's Rainmaker Retires," *The Jerusalem Post*, March 5, 1971, 5.

39 "Australia's Rainmaker," 5.

40 "Australia's Rainmaker," 5.

41 Erickson and Badilla, "Cloud seeding in Chile," 48.

42 "Programa para provocar lluvias en la Zona Norte," *El Mercurio*, June 13, 1967, 1 and 16.

43 "No va a llover sobre Arica sino en zonas determinadas," *La Concordia*, June 10, 1967, 1 and 3.

44 "No va a llover sobre Arica," 1 and 3.

hundreds of kilometers to the south.[45] The text emphasized the alliance between the Ministry of National Defense, the Ministry of Agriculture, and the Universidad del Norte. Faced with an arid region and plans for its agricultural development, it proposed using "techniques that allow the artificial stimulation of precipitation, as long as certain cloud conditions and other physical-meteorological factors exist." At the same time, it was based on previous studies that "have allowed the existence of favorable conditions for artificial stimulation or precipitation to be corroborated in the mountainous areas of certain regions in the north of the country."[46]

Defense Minister Juan de Dios Carmona traveled to the initiative's inauguration with Agriculture Minister Hugo Trivelli, senior Chilean Air Force (FACH) officers, and CORFO officials.[47] The agreement was signed on June 9, 1967, in the city of Arica, in the far north of Chile, a desert region with minimal precipitation levels.[48] However, cloud seeding had already begun in the area near the town of Belén a few days earlier. As a complementary project, the agreement included creating a Center for Ecological Research for the country's northern region and experimental programs to harvest condensation from the coastal fogs known as *camanchaca*. The Ministry of Agriculture was the project's main sponsor in terms of funding and sought to bring the Chilean Meteorological Office and the Ministry of Public Works' Irrigation Department on board. Together, they sought "to increase water resources in the western springs that run toward the Pacific by stimulating rainfall in certain areas of the mountain foothills."[49]

While the press in the capital focused on the project's technical and institutional details, the local press in Arica followed the details far more closely and was more sensitive to issues related to water and drought, given the geographic conditions in which people lived there. In fact, in contrast with the capital press' silence on the global "Water for Peace" conference, the Arica newspaper *La Concordia* did cover it, especially the debates and technical proposals for water desalination presented at the event, seen as promising by the residents of a coastal city surrounded by desert.[50]

The local press had already reported on the META project a week before its inauguration and there were tremendous expectations regarding the research that was "of paramount importance for the country as a whole, but especially for our region."[51] But the people of Arica were not all positive. What worried them the most were the places where rains would be produced, given that the city, located on the coast, was unprepared for rain, which can cause disasters even to this day. At the press conference in Arica to introduce the project, José Cristoffanini and the president of the Universidad del Norte explained that it would not rain in Arica given that this would only happen in places where there were clouds. At the same time, they reported that the precipitation

45 "Un completo éxito lluvias artificiales," *La Concordia*, June 13, 1967, 2.

46 "Convenio Tripartito," *La Concordia*, June 11, 1967, 1 and 2.

47 "Plan para lograr lluvia artificial en Zona Norte," *El Mercurio*, June 8, 1967, 17.

48 "Lluvias artificiales," *Las Últimas Noticias*, June 8, 1967, 20; "Plan META provocará lluvias en el Norte," *La Concordia*, June 7, 1967, 5.

49 "Programa para provocar lluvias," 1 and 16.

50 "La lucha contra la sequía," *La Concordia*, May 30, 1967, 3.

51 "Importante convenio de la Universidad del Norte," *La Concordia*, June 2, 1967, 7.

they had managed to produce so far had been concentrated in the Cuesta del Burro region and Ticnamar, near Putre.[52]

META focused significant efforts on the so-called Arica Project as of 1967, but the 1968 drought led to an increase in cloud-seeding attempts in the country's central region, though, with unsatisfactory results. David Erickson and Oscar Badilla affirm that the state-owned electric company ENDESA carried out experiments near Santiago in 1968 using "four silver iodide ground generators positioned in various locations throughout the mountains surrounding the city." They also indicate that no official reports were produced on this experiment.[53] The experiment was followed by the press, however, which kept in mind the experiments that had started in the northern part of the country shortly before. The newspaper *Las Últimas Noticias* covered the issue during the great drought of 1967-1969, stating that "man's longstanding ambition to dominate the weather could come true in the short term if the scientific experiments being carried out all over the world to find an appropriate technique to make artificial rain are successful." It then reported that the results in northern Chile had not had the same impact as the experiments carried out in the central region in the winter of 1968. There were reasons for this despair after the Chilean Air Force had seeded clouds in the region between Los Andes and Rancagua between 22nd of June and 22nd of July as part of the META project. According to meteorologist Augusto Llano, FACH chief of Hydrometeorology, the problem was that they had been unable to overcome "the wall," alluding to the "high pressure that exists off the coasts of Chile and Peru, a sort of insurmountable barrier for cold fronts and which gradually thickens," obliging cold fronts to "flank" this barrier, which tended to bring the rains to the central region of Chile.[54]

Despite the limited results on the northern part of the country, José Cristoffanini did not give up and enthusiastically declared in late 1969: "But I have seen dramatic results several times after putting silver iodide into the bases of some of these anchored storms. But we shall see. In the new phase, we shall have weather balloons, more meteorological stations, time lapse cameras, and other equipment to determine whether we are right." However, the experiments were also a source of concern for the team in charge of the META project due to the potential diplomatic implications of using clouds that could be claimed by Bolivia or Peru at the same time. In fact, some years earlier, there was a diplomatic impasse between India and Pakistan because "both claimed legal rights to the water content of cloud in the [border] area, and there were charges of cloud theft."[55] For the same reason, given the tensions between Chile and its neighbors at the time, especially Bolivia, with which there were open disputes over the waters of the Lauca river, it was thought that "the seeding of disputed clouds could conceivably add fuel to the dispute."[56]

In one way or another, what was behind the whole META project was an expression of particular imaginaries of the relationship between human beings and nature. These were expressed through the design of scientific-technological projects that assumed the construction of a social order in which

52 "No va a llover sobre Arica," 1 and 3.

53 Erickson and Badilla, "Cloud seeding in Chile," 48.

54 "Muro de alta presión ataja las lluvias," *Las Últimas Noticias*, August 21, 1968, 5.

55 "Chilean Pilots Take Peace Making Role: Plan to Seed Clouds over Northern Desert Area," *The New York Times*, December 25, 1969, 7.

56 "Chilean Pilots Take Peace Making Role: Plan to Seed Clouds over Northern Desert Area," *The New York Times*, December 25, 1969, 7.

the state played a predominant role by having the power to provide mechanisms that allowed controlling climate variables. More specifically, they were sociotechnical imaginaries, which had become powerful cultural resources at the time and shaped innovative replies. Similarly, as Jasanoff and Kim point out in the case of the United States, which also applies to Chile, they led the population to believe that "technology's benefits are seen as unbounded while risks are framed as limited and manageable."[57]

3.2. Melting glaciers

The Rapel hydroelectric power plant was inaugurated on June 21, 1968, and it was the largest ever built in Chile at the time. It was a long-awaited project, part of the plan that the state-owned electricity company ENDESA had designed in the early 1940s to generate enough electricity to modernize the country by industrialization through the substitution of imports and increased domestic electricity coverage.[58] The construction had begun in 1960 to take advantage of the waters of the Rapel river that originates in the intersection between the Tinguiririca and Cachapoal rivers. The great dam ended up flooding a large area and creating the artificial Lake Rapel, covering an area of about 80 km^2 and stores 700 million m^3 of water, allowing almost 25% of total service power to be generated there.[59] Those who worked on this project proudly celebrated the achievement as a true milestone in national engineering, an event that for some became part of the "technological heritage of the nation."[60] President Eduardo Frei Montalva, who inaugurated the works in June 1968 in the middle of the drought, did not spare praise either, highlighting Rapel's great importance to the progress and productivity of a country anxiously seeking modernity.[61]

Beyond the joy of the inauguration, the initial months of operation were a headache for the engineers and managers of ENDESA, the state company that had built the power plant and supervised electricity generation and the interconnected system that allowed the flow of electricity throughout the country. Even though the Rapel parish priest "implored the heavens' protection for the work" at the inauguration, the heavens did not drop any water during that winter.[62] In mid-1968, ENDESA's concern over the effects of the drought was evident to the point of describing the situation as a "silent earthquake." "1967 was a dry year, and this one is even more so, to the extent that you would have to go back over 100 years in time to find a similar phenomenon," ENDESA's own engineers wrote in their bulletin. In June 1968, in the middle of winter, they were worried about the lack of snow and complained that "its white and wet presence" had not yet begun to fall.[63]

---

57 Sheila Jasanoff and Sang-Hyun Kim, "Sociotechnical Imaginaries and National Energy Policies," *Science as Culture* 22, n.º 2 (2013): 190, doi 10.1080/09505431.2013.786990

58 Rafael Sagredo, "Electricidad para el desarrollo," in *Historia de la Ingeniería en Chile*, coordinated by Sergio Villalobos (Santiago de Chile: Hachette, 1990), 353-358.

59 Sagredo, "Electricidad para el desarrollo," 355.

60 "Central Rapel," *Acontecer Rapelino*, 1967, 2

61 Fernando Purcell, "Dams and Hydroelectricity: Circulation of Knowledge and Technological Imaginaries in South America, 1945-1970," in *Itineraries of Expertise: Science, Technology, and the Environment in Latin America's Long Cold War*, edited by Andra B. Chastain and Timothy W. Lorek (Pittsburgh: University of Pittsburgh Press, 2020), 217-236.

62 ENDESA, "La Central Rapel en la ruta de la energía," *Endesa*, XVI, n.º 62, 2-3.

63 ENDESA, "La sequía: un terremoto silencioso," *Boletín* 1, n.º 163 (1968), 4-5.

The Rapel dam was forced to reduce its operations to a minimum shortly after its inauguration due to extreme drought and lack of water. This situation led some of the engineers to consider emergency measures to cause water to flow from the glaciers in the mountains to the rivers that fed the new Lake Rapel. Historical evidence showed that this had been done before during the drought of 1924-1925, when workers from the General Public Works Department and the Local Monitoring Board went into Cajón del Maipo near the country's capital to dynamite glaciers. These experiments were a success since they sped up the melting process, though they were abandoned due to the method's high cost.[64]

Given that the scenario did not change in the following months of 1968, and even worsened with the onset of summer, ENDESA planned an experiment. They proposed "a solution that is daughter of technique as much as it is inventiveness: coloring the glaciers to retain the heat of solar rays better so they can finally release the water needed so badly here below to generate electricity or for irrigation."[65]

The operation was run by ENDESA's Generation Department and then transferred to the Civil Engineering Department for execution, where the company's Hydraulic Works section came together with the Hydrology Division. Geologist Cedomir Marangunic had just arrived from finishing his PhD in the United States, where he specialized in glaciers. In late 1968, he started to work for ENDESA on developing this technology, which consisted of accelerating the melting of glaciers by sowing dark particulate matter to increase the fusion rate. Marangunic's inspiration came from the Soviet Navy's practice of dropping black sand on icebergs floating in the Arctic to increase their fusion rate and cause them to melt.[66] In fact, these practices were known to the scientific community in the United States in which Marangunic was immersed while completing his Ph.D. The United States knew that the Soviets had turned to the "artificial intensification of the melting of sea and river ice with the aim of a more rapid freeing of vessels frozen in the ice, for laying water channels in the ice for passage, for more rapid ice removal from the harbors of ports and creeks, various river sections, etc." They were also aware that experiments had been underway since at least 1939, which were aimed at "the artificial intensification of melting snow by dusting its surface with various substances—ashes, dirt, slag, coal, soot, etc."[67]

Experimentation in Chile began in 1968. At first, in December 1968, the effectiveness was analyzed by coloring small sections of glaciers with manual sprayers, carried out in El Morado near Santiago. After that, the aerial reconnaissance stage began in the O'Higgins region, a bit further south, where the watercourses that fed Lake Rapel had their source, to find appropriate places to color glaciers where aerial maneuvers could also be performed at the same time without risk.

64 "La sequía que azota a la zona central del país adquiere caracteres de extrema gravedad," *El Diario Ilustrado*, October 27, 1924, 2

65 ENDESA, "Fumigan glaciares para derretir sus hielos," *Boletín* 1, n.º 175 (1969), 10.

66 Interview with Cedomir Marangunic, June 21, 2016.

67 "Artificial Intensification of the Melting of Mountain Glaciers for Increasing the Runoff of Rivers in Central Asia," University of Arizona Libraries, Special Collections, James E. McDonald papers, box 36, folder "Climate Modification," 3. This report on glacier melting practices in the Soviet Union is based on the translation of several scientific publications originating in the Soviet Union. The translation of Soviet scientific research and their availability to the US scientific community was funded by the Joint Publications Research Service, an organization established to fulfill the translation and foreign-language research needs of various federal government departments.

Ultimately, the Cotón glacier was chosen at an altitude of 13,000 feet and covering an area of 7.5 km at the time. At the same time, the first spraying tests begun at the Tobalaba airdrome in Santiago, using "black smoke," a sort of particulate soot used to produce black paint. Large rolls of paper were spread out on the runway, and a plane would fly over them and launch the soot. Once satisfied with how to spread it using agricultural crop-dusting pumps, tests were performed in El Morado to measure the melting of glaciers and the effectiveness of the system. The tests performed in Cajón del Maipo led to adjustments in the size of the particulate matter.

The conditions over the summer had aggravated the impact of the drought, so it became imperative for ENDESA to perform the tests. By early April 1969, Marangunic and his team, which in reality was composed of his mountaineering friends Francisco Vivanco and Waldo Espinoza, had set themselves up by the Cotón glacier. They were supplied with stakes and flags to mark out the area for the plane to color. Nothing was left to chance, and for this reason, "with the purpose of determining the increase in flow that would be produced due to obscuring the entire surface and the time this effect would last, control sections were installed in a stream fed by this glacier and in another neighboring stream whose surrounding ice was not obscured, to control the impact of the experiment."[68]

In addition to placing wooden stakes to delimit the space and to measure how much the glaciers diminished due to the increased fusion rate, white cloths were spread across the ice to determine the amount and density of the particulate matter dropped onto the surface of the Cotón glacier. Ultimately, two types of particles were tested: the above mentioned "black smoke" and another kind of black powder produced from ground mineral coal.

The numbers showed success, and ENDESA's engineers celebrated the results of Marangunic's experiment. "The preliminary analysis of the measurements show an increase between 100 and 200% of the ablation in the obscured areas versus untreated areas."[69] Similarly, further experiments were carried out that led to the discovery that the Cotón glacier not only had optimal conditions due to its location and easy access by air and land but also because its temperature remained at 0 degree Celsius at different depths, thus preventing the water from refreezing after the fusion achieved the surface.[70] However, at ENDESA, people were not convinced that the experiments should continue because there remained unknown factors to be cleared up. Ultimately, they were convinced that it was necessary to create a registry of glaciers where this specific technique could be developed and that further experiments were needed until lower-cost dyes could be produced. Likewise, there was a need to measure the duration of the dye's effect and decide whether it was better to use planes or helicopters in these experiments. But, beyond this, a sense of satisfaction prevailed, as evidenced in the institutional bulletin: "It was an experience worthy of attention, given that, if it is both economically and technically feasible, as is hoped, these frozen water deposits could be used like a reservoir, where the surface would be obscured at the appropriate time, instead of opening the floodgates."[71]

These expressions regarding humanity's alleged capacity to control nature speak for themselves. The idea of using natural resources "at will" was behind these experiments, which tells a

68 ENDESA, "Fumigan glaciares," 11.

69 ENDESA, "Fumigan glaciares," 11.

70 ENDESA, "Fumigan glaciares," 11.

71 ENDESA, "Fumigan glaciares," 11.

lot about the kind of relationship between human beings and the environment being forged at the time. Unlike now, predominant notions were those that legitimized all types of intervention and control of nature to benefit human beings and the national modernization project. However, this was not just a Chilean reality. All sorts of interventions in water were undertaken in different parts of the world that, in one way or another, assigned unique features to the hydrosocial cycle[72] in each one of them.[73]

Poverty levels in Chile were extreme in the 1960s, the population was uneducated, and there was a widely shared desire to emerge from underdevelopment, which meant that the effects of the drought had to be fought at any cost. The state took on the responsibility of guaranteeing the population's welfare, due to which, following the precepts of ECLAC, it defended the idea that "improving the living conditions of popular urban and rural sectors would help expand the domestic market for industrial production."[74] This vision gave full legitimacy to ENDESA to use scientific and technological resources to melt glaciers, to the extent that the availability of resources entailed a positive impact on agriculture, energy, and water for human consumption. In addition, there was no awareness at the time of the deterioration caused by the climate change process under way. To put this into perspective, it must be noted that the Chilean state addressed "the water dilemma" in the 1960s in the context of other existing challenges. The UN Assembly declared the 1960s as the International Development Decade in January 1961. The idea of development, especially in so-called Third World countries, was associated with achieving social and material conditions, which required the availability, exploitation, and use of both renewable and nonrenewable resources, all of which increased the pressure and had a decisive environmental impact on developing countries.[75]

Beyond the above, the experiments were abandoned as soon as the rains began to dissipate the effects of the Great Drought during the autumn of 1969. This indicates the existence of a limiting factor in the durability of scientific-technological experimentation processes, which only made sense in the context of the crisis and lost meaning in the final year of the decade, once the most pressing conditions were overcome.

Conclusions

As in previous cases in Chile, the drought of the late 1960s was considered a passing weather phenomenon; thus, the government wasted this opportunity to project or create a new permanent institutional framework for water management. The fact that the crisis did not dramatically affect

72 Erik Swyngedouw, "The Political Economy and Political Ecology of the Hydro-Social Cycle," *Journal of Contemporary Water Research and Education* 142 (2009): 56-60, doi: https://doi.org/10.1111/j.1936-704X.2009.00054.x; Rutgerd Boelens, "Cultural politics and the hydrosocial cycle: Water, power and identity in the Andean highlands," *Geoforum,* 57 (2014), 234-247, doi: https://doi.org/10.1016/j.geoforum.2013.02.008

73 Jamie Linton, "Modern water and its discontents: A history of hydrosocial renewal," *WIREs Water* 1 (2014): 111-120, doi: https://doi.org/10.1002/wat2.1009

74 Silva, *En el nombre de la razón*, 146.

75 Sara Lorenzini, *Global Development: A Cold War History* (Princeton: Princeton University Press, 2019), 133-137.

the country's capital—with the largest proportion of the population and the seat of political power concentrated there—also contributed to this.[76]

The most profound impact was that Chile joined in the efforts that today are typified as geoengineering—in other words, "playing God" with climate and natural resources.[77] The control of the weather, the sophisticated manipulation of glaciers, and the construction of reservoirs and deep wells were scientific-technological products especially validated during the Cold War worldwide, and Chile was no exception. As Simo Laakkonen, Viktor Pál, and Richard Tucker remind us, the Cold War "signified a global power struggle over the control of natural resources," to which one can add their manipulation for self-benefit.[78] By the mid-twentieth century, there was a growing optimism regarding human capacity to control and manipulate water resources and even weather phenomena, like hurricanes, hail, and frosts.[79] In addition, expert knowledge in these areas placed the state and its technocrats at the center of the debate, not necessarily the people. All of this was reinforced by a dichotomy between human beings and nature, perspective that did not see them as integrated; the challenges of modernity strengthened this artificial separation, especially in economies such as Chile, based on the exploitation of natural resources.

What happened during the 1960s had long-lasting consequences. Scientific and technological efforts to experiment with weather modification and the alteration of glaciers prevailed over time. Rain-making experiments continued in the 1970s. During a new drought in 1976, experiments resumed and continued until the end of the decade.[80] In 1996, the mayor of Las Condes, one of the counties of the capital of Chile, tried to generate artificial rain to combat the effects of pollution with an important media coverage.[81] In 2019, the Minister of Agriculture Antonio Walker traveled to China and visited the Jizhou meteorological station to explore the possibilities of Chinese advice in the generation of artificial rain.[82] Cedomir Marangunic continued working with glaciers, and his company still carries out research projects on glaciers, snow, and avalanches. In 2007, he completed an experiment transporting a mass of ice. Using mining trucks, 30,000 tons of ice were removed to a new place to avoid its accelerated retreating.[83]

Beyond the scope of their experimentations, these activities speak of a historical projection of interventions in which environmental imaginaries have validated efforts to control nature. These attempts grew more significant in the 1960s, when there was a considerable impulse by the state, with support from science and technology, to transform water resource management.

---

76 Elizalde Mac-Clure, *La sobrevivencia de Chile*, 59-60.

77 Clive Hamilton, *Earth Masters. Playing God with the Climate* (New Haven: Yale University Press, 2013).

78 Simo Laakkonen, Viktor Pál, and Richard Tucker, "The Cold War and environmental history: complementary fields," *Cold War History* 16, n.º 4 (2016): 378, https://doi.org/10.1080/14682745.2016.1248544

79 Jerry E. Smith, *Weather Warfare. The Military's Plan to Draft Mother Nature* (Kempton: Adventures Unlimited Press, 2006).

80 Erickson and Badilla, "Cloud seeding in Chile," 48.

81 "De la playa artificial a los drones vigilantes. Cinco ideas polémicas de Joaquín Lavín," *La Tercera*, Santiago, April 16, 2017, 18.

82 "Gobierno estudia en China la técnica del 'bombardeo de nubes' para provocar lluvias y analiza replicarlo en nuestro país," *El Mercurio*, Santiago, August 31, 2019, C3.

83 "Where would you like your new glacier?" *Tierramérica. Environment and Development*, Santiago, February 24, 2014, http://www.ipsnews.net/2014/02/like-new-glacier/

Bibliography

Primary Sources

Archives

1. University of Arizona Libraries. United States. Special Collections, James E. McDonald Papers.
2. Archivo Nacional de la Administración (ARNAD), Santiago de Chile, Chile. Fondo Ministerio de Agricultura.

Periodical Publications

3. *Tierramérica. Environment and Development*, New York, United States.
4. *Acontecer Rapelino*, Rapel, Chile.
5. *El Día*, La Serena, Chile.
6. *El Ilustrado*, Santiago de Chile, Chile.
7. *El Mercurio*, Santiago de Chile, Chile.
8. *La Concordia*, Arica, Chile.
9. *La Nación*, Santiago de Chile, Chile.
10. *La Tercera*, Santiago de Chile, Chile.
11. *Las Últimas Noticias*, Santiago de Chile, Chile.
12. *The Jerusalem Post*, Jerusalem, Israel.
13. *The New York Times*, New York, United States
14. ENDESA, *Boletín*, 1968 and 1969, Santiago de Chile, Chile.

Interview

15. Author with Cedomir Marangunic, June 21, 2016

Secondary Sources

16. Boelens, Rutgerd. "Cultural politics and the hydrosocial cycle: Water, power and identity in the Andean highlands." *Geoforum* 57 (2014): 234-247, doi: https://doi.org/10.1016/j.geoforum.2013.02.008
17. Buckley, Eve E. *Technocrats and the Politics of Drought and Development in Twentieth-Century Brazil*. Chapel Hill: University of North Carolina University Press, 2017.
18. Budds, Jessica. "Contested H2O: Science, Policy, and Politics in Water Resources Management in Chile." *Geoforum* 40 (2009): 418-430, doi: https://doi.org/10.1016/j.geoforum.2008.12.008
19. Camus, Pablo, and Fabián Jaksic. *Clima y Sociedad. El fenómeno El Niño y la Niña en la historia de Chile*. Santiago: Instituto de Geografía UC, 2022.
20. Camus, Pablo, and Fabián Jaksic. "La gran sequía de 1968: efectos sociopolíticos y crisis de la democracia en Chile." *Revista de Historia* 28, n.º 2 (2021): 271-293, doi: http://dx.doi.org/10.29393/rh28-34gspf20034
21. Carey, Mark. *In the Shadow of Melting Glaciers. Climate Change and Andean Society*. Oxford: Oxford University Press, 2010.
22. Carey, Mark, Michel Baraer, Bryan G. Mark, Adam French, Jeffrey Bury, Kenneth R. Young, and Jeffrey McKenzie. "Toward Hydro-Social Modeling: Merging Human Variables and the Social Sciences with Climate-Glacier Runoff Models (Santa River, Peru)." *Journal of Hydrology* 518 (2014): 60-70, doi: https://doi.org/10.1016/j.jhydrol.2013.11.006

23. Chastain, Andra B., and Timothy W. Lorek. "Introduction." In *Itineraries of Expertise: Science, Technology and the Environment in Latin America's Long Cold War*, edited by Andra B. Chastain and Timothy W. Lorek, 217-236. Pittsburgh: Pittsburgh University Press, 2020.
24. Davis, Mike. *Late Victorian Holocausts. El Niño Famines and the Making of the Third World*. London: Verso, 2017.
25. Donoso R., Jaime. *Chile y sus recursos hidráulicos*. Santiago de Chile: CORFO, 1967.
26. Elizalde Mac-Clure, Rafael. *La sobrevivencia de Chile*. Santiago de Chile: Ministerio de Agricultura, Servicio Agrícola y Ganadero, 1970.
27. Erickson, David, and Oscar Badilla. "Cloud seeding in Chile." *Journal of Weather Modification* 14, n.º 1 (1982): 47-52.
28. Fleming, James R. *Fixing the Sky. The Checkered History of Weather and Climate Control*. New York: Columbia University Press, 2010.
29. Hamilton, Clive. *Earth Masters. Playing God with the Climate*. New Haven: Yale University Press, 2013.
30. Jasanoff, Sheila, and Sang-Hyun Kim. "Sociotechnical Imaginaries and National Energy Policies." *Science as Culture* 22, n.º 2 (2013): 189-196, doi: https://doi.org/10.1080/09505431.2013.786990
31. Jasanoff, Sheila. "Future Imperfect: Science, Technology, and the Imaginatios of Modernity." In *Dreamscapes of Modernity. Sociotechnical Imaginaries and the Fabrication of Power*, edited by Sheila Jasanoff and Sang-Hyun Kim, 1-33. Chicago: The University of Chicago Press, 2015.
32. Jones, Rebecca. *Slow Catastrophes. Living with Drought in Australia*. Clayton, Victoria: Monash University Publishing, 2017.
33. Josephson, Paul. *Industrialized Nature. Brute Force Technology and the Transformation of the Natural World*. Washington: Island Press, 2002.
34. Laakkonen, Simo, Viktor Pál, and Richard Tucker. "The Cold War and environmental history: complementary fields." *Cold War History* 16, n.º 4 (2016): 377-394, doi: https://doi.org/10.1080/14682745.2016.1248544
35. Lemon, Michael, and Eden Medina. "Technology in an Expanded Field: A Review of History of Technology Scholarship on Latin America in Selected English-Language Journals." In *Beyond Imported Magic. Essays on Science, Technology and Society in Latin America*, edited by Eden Medina, Ivan da Costa Marques, and Christina Holmes, 111-136. Cambridge: The MIT Press, 2014.
36. Linton, Jamie. "Modern water and its discontents: A history of hydrosocial renewal." *WIREs Water* 1 (2014): 111-120, doi: https://doi.org/10.1002/wat2.1009
37. Linton, Jamie, and Jessica Budds. "The hydrosocial cycle: Defining and mobilizing a relational-dialectical approach to water." *Geoforum* 57 (2014): 170-180, doi: https://doi.org/10.1016/j.geoforum.2013.10.008
38. Llona, Carlos. "La buena aplicación del agua." *Revista Chilena de Ingenieros y Anales del Instituto de Ingenieros* 340 (1969): 9-15.
39. López, Nicolás, "Un terremoto silencioso. Sequía y crisis social en el campo chileno, 1967-1969." In *Seminario Simon Collier 2017*, 99-127. Santiago de Chile: Instituto de Historia UC, 2017.
40. Lorenzini, Sara. *Global Development: A Cold War History*. Princeton: Princeton University Press, 2019.
41. Medina, Eden, Ivan da Costa Marques, and Christina Holmes, eds. *Beyond Imported Magic. Essays on Science, Technology, and Society in Latin America*. Cambridge: MIT Press, 2014.
42. Medina, Eden. *Cybernetic Revolutionaries: Technology and Politics in Allende's Chile*. Cambridge: MIT Press, 2011.

43. Olson, Tore. *Reformers and the Remaking of the US and Mexican Countryside*. Princeton: Princeton University Press, 2017.
44. Purcell, Fernando. "Dams and Hydroelectricity: Circulation of Knowledge and Technological Imaginaries in South America, 1945-1970." In *Itineraries of Expertise: Science, Technology, and the Environment in Latin America's Long Cold War*, edited by Andra B. Chastain and Timothy W. Lorek, 217-236. Pittsburgh: University of Pittsburgh Press, 2020.
45. Sagredo, Rafael. "Electricidad para el desarrollo." In *Historia de la Ingeniería en Chile*, coordinated by Sergio Villalobos, 339-357. Santiago de Chile: Hachette, 1990.
46. Schneider Singer, Hans, and Orlando Peña Alvarez. "Un aporte al estudio de la sequía en Chile." *Revista Geográfica* 83 (1975): 109-125, https://www.jstor.org/stable/40992289
47. Silva, Patricio. *En el nombre de la razón. Tecnócratas y política en Chile*. Santiago de Chile: Ediciones Universidad Diego Portales, 2010.
48. Smith, Jerry E. *Weather Warfare. The Military's Plan to Draft Mother Nature*. Kempton: Adventures Unlimited Press, 2006.
49. Swyngedouw, Erik. "The Political Economy and Political Ecology of the Hydro-Social Cycle." *Journal of Contemporary Water Research and Education* 142 (2009): 56-60, doi: https://doi.org/10.1111/j.1936-704X.2009.00054.x
50. Tinsman, Heidi. *La tierra para el que la trabaja. Género, sexualidad y movimientos campesinos en la Reforma Agraria chilena*. Santiago de Chile: Lom-Centro de Investigaciones Diego Barros Arana, 2009.
51. Tucker, Richard. "Containing Communism by Impounding Rivers: American Strategic Interests and the Global Spread of High Dams in the Early Cold War." In *Environmental Histories of the Cold War*, edited by John McNeill and Corina R. Unger, 139-164. New York: Cambridge University Press-German Historical Institute, 2010.
52. Wolfe, Mikael D. *Watering the Revolution. An Environmental and Technological History of Agrarian Reform in Mexico*. Durham: Duke University Press, 2017.

❧

Fernando Purcell

He received his PhD in History from University of California, Davis (United States). He is currently professor of the Instituto de Historia, Pontificia Universidad Católica de Chile, and member of the Centro de Cambio Global UC. He has published "Dams and Hydroelectricity: Circulation of Knowledge and Technological Imaginaries in South America, 1945–1970," in *Itineraries of Expertise: Science, Technology, and the Environment in Latin America's Long Cold War*, edited by Andra B. Chastain and Timothy W. Lorek (Pittsburgh: Pittsburgh University Press, 2020), 217-236; *The Peace Corps in South America. Volunteers and the Global War on Poverty in the 1960s*. (Cham, Switzerland: Palgrave Macmillan, 2019). fpurcell@uc.cl