Bonn Contact Group on Climate,
Peace and Security ahead of COP29

Report

Ripples of Discord: Addressing Water Conflicts in the Anthropocene

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Report on the nexus between climate change and water scarcity, particularly that caused or accentuated by conflict

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RESTART INITIATIVE

Bonn Contact Group on Climate Peace and Security ahead of COP29

About

The Bonn Contact Group on Climate Peace and Security ahead of COP29 brings together professionals, academics and civil society activists from across Europe and beyond who support the process of bringing to the COP29 process the agenda of peace.

The Group was established at the end of the Bonn Dialogue Meeting on Climate Peace and Security, held in Bonn on 3 May 2024. The landmark meeting brought together representatives of the COP28 and COP29 presidencies UAE and Azerbaijan), representatives of think tanks, civil society organisations and academics, and other stakeholders, for a dynamic exchange of views on how to build on the success of COP28 in Dubai, and particularly how to take forward the COP28 Declaration on Climate, Relief, Recovery and Peace. It was felt that what was achieved in Dubai should not be lost and that civil society needs to work with the Azerbaijani presidency of COP29 to consolidate the ideas and take them forward.

Given the vastness of the topic, and the limitation of time and resources, the BCG decided that in between now and November, it will focus on three sub-themes: Food Insecurity, water scarcity and Contamination by remnants of war.

The members of the Bonn Contact Group are organised in three task forces, dealing with the three sub themes. Their job is to prepare reports on the three sub-themes that will help inform discussions and decisions.

• To gather expertise on their topic of interest with a view to preparing, by September 2024, a report of a sufficiently robust level to feed into the discussions of the COP29 meeting.

• To engage with the COP Troika countries and other state and non-state parties on the theme in the run-up to the COP29 in Baku and beyond, and to support the holding of a day of peace within the context of COP29 in November in Baku.

Who is Who?

The work of the Bonn Contact Group is coordinated by LINKS Europe Stichting. The general coordinators of the Bonn Contact Group are Dr Dennis Sammut, Director of LINKS Europe; Leo Wigger from the Candid Foundation; and Isabelle McRae from Restart Initiative, are part of the core team. LINKS Europe provides the secretariat and logistical support for the initiative. Around 30 European and international experts have signed up for the contact group. They will be directly involved in the September workshops and in the preparation of the core recommendations on the themes of food insecurity, water scarcity and land contamination.

For more information about the Bonn Contact Group, please contact Maximiliaan van Lange at LINKS Europe. (maximiliaan@links-europe.eu).

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Problem Analysis

This article explores the intricate nexus between climate change, water stress, and conflict, focusing on both the physical scarcity of water and the broader social and governance factors that exacerbate these challenges. By examining two diverse case studies—Yemen and Chile—the article highlights how water scarcity, intensified by climate change, can fuel societal tensions and conflict. In Yemen, where a protracted civil war has been unfolding, the worsening impacts of climate change, coupled with dwindling water resources, are deepening the already critical humanitarian crisis. Water scarcity has become a powerful driver of conflict, intensifying local disputes and heightening the overall instability of the country. In contrast, Chile, while not engaged in armed conflict, faces significant water stress linked to its role in the global fight against climate change. As a leading producer of lithium—a critical mineral for renewable energy technologies—Chile′s water resources are under increasing strain from extraction activities. This has spurred tensions among various societal groups, particularly in regions already suffering from severe water poverty. By comparing these two cases, the article illuminates the complex interplay between environmental degradation, resource scarcity, governance, and societal stability, offering crucial insights into the broader global challenges posed by the climate change-water-conflict nexus.

Currently, many regions and countries worldwide are experiencing increasing stress on their water resources (Zekri 2020; Amery 2015; Keulertz and Allan 2019). A myriad of factors, such as demographic and industrial growth, environmental and climatic changes, and irresponsible usage, further strain this precious resource, which is indispensable for the survival, development, and security of humanity (Vörösmarty et al. 2000; Hoff 2009). Additionally, the transformation of economies and current energy systems is closely linked to the issue of sustainable water management and future accessibility. The extraction of critical minerals and the production of clean technologies like hydrogen require significant freshwater resources, potentially depleting local supplies and impacting ecosystems and communities (Helerea, Calin, and Musuroi 2023; Sparks et al. 2014; Sehn and Blesl 2021; Meng and Asuka 2022). This suggests that water management is both a local issue and an essential component of global change and globalization (Pahl-Wostl, Gupta, and Petry 2008; Gupta, Pahl-Wostl, and Zondervan 2013). The concept of ′virtual water′—the hidden flow of water used in the production and trade of goods and services—highlights the global entanglement of local water needs (J. A. Allan 2011). Almost every product has an immense water footprint throughout its value chain, which often goes unnoticed when products are exported, potentially causing severe water imbalances in other regions. The combined impacts of local changes to water systems, along with the pressures from a globalizing economy and climate change, have resulted in water scarcity for many people on this planet (Hoff 2009). Additionally, unrestrained economic development and industrialization are increasingly degrading water quality, leading to pollution and contamination that threaten both ecosystems and human health (Gunda et al. 2019).

In general, the concept of ‘water security’ extends beyond simply addressing diminishing water supplies. According to UN-Water (2013), water security is defined as “the capacity of a population to safeguard sustainable access to adequate quantities of water of acceptable quality for sustaining livelihoods, human well-being, and socio-economic development, ensuring protection against water-borne pollution and water-related disasters, and preserving ecosystems in a climate of peace and political stability.” This comprehensive definition encompasses not only the availability of water but also issues related to access, which involve fundamental individual rights, national sovereignty over water resources, equity and affordability, and the roles of states and markets in the allocation, pricing, regulation, and distribution of water (Gunda et al. 2019).

1 World Resources Institute. (2023, August 16). Aqueduct Country Ranking. https://www.wri.org/applications/aqueduct/country-rankings/

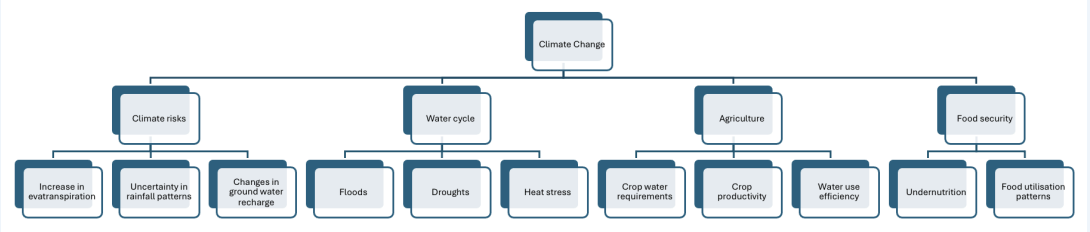
2 UN-Water, Water Security & the Global Water Agenda: A UN-Water Analytical Brief (2013), http://www.unwater.org/publications/water-securityglobal-water-agenda/

However, access to water is not equal for everyone. Approximately 40 percent of the global population lives in river and lake basins that span two or more countries, with over 90 percent residing in nations that share these basins. There are 286 transboundary lake and river basins worldwide, covering nearly half of the Earth's land surface and accounting for about 60 percent of global freshwater flow. A total of 148 countries have territory within these basins, with 21 countries entirely situated within them. Additionally, around 2 billion people globally rely on groundwater, including more than 500 transboundary aquifer systems (Vink 2020).

As a result, humanity has attempted to address the declining availability of water and tackle the challenges associated with 'Peak Water.[3] For instance, technological advancements such as desalination, wastewater collection and treatment, rainwater harvesting, storage and use have been expanded for decades. These technologies help mitigate some of the problems. However, they also exacerbate others. Currently, many of the costly and energy-intensive desalination plants are still powered by fossil fuels, which contribute to climate change. Additionally, the issue of discharging brine and other chemical by-products into the oceans remains a persistent problem, making desalination technology unsustainable until today (Naderi Beni et al. 2021; Anastasi 2024). Similarly, current experiments with cloud seeding in particularly dry regions are considered high-risk technologies that could significantly and permanently alter the delicate meteorological balance. This all underscores that water technologies are not the 'silver bullet' many hope for.

Scholarship increasingly concludes that the water crisis is primarily a 'crisis of governance,' requiring more than technocratic and depoliticized management and engineering processes. It is fundamentally a deeply political challenge spanning from the global to the local (i.e. glocal) level (Gupta, Pahl-Wostl, and Zondervan 2013; Swyngedouw 2014). As an irreplaceable and incredibly valuable resource, and if not managed properly, water faces increasing demand and intensifying competition. This growing competition is widely believed to lead to increased tensions both within and between nations. Furthermore, it is noted that global warming may dramatically exacerbate these effects (Vörösmarty et al. 2000; Scott and Sugg 2015; Lange 2022). Figure 1 illustrate the interconnectedness of climate change with changes in water availability, sufficiency and access, highlighting its broader impact on various factors that threaten human livelihoods and security. In due consideration, climate change could accelerate global tensions, potentially leading to conflicts over access to water resources, thereby threatening peace and stability worldwide. Especially in regions of political instability, climate change is frequently described as a 'threat multiplier' (Goodman and Baudu 2023), exacerbating social stresses that contribute to radicalization and weakening state capacities. These stresses arise from droughts, floods, food shortages, and the disruptions caused by migrants fleeing dangerous areas or seeking new livelihoods when their agricultural systems become unproductive.

Figure 1: Climate change impacts on water patterns, agriculture and food security (cited from: Kingra and Kukal 2024, 283)



3 https://pacinst.org/press_center/press_releases/concept_of_peak_water_2011.pdf

Two main driving forces can be identified how the nexus between climate, water and security is playing out. On the one hand, natural and anthropogenic climate change dynamics as well as responses to it lead to deterioration of existing water resources, threatening economic prosperity and social welfare. In this vein, several regions and countries have been experiencing severe droughts and agricultural failures due to climate change exacerbating socio-economic stresses, intensifying competition for water and contributing to tensions and conflicts (Naderi Beni et al. 2021; Kim and Garcia 2023). On the other hand, existing conflicts have a major negative footprint on water availability: conflict-driven destruction of water infrastructure exacerbates water scarcity, oftentimes forcing communities to over-exploit natural water sources, reducing groundwater levels, and exacerbating regional climate patterns (see also: Bonds 2016; Sowers and Weinthal 2021; Weinthal and Sowers 2019; Mohamed, Anders, and Schneider 2020). However, in unstable political contexts, water resources can become not only a target but also a weapon used to achieve strategic objectives (Marcus DuBois King 2015; Lossow 2020; Daoudy 2020b). Additionally, displacement due to conflicts increases pressure on local water resources, leading to environmental degradation and altering local microclimates with broader climatic impacts over time (Kim and Garcia 2023).

Against this backdrop, this study delves into current discussions regarding the interconnections between water scarcity and conflict. It posits that there is neither a straightforward causal relationship nor a simple correlation between water and conflict. Thus, it challenges environmental determinism and instead emphasizes broader social science frameworks encompassing governance, power dynamics, and inequalities. The study investigates two cases involving various water issues to illustrate the range of water-conflict relationships.

Unpacking the water-conflict nexus

Understanding the connection between water and climate change is often framed by two major perspectives in international relations: neorealism and neoliberalism. Neorealism views the global system as competitive, where states prioritize their own survival, leading to potential conflicts over scarce resources like water. In contrast, neoliberalism highlights the potential for cooperation, arguing that international agreements and collaboration can address shared challenges such as water scarcity. These two mainstream schools of International Relations help shape how we think about global challenges, including water scarcity and conflict (Szálkai and Szalai 2023). To better analyze the link between water and conflict, it's helpful to first explore two key ideas—Neo-Malthusianism and Cornucopianism—which offer different views on resource use and environmental limits, and to consider how they apply to this issue. These ideas closely align with the neorealist concern about resource scarcity and conflict, as well as the neoliberal emphasis on cooperative solutions to environmental challenges.

The Neo-Malthusian approach, inspired by the British author Thomas Malthus, focuses on the idea that resource scarcity, exacerbated by population growth, can lead to famine or war. Modern Neo-Malthusians are concerned with conflicts arising from the growing gap between the increasing demand for finite resources and the decreasing supply due to overuse, demographic pressures, or environmental factors (Homer-Dixon 1994; 1999).

The notion that there is a direct causal relationship between dwindling resources and conflict has been particularly discussed in the context of water: as a finite resource, water poses a dual threat of conflict due to scarcity and increased vulnerability for states. Less water naturally has additional consequences, such as the decline of crop production and the loss of fertile land, which can, in turn, trigger conflict situations (Vesco et al. 2021). In this regard, govern-

ments view water as a strategic resource crucial for their security and survival, and theoretically, states seek absolute and exclusive sovereignty over it. Because every state aims to protect its water reserves, competition and unilateral actions inevitably escalate, especially in the case of shared water resources, which, according to Neo-Malthusians, can easily culminate in water disputes. Studies have primarily focused on 'extreme cases,' often using the hyper-arid region of the Middle East as a key reference point (Naff 1994; Amery 2020). In this regard, alleged transnational 'water wars' over management in the Jordan River Basin as well as damming policies in the Tigris-Euphrates Basin or Nile Basin are frequently cited as examples (Bulloch and Darwish 1993; Amery 2002; Al-Muqdadi et al. 2016). While such Neo-Malthusian apocalyptic scenarios have become less common in scientific publications, fears of future 'climate' or 'resource wars' (Klare 2002; Welzer and Camiller 2012) are still occasionally reignited in public discussions. This contrasts sharply with empirical evidence showing that transboundary river systems are more often associated with low-level conflicts and diplomatic tensions than full-scale war (Wolf, Yoffe, and Giordano 2003; Furlong, Petter Gleditsch, and Hegre 2006; Bencala and Dabelko 2008; Scheffran et al. 2012; Selby, Daoust, and Hoffmann 2022).

In fact, the increase in international water agreements over the past decades indicates growing cooperation. This trend supports advocates of the neoliberal Cornucopian approach, which critiques Neo-Malthusianism. Cornucopians do not entirely dismiss the idea that water scarcity can lead to conflict. However, they argue that interdependencies more often result in cooperation, as it is a more rational and cost-effective approach than escalating tensions (Elhance 1999; Swain 2001; Yoffe, Wolf, and Giordano 2003). According to this approach, which is frequently also labeled as 'hydro-diplomacy', the overall goal should be to create a situation with positive spillover effects. This involves strengthening formal regulations and institutions, fostering technological advancement, and promoting the exchange of information, all with the aim of increasing water resources available for human use and reducing pressure on existing resources (Szálkai and Szalai 2023). It also gave rise to the promotion of integrated water resource management (IWRM) as a key policy tool (Daoudy 2020a).

However, both approaches are based on deterministic and simplistic assumptions that changes in the water resource dynamics will lead to specific consequences. Also, the related concept of hydro-hegemony, which characterizes the power asymmetries of shared water resources through a powerful agent that controls the basin as the most powerful riparian state, reiterates the narrow focus on states as primary and unitary actors and the view of water as a mere commodity (Williams 2020; Seeberg 2024). These perspectives fall into a 'territorial trap' by concentrating on states and their sovereignty and control over water, while overlooking the more complex and reciprocal human-environment relationships (Furlong 2006). Moreover, it has been criticized that this traditional thinking is based on Western-centric mainstream International Relations (IR) assumptions, which are scarcely applicable to other world regions (Ahmadzai 2023). The simplified cooperation-conflict dichotomy often does not hold up to reality checks. For example, Israel can be ostensibly seen as a hydro-hegemon, yet the water issue as part of the Middle East conflict remains unresolved despite promising solutions (Hussein, Menga, and Greco 2018). Examples from Central Asia also show how the management of shared water resources has shifted from cooperation to episodes of conflict. Other studies in the Nile, Tigris-Euphrates, and Indus River basins have revealed the significant role identity plays, far removed from rational actions (Ghoreishi, Mianabadi, and Jafari 2023).

In this context, Harry Verhoeven refers to both Neo-Malthusianism and Cornucopianism as

“fata morgana dreams” because they profoundly overlook the significance of localization and the dynamics of political ecologies (Verhoeven 2011, 702). Thus, he aligns himself with a tradition that has primarily emerged from critical geography over the past decade and has made a significant contribution to the understanding of the water-conflict nexus (Furlong 2006). Especially advocates of Political Ecology shifted attention to the explanatory power of ‘social production of nature’ meaning ‘how we produce nature and who controls this production of nature’ (Furlong 2006, 445; Le Billon 2001). In this vein, they also emphasized the cross-scale nature or 'spatiality' of water governance, where various actors are involved from the local to the global level (Swyngedouw 2014).

Aligned with studies on environmental peace and security, political ecologists argue that water scarcity frequently triggers social disputes and non-violent conflicts. The escalation of these tensions often hinges on pre-existing negative socio-political relationships between groups and the specific traits of political systems (Le Billon and Duffy 2018; Scheffran et al. 2012; Ide et al. 2021). Local realities and specific broader socio-economic and political circumstances that can increase the risk of violent conflict include aspects such as governance arrangements, livelihood options, internal and international migration, geopolitical realignments, existing sociocultural conditions or power relations including processes of state-building, war-making and development (Selby 2005; Selby and Hoffmann 2014; Verhoeven 2011; 2015; Ide et al. 2021; Kim and Garcia 2023; Ide 2018; Daoudy 2020a; Selby, Daoust, and Hoffmann 2022).

The following sections will empirically examine the complex interplay between climate change, water stress, and conflict, focusing on two distinct case studies: Yemen and Chile. Yemen is selected because it represents a stark example of how worsening water scarcity, exacerbated by climate change and ongoing civil conflict, deepens a humanitarian crisis. In Yemen, limited water resources have become a significant driver of local disputes, contributing to the country's instability and suffering. In contrast, Chile serves as an important case for understanding the social tensions that can arise from resource extraction in a relatively peaceful context. As a leading producer of lithium, essential for renewable energy technologies, Chile faces significant water stress due to the demands of mineral extraction, raising concerns about local water availability and igniting tensions among communities already experiencing water poverty. By analyzing these two cases, the article highlights the complex interplay of environmental degradation, resource scarcity, governance, and societal stability, providing valuable insights into the broader global challenges related to the climate change-water-conflict nexus.

Yemen: Water emergency during global warming and armed conflict

The Middle East is a region under significant water stress, where access to adequate water supply is considered a strategic asset, leading to the securitization of water resources. This securitization, coupled with a fragile regional environment marked by chronic political instability and armed conflict, fosters deep-seated distrust among various actors, thereby reducing the likelihood of cooperation (John Anthony Allan 2008; Gleick 2019; Marcus Dubois King 2021). This is particularly evident in Yemen. For some time, climatic stress and environmental degradation significantly impacted Yemen′s agriculture and rural life, leading to food insecurity and severe water scarcity. Yemen, described as "one of the oldest water management civilizations in the world" (Ward 2015, xxi), confronts critical challenges in water supply (Haidera et al. 2011). According to Helen Lackner, "water represents the primary constraint for Yemen′s future" (Lackner 2019, 110) that has historically been mismanaged considering context factors such as population growth, groundwater depletion, market-driven agricultural practices, and inefficiencies in water use leading to pollution (Weiss 2015). Approximately 2,500 people are estimated to die annually due to local water conflicts in the country (Al-Saidi 2020). The ongoing civil war, coupled with a humanitarian crisis and high susceptibility to both short- and long-term climate change effects, present formidable barriers to Yemen′s sustainable development and prospects for reconciliation (Bilkis and Zumbraegel 2022).

There are several aspects to consider when trying to understand in what way environmental change and violent conflict are intertwined in Yemen, these include a high degree of climate vulnerability while equally being highly dependent on natural resources (Aklan 2024). Furthermore, since the outbreak of the war, a dysfunctional governance system is in place that is neither able to enforce authority nor to ensure the maintenance of key tasks of a social contract including a loss of protecting and provision of key services, leading to an erosion of legitimacy and believe in the governments functioning from the majority of citizens (Al-Mowafak 2021; see further: Loewe, Zintl, and Houdret 2021). Furthermore, there are several actors stepping into this political vacuum. These include parties to the conflict such as the internationally recognized government of Yemen (IRGY), the Houthis, Al Qaeda, and various international actors including Saudi Arabia, Iran, the United Arab Emirates and the United States. Major tribal confederations, due to their significant political influence, are also key players in this conflict. This intricate web of actors has resulted in Yemen being fragmented into several distinct political and military zones of control (Sowers and Weinthal 2021).

This intricate web of actors, combined with the ongoing civil war, highlights how water-related climate security pathways in Yemen are bound to a complex interplay between conflict and climate change, both of which are driving water scarcity. Prior to the conflict, public water systems served only half the population but were already responsible for 90% of groundwater extraction (Haidera et al. 2011). Since the 1970s, investments in lift-pumps and other extraction technologies, like deep-drilling, have risen, displacing traditional irrigation systems such as spate-flow irrigated wadis in lower areas and qanat irrigation in the highlands. While these modern technologies were considered a blessing for significantly expanding agriculture, they also revealed how severely the groundwater reserves suffered and literally dried up the land (Weiss 2015). The rapidly increasing climate change with less rainfall and longer heat periods exacerbates this situation (Ward 2015; Lackner 2019; Al-Akwa and Zumbraegel 2021).

Since 2014, fighting and flash floods have decimated irrigation facilities, leaving just a fifth of

public water and sanitation facilities operational. As a result, most Yemenis now rely on private sources, such as water tankers and private wells, which has negatively impacted water quality, affordability, and availability (Aklan 2024). Rural farmers, who rely heavily on private wells for irrigation, face significant challenges. The cost of machinery for water extraction and the need for a consistent energy supply make it difficult for most to manage water supply independently. Consequently, wells are often controlled by particular actors, including community leaders, conflict actors, and wealthy landowners, who extract water unsustainably. Both urban and rural areas have seen landowners engaging in unregulated well-digging, exacerbating water scarcity. Consequently, conflict regarding water resources in Yemen arises not only due to the physical scarcity of the resource itself but also because distribution schemes favor specific classes of Yemeni citizens, often to the detriment of others (Weiss 2015).

Another water-related problem stems from the fact that many farmers have turned to planting qat, instead of coffee or other types of fruit. As a cash crop available year-round, qat cultivation offers higher financial returns, which was important to compensate financial losses due to the war. However, its extensive growth has depleted water sources due to intensive irrigation needs. This shift has resulted in numerous wells drying up in the region, sparking conflicts among neighboring farmers over diminishing water resources (Weiss 2015; Bilkis and Zumbraegel 2022; Al-Saidi 2020). Changing rainfall patterns and prolonged droughts further complicate water access, and women bear the brunt of these challenges. They often travel long, dangerous distances to collect water. Furthermore, due to rising poverty and the inability to afford public water bills, many people in urban regions such as Sana′a city are compelled to fetch water from diminishing free sources provided by philanthropists or international aid, as the cost of water increases, and traditional reserves diminish. Households, often comprising extended family members, place additional strain on water resources. Typically, each household receives only one canister of 10 to 20 liters. At water collection points, stronger women often dominate weaker ones. Women and children frequently engage in disputes over priority access to water and the quantity they can collect, sometimes resulting in physical altercations among water collectors (Bilkis and Zumbraegel 2022).

Simultaneously, the damage to infrastructure caused by the war has exacerbated the situation. Extensive destruction by external powers, notably the Saudi Arabia and UAE-led coalition, has devastated existing freshwater infrastructure, including water pipelines, wells, dams, desalination plants, well drilling sites, water pumps, irrigation canals, water storage tanks, water bottling facilities (Gleick 2019). For instance, a single attack on a water facility in Sa'ada in the summer of 2018 left 10,500 people without access to water (Sowers and Weinthal 2021). Exploded and unexploded war materials and weapons, such as landmines, cluster munitions, and improvised explosive devices, pose a constant threat. They have obstructed access to crucial agricultural fields and increasingly contaminated groundwater reserves, further depleting already scarce water resources (Al-Mowafak 2021; Center for Civilians in Conflict (CIVIC) 2022).

Overall, conflict-ridden Yemen is a vivid example of the interweaving of environmental changes and conflict, and its impact on water access. While water, in particular, has become an especially scarce resource due to mismanagement and advancing climate change for decades, the civil war has exacerbated these trends in numerous ways. Consequently, the country, already one of the most affected globally by severe climate effects, is unable to build climate resilience to counteract this trajectory. The ongoing armed conflict and the deterioration of water resources exemplify the concept of "slow violence" as described by Nixon (2011).

The country's water systems have become involuntary accomplices in this gradual yet pervasive violence, inflicting harm on the population over time. Yemen's rivers and aquifers are increasingly stressed by both military actions and mismanagement, leading to widespread water scarcity and contamination. The impacts of climate change exacerbate this situation, rendering existing water infrastructure unreliable and insufficient to meet the needs of the people. As water resources dwindle, they symbolize the failures of development policies and governance, becoming a focal point for community unrest and resistance. The slow erosion of water security in Yemen illustrates how the intersection of environmental degradation and armed conflict can inflict prolonged suffering on vulnerable populations, revealing the deep injustices inherent in the ongoing crisis.

Chile: Water scarcity as a consequence of the energy transition

Due to its geographical condition, Chile is characterized by an unequal distribution of water resources. While the country's north is home to the driest desert in the world, rainfall is abundant in the south (Ministerio de Obras Públicas 2013). To the north of the capital Santiago, located in the country's centre, there are arid and semi-arid areas with a physical water deficit. These shortages are linked to climatic conditions, which are being aggravated by climate change. A megadrought affecting the country since 2010 has led to diminishing rainfalls over recent years affecting water availability across the country (Garreaud et al. 2020). Disputes over water access and use have been more pronounced in the northern part of the country (Cantillana and Iniesta-Arandia 2022; Fragkou et al. 2023). However, water shortages are arising more and more in the southern part of the country where communities must be supplied with drinking water by water trucks (Dame and Höhl 2023; Oppliger, Höhl, and Fragkou 2019). While climate change has reduced the physical availability of water, other factors, such as land-use changes, mining and hydroelectric power development have also intensified into water conflicts (Höhl et al. 2021; Ocampo-Melgar et al. 2022; Cardoso and Pacheco-Pizarro 2022; Delgado et al. 2021).

In Chile, the ways in which decarbonization and climate change mitigation strategies tied to the accomplishment of the Sustainable Development Goals (SDGs) create new dynamics and impact water use and access, can be observed in different contexts and geographical settings. Measures such as technological changes in energy generation, storage and transmission, as well as new mobility patterns have led to negative social and environmental impacts in already conflict-ridden areas (Owen et al. 2022). As new actors demand access to water, the pressure on this resource intensifies, further exacerbating water conflicts in Chile.

Access and use of water were entirely privatized in Chile during the Pinochet dictatorship (1973-1990). In 1981, the Water Code was passed, entitling users to water rights for free. The water rights distinguish between those that are consumed (consumptive) and those that are restored to the source (non-consumptive). Both surface and groundwater were assigned through this mechanism (Bauer 2015; Budds 2020). Water rights holders are allowed to trade or inherit their rights once they have been registered. However, how water rights are utilized depends more on the interests of the holders than on formal prioritization, such as the use for drinking water. As a result, this legal framework has led to an unequal distribution of water rights, privileging certain economic sectors such as export-oriented agriculture, mining, and hydropower generation. Large agrobusiness firms and hydroelectric companies accumulate water rights throughout the country, gaining control over the water use and fueling conflicts

(Budds 2020; Dame et al. 2023; Usón, Henríquez, and Dame 2017). Furthermore, the Water Code separates water rights from land ownership, which has led to conflicts, particularly in Indigenous territories (Prieto 2015; 2016). However, this separation also facilitates the allocation of water for economic activities and climate change mitigation strategies, such as hydroelectricity and green hydrogen project development.

Regarding water use in rural areas, 46% of Chile's rural population is supplied with water from wells, springs and cistern trucks. The rest of the population in these areas receives water through a decentralized system that builds on water user associations. In 2019, 1,843,919 beneficiaries received water from one of the 1,939 Rural Drinking Water (RDW) systems in Chile (Ministerio de Obras Públicas 2023). These RDW systems are self-organized committees responsible for managing rural water distribution. The committees oversee financial management, maintain water infrastructures, and conduct regular quality checks on potable water quality. Each RDW committee is headed by a board of directors elected among all members of the RDW committee (Nicolas-Artero 2016; Nicolas-Artero et al. 2022). However, these community-based water supply systems face competition for resources in water-scarce areas from other economic activities. The Water Code requires RDW systems to acquire water rights to supply water to its users. With climate change and increasing demand exacerbating water scarcity, issues with drinking water provision in rural areas arise when RDW committees are unable to secure additional water rights due to overallocation (Bustos-Gallardo, Bridge, and Prieto 2021) In such cases, the state must provide drinking water as a human right, often resorting to water deliveries by truck to meet the needs of rural communities.

In the arid and semi-arid regions north of Santiago, most water rights have already been allocated. As a result, new entrants, related to green hydrogen projects, must negotiate with current water rights holders or seek alternative water sources. Even in Chile′s southernmost region, Magallanes—another key area for green hydrogen development—water scarcity remains a significant issue (Galaz 2023). To address these challenges, the use of desalinated water for (green) hydrogen projects aimed at export has gained attention (Bertram 2024). Consequently, these projects are envisioned to be situated near to the sea (San Martin et al. 2024). This approach aims to support the growth of the new industry while minimizing water conflicts, thereby reducing the potential contradiction between climate change mitigation strategies and social impacts.

In addition to hydrogen, lithium is a crucial resource for the energy transition (Greim, Solomon, and Breyer 2020). Its extraction in the Atacama Desert has been described as water intensive and environmentally challenging (Bustos-Gallardo, Bridge, and Prieto 2021). However, lithium is not the only vital resource for the energy transition; copper, which is also heavily used in electromobility, requires significant water resources for its extraction (Martins et al. 2021). The extraction of both minerals has led to conflicts with local communities. A key issue is the increasing scarcity of clean water, not only for drinking but also for agriculture and tourism (Akchurin 2023; Jerez, Garcés, and Torres 2021). The fragmented organization of water management within state agencies leads to governmental programs that tackle issues in isolation, which exacerbates conflicts (Donoso 2021). The formal state bodies responsible for water security have limited authority (Budds 2013), though recent reforms have slightly expanded their roles. Consequently, water scarcity is primarily managed through emergency measures—typically technological or infrastructural solutions—to provide immediate relief rather than through a holistic approach to planning water use and access across different sectors. This approach is partly due to the Chilean water market's intent to remain neutral, avoiding the prioritization of specific types of water use. However, this neutrality

overlooks the social, cultural and political factors that underpin water conflicts in Chile.

Overall, the Chilean case highlights the complexity of water conflicts and demonstrates that infrastructural and technological measures alone are insufficient to resolve these issues. The lack of dialogue and negotiation among different water users often leads to disputes. Additionally, existing regulations contribute to water scarcity by failing to integrate with policies addressing climate change and energy transitions. For instance, the expansion of renewable energy systems tends to assume water availability without considering it as a potential constraint on development. This poses significant challenges for the future, as Chile is at high risk for extreme water stress in the years ahead (WRI, 2023).

Recommendations

Water scarcity manifests on multiple scales affecting social vulnerability and political stability. To address and mitigate these pressing risks, the following chapter outlines five key recommendations for action within the framework of COP29. These remarks are intended to highlight how they can contribute to peace and conflict resolution, both in post-conflict contexts and as preventive measures to mitigate escalating social tensions and grievances. This perspective is based on the belief that many current environmental peacebuilding initiatives tend to be applied superficially, often addressing only short-term symptoms rather than fostering long-term solutions. To create meaningful change, it is essential to focus on the root causes of conflict by actively engaging with issues of justice and ensuring the broad inclusion of diverse stakeholders. This approach aligns with research that emphasizes the second (restorative) and third (sustainable) levels of environmental peacebuilding, underlining the necessity of comprehensive strategies for achieving lasting peace (Dresse et al. 2019).

Promote a holistic understanding of water scarcity and security: As this article, as Figure 1 illustrates, addressing water scarcity requires more than just managing decreasing water availability. It calls for a holistic approach that considers the complexities of local political and ecological adaptations. Approaches like the Integrated Water Resource Management (IWRM) already address both long-term and short-term adaptation needs by integrating socio-economic mechanisms to manage water resources effectively in the face of climate change and other pressures. Meanwhile, the Water-Energy-Food-Ecosystem Nexus (WEFE Nexus) underscores the interdependence of water, energy, food security, and ecosystems, emphasizing the need for coordinated strategies across these interconnected sectors. However, these proposals need to be extended and who needs to be involved at what scale for 'integration' should be further discussed.

Re-politicize water issues and promote environmental justice: Many hydrological projects focus on technical solutions that, however, fail to actively manage conflict and exploit opportunities for dialogue. In future, more voices should advocate for the re-politicization of water issues, emphasizing the need for governance frameworks that address both local and global dimensions of water insecurity. Incorporating principles of environmental justice, which extend beyond mere preservation to include the improvement of quality of life for affected communities, is crucial. This involves recognizing local communities, enhancing their participation, and respecting their choices. Efforts should focus on ensuring that water policies address social vulnerability and promote equity.

Strengthen international institutions for binding decisions: To effectively address water scarcity, it is essential to enhance global cooperation by strengthening international institutions capable of making binding decisions. This involves fostering trust and demonstrating genuine concern from developed countries to gain support from the Global South. Current global climate governance often lacks mediation efforts that bring stakeholders together. Effective collaboration will require balancing global environmental goals with respect for national sovereignty and development strategies.

Support data sharing, strengthen human capacity and improve transparency: The global community should prioritize improving data sharing, access, and transparency to better understand and manage water resources. Enhanced data collection and dissemination will support informed decision-making and enable more effective responses to water scarcity. A key objective is to build human capacity by training personnel in national and local environmental authorities. Risk assessments should be tailored to local environmental conditions to prioritize the most pressing threats. This will foster a pool of qualified experts in environmen-

tal issues who can coordinate efforts across governments and localities to collectively address climate change and environmental degradation.

Empowering local activities and community responses while considering local contexts: In the absence of effective state capacities and responses, local actors often emerge to address urgent environmental challenges like water scarcity. Empowering these actors with knowledge and technology is essential. For example, developing and implementing micro-hydropower projects, which have proven beneficial in some regions like Nepal (Krampe 2018), can promote sustainable water use and energy production. However, it is crucial that these technological and infrastructural solutions are adapted to local conditions and do not worsen water scarcity, especially in conflict-affected areas. Additionally, integrating indigenous knowledge is crucial for addressing climate-related water shortages. In Yemen, this could involve enhancing traditional irrigation systems through initiatives like terrace rehabilitation and rainwater harvesting projects.

Conclusion

The alterations in the hydrological cycle, driven by both natural and human-induced factors, are expected to significantly undermine existing water infrastructure. This deterioration will heighten societies' vulnerability to water-related disasters and erode water security, exacerbating the challenges posed by climate change. This article has underscored the intricate relationship between water and conflict within the context of climate change. It reveals that the issue extends beyond mere water scarcity, as illustrated by the case of Yemen, where both climate-induced drought and ongoing conflict contribute to a precarious situation. Similarly, in Chile, specific water policies and mitigation strategies such as the extraction of lithium—while crucial for a climate-friendly transition—highlight how water resources can become a focal point of conflict when not managed effectively.

A comprehensive understanding of the water-conflict nexus requires more than just examining water management practices. It necessitates an in-depth analysis of contextual factors, including political, institutional, and socio-economic drivers, alongside climatic influences. The link between climate change mitigation strategies and their impact on water resources is often not directly recognizable. This is precisely why an in-depth and detailed analysis of the effects of the measures is absolutely essential. Such a nuanced approach can lead to more effective strategies for conflict resolution or prevention. The studies reviewed emphasize the need for vulnerability analyses that are contextually grounded, taking into account a range of climatic and non-climatic factors. Key elements driving conflict include social grievances, often intensified by environmental stressors such as droughts, and the absence of effective channels for addressing these grievances within specific legal or political frameworks, especially under authoritarian regimes.

In conclusion, addressing water scarcity and related conflicts requires a multi-faceted approach that integrates technical, social, cultural, and political dimensions. By understanding and addressing these complex dynamics, more targeted and effective interventions connecting global and local levels can be developed to manage water resources sustainably and reduce the risk of conflict.

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