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Research Report

Climate change and differential water access in Santiago, Chile: a critical approach to climate attribution

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Introduction

Linking the discrete socio-economic impacts of extreme weather events to climate change is a rapidly growing area of academic and policy interest (IPCC 2022). Hydroclimatic attribution studies evaluate the contribution of anthropogenic climate change to the length or intensity of an extreme weather event or broader hydroclimatic shift. These studies feature heavily in causal claims made in public discourse, media coverage of disasters, and climate litigation on the relationship between the climate crisis and its impacts on lives and communities (Stuart-Smith et al., 2021a). Largely missing from the attribution research approach, however, is attention to the socio-political co-production of the disaster. The politics of attributing water scarcity and patterns of water (in)access to climate change, and how this narrative may serve certain actors more than others or deepens existing hydro-social relations is likewise missing.

Decades of scholarship in human geography and political ecology offer a clear warning of the dangers of dismissing human vulnerability and over-emphasizing the biophysical contribution to disasters (O'Keefe, Westgate & Wisner, 1976). This body of work demonstrates that the discourse of disasters as 'acts of god' allows the root causes of human vulnerability, such as poverty, resource deprivation, and inequality, to persist unaddressed (Taylor, 2015). A handful of studies have begun integrating these political ecology perspectives to critique the current climate-centric attribution paradigm and argue for a vulnerability-centric attribution discourse (Lahsen & Ribot, 2022; Raju, Body & Otto, 2022).

The central Andes is a key region for attribution research because glaciers make up a large share of societal water supply and their recent rapid retreat has been attributed closely to climate change (Mukhopadhyay, 2012; Stuart-Smith et al., 2021b). Regional Andes literature documents the unique socio-economic, geographical, and cultural factors that shape human vulnerability to environmental and climatic change in the region (Eakin & Lemos, 2006; Carey, 2010; Mills-Novoa et al., 2017). Central Chile has additionally faced an unprecedented 'mega-drought' since 2010. Twenty-five percent of the intensity of the drought has been attributed to climate change (Boisier et al., 2016). Santiago's water source, the Maipo River, has dwindled, falling to 28% of its historic average flow rate in the summer of 2019 (Ayala et al., 2020). This river provides potable water for 8 million urban users and 200,000 rural residents and irrigation for Chile's breadbasket agricultural economy (Donoso, 2018). Some rural populations have relied for years on government cistern deliveries or have begun walking multiple hours per day to fetch spring water (Lucero, 2020). In contrast to climate change, some previous

studies have instead highlighted the role of Chile's neoliberal water governance regime in deepening disparities in water scarcity burdens (Budds, 2013; Bauer 2015).

Dissertation Research Approach

My dissertation builds a new interdisciplinary approach to attribution that integrates critical perspectives in social sciences and physical studies on climate change impacts. In the case of Santiago, Chile, I characterize the socio-economic impacts of glacier retreat and drought, both of which have been hydro-climatically attributed to climate change (Ayala et al., 2020; Stuart-Smith et al., 2021b). My dissertation documents and evaluates how climate change, by way of glacier retreat and drought, have interacted with human vulnerability to exacerbate water access disparities and impose differential socio-economic impacts. I evaluate the extent to which these impacts can be attributed to climate change and build a research model that is transferable to other regions on the frontlines of climate change in the glacierized Andes and Himalayas. This project contributes to a new critical, socially-embedded approach to climate change attribution that is centered on vulnerability and in conversation with loss and damage politics.

The motivating question of my dissertation is: What are the processes and mechanisms by which climate change has deepened existing patterns of water access in the Andes region? My dissertation has two linked research questions. My first research question asks: How have hydrological and human responses to glacier retreat and meteorological drought conditions combined to drive changes in streamflow production in the Santiago headwaters during the mega-drought period? And the second asks: **How has hydrological change during the drought interacted with human vulnerability to produce differential drinking water access in the Santiago Metropolitan Region?**

With the support of Tinker/CLAS, towards the second research question, I am gathering qualitative data to characterize how issues of water access, deepened by climate change, compound existing socio-economic inequities. I employ multiple qualitative methods that together provide deeper insights into the material, biophysical, and social reality of how drinking water is accessed in the region, and how hydrological change has interacted with these systems. These include semi-structured interviews to capture discrete and disparate experiences of water access, participant observation of community meetings to understand dynamics between actors, and household surveys to deepen insights on the material and biophysical realities of changes in water use and management. Through iterative thematic coding of transcripts, fieldnotes, and survey responses, I will elucidate discrete socio-economic impacts of changes in water access, perceived drivers of change and disparate experiences.

In my analysis, I will first reconstruct the history of how rural communities were rendered vulnerable to the mega-drought and how the state response during the drought event played out. I will then analyze how rural drinking water access changed during the mega-drought and its social and economic impacts. Further, I will situate how a climate change-induced event interacted with structural political economic factors in this case to produce material changes for people and the environment, by

drawing on the lens of political ecologies of climate change adaptation and vulnerability (Taylor, 2015; Thomas et al., 2019). This lens allows me to understand climate change vulnerability as linked but distinct from development processes and disaster vulnerability (Bassett & Fogelman, 2013; Webber, 2016). I filter in insights from the literature on the materiality of water scarcity and access to link societal choices on how we govern and manage water to household and community-scale experiences (Ennis-McMillan, 2001; Wutich & Ragsdale, 2008). This frame allows me to critically analyze the causal links between social outcomes and their physical and social drivers, building a new vulnerability-focused theory of climate attribution.

CLAS/Tinker Research Activities

During my CLAS/Tinker grant period (March 1 - June 1, 2023) I conducted preliminary semi-structured interviews with rural potable water users and government officials, engaged in participant observation of water user community and stakeholder meetings, and performed site visits of key landmarks in the river basin. This qualitative data collection is fundamental to shaping the second phase of my field research, which includes conducting a survey that compares households who lost household potable water access during the drought period with those who likewise did not have it before. This early field work research period was also invaluable to conduct a local literature review, seek out new contextual demographic and hydrological data sets, deepen my relationships with my two local research collaborators, and develop a collaboration with a potable rural water capacity-building organization.

1. **Interviews (n = 40 currently)**
    a. *Rural water associations* (n = 18) known in Chile as ('APRs') were contacted through a snowball method that was supplemented by cold calls to associations with publicly-available contact information. There are 110 government-recognized APRs in the Santiago Region.
        i. I am ensuring regional representativeness by factors that were stressed by associations themselves: size, type (committee or cooperative), age, semi-rural or rural, surface vs. groundwater, and municipality.
    b. *Informal local water councils* (n = 1) this self-organized community group was interviewed to provide additional perspective to formalized APRs.
    c. *National government officials* (n = 7) who work directly on potable water planning, policy, or management, ranging from top officials to analysts
    d. *Local government officials* (n = 8) who work on potable water infrastructure and emergency response to potable water shortages
    e. *Rural potable water advocacy groups* (n = 5) who represent or work directly with APRs on legal advocacy and capacity building
    f. *Urban potable water utility* (1) to contrast to the rural experience

2. **Participant observation:**

   a. Monthly meetings of key water stakeholders from the private and public sectors and civil society for the formation of the national government's Maipo River Basin Council (4 sessions)
   b. National government community meetings for water manager and user capacity building (2 sessions)
   c. Maipo River citizen science volunteer group (5 sessions) to understand hydrological changes through the basin and time

3. **Site visits of key landmarks:**
   a. Tour of the urban utility's potable water storage facility
   b. Tour of national government General Water Directorate offices for National Patrimony Day
   c. Maipo River dry spots (1 point identified in the literature, 3 others self-found or by recommendation from preliminary interviews)
   d. Extensive walking and running routes along the riverbed and canals

4. **Other research activities:**
   a. **Local literature review**: I conducted a local Spanish-language literature review of academic and grey literature, news clips, and social media material on the impacts of the mega-drought on water access and policies and historical events that have shaped potable water provision in the region.
   b. **Gathering contextual data:** I amassed a collection of publicly available datasets on rural water association locations and sub-regional socioeconomic demographics and hydrological change.
   c. **Stakeholder mapping:** I mapped relevant local stakeholders (approx. 200) and constructed a contact sheet of potential interview subjects.
   d. **Research assistant hire:** I developed a position description and circulated it to research collaborators and partners to recruit two university research assistants.

5. **Other academic activities:** I had 16 preliminary conversations with local academics when I arrived to improve the feasibility and rigor of my methodology, dig deeper into the local context, look for points of collaboration, and expand my network. I've attended several local seminars and conferences including a glaciology research conference, a conference on water management, seminar series on water law and policy co-hosted by the national government, a rural science-community environmental conference, an environmental conflict seminar, and a student seminar on water research. Through one of my collaborators, I joined a local research group (the Center for Transdisciplinary Systemic Studies) and participate regularly in her research group.

Emerging Themes in Data Collection

Access to rural drinking water during the drought has changed materially and significantly. These changes have been most acute furthest from the river where the

groundwater table was low but has dropped significantly as irrigationists and mining companies have switched from surface to also groundwater. Due to surface sources and groundwater wells drying, several APRs have reported forced school closures due to a lack of running water and families chronically rationing water in the household, developing reuse techniques, and seeking out unaffordable and precarious alternative water sources. Numerous APR leaders have emphasized that the burden of coping with water rationing often falls on women, particularly those with young children. While the national and municipal governments have invested heavily in emergency water tanker trucks (now a permanent system for many communities), the water they bring is insufficient in many cases to meet basic household needs and households often supplement with other sources or through rationing.

Water scarcity (from hydrological change) and water access are not exactly correlated. For example, half of the rural population in the region likewise did not have formal drinking water access before the drought began, including in areas with abundant surface and groundwater. Across diverse cases of APRs, drought conditions appear to be deepening issues of access rather than introducing new issues. Likewise, water scarcity seems to be a parameter condition to water access even if it does not determine it. For some rural communities, it is possible that the human response to drought conditions (i.e., agriculturalists switching from surface to groundwater) had more of an impact on the water access of neighbors than the drought itself. Rural potable water users are bearing the brunt of water market-driven and uncoordinated drought-adaptation choices by larger water users in the basin.

I'm still working to develop a clear analysis of the social mechanism through which water scarcity and inequities in access are produced in this case. This analysis will help me explain why some communities started with higher vulnerability and have borne disproportionate burdens of drought impacts.

Next Steps: Stage Two in Data Collection

1. Finishing up interviews with rural water associations with an eye to fill in gaps and prep for survey site selection
2. Designing and conducting the survey
3. Finish up participant observation: APR advocacy group meetings and join a tanker truck for their delivery route
4. Community validation and dissemination of findings via community reports
5. Contextual demographic and hydrological analysis to show water access and vulnerability socio-spatial dynamics before the drought began and how they progressed through time

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