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Troubled Waters in Conflict and a Changing Climate: Transboundary Basins Across the Middle East and North Africa

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CHAPTER 6

Yemen's Water Woes: Why Climate Change Is a Drop in the Bucket

Mohammad Al-Saidi

Introduction

The water crisis in Yemen did not start with the current conflict. It is a governance crisis stemming from sustainability failures dating back to the post-independence era. Groundwater depletion has been underway for decades, threatening the food security and livelihoods of the Yemeni people who predominantly work in agriculture. From the 1970s until the late 1990s, the state promoted [unrestricted use of groundwater and subsidized energy](#) to foster agriculture-based development. In the 1990s and 2000s, Yemen pursued more sustainable management of its water resources by establishing new water institutions and passing reform legislation. However, since the outbreak of conflict in 2015, these critical reforms have been on hold. The only way that Yemen can address the water challenges of the coming years is to recommit to this erstwhile path toward sustainable water management.

The [intensifying water crisis](#) in Yemen is manifested in the country's imbalance between freshwater demand (about 3.9 billion cubic meters per year) and water supply from renewable resources (1 billion cubic meters per year from surface water and another 1.5 billion cubic meters from groundwater), which has resulted in the overabstraction of groundwater. Current water and sanitation services do not even reach all Yemenis, with the ongoing war further exacerbating the situation. The agricultural sector's inability to provide food security is also related to water inefficiencies and poor crop selection. These water and food security concerns exceed even those related to climate change, which, despite its [understudied and inconsistent impacts](#) (for example, on precipitation) will further increase vulnerability and reduce both the [crop yields and income](#) of Yemeni rain-fed farmers.

This chapter first examines how Yemen's current water problems are related to its failure to tackle sustainable water management and then looks for opportunities to restart water reforms. After outlining the legacy of water mismanagement in Yemen, this chapter

explores the successes and limitations of past water-sector reforms and, using these efforts as a starting point, argues for building back and updating these reforms through state-led engagement and infrastructure development with the support of the international community.

Legacies of Water Mismanagement

Even before Yemen's current conflict, a severe water crisis was mounting. Groundwater is a vital water source, accounting for 70 percent of the country's water use. It is essential for feeding the Yemeni population, who largely depend on subsistence farming. Yemen's [groundwater aquifers](#) contain reserves of about 35,000 million cubic meters, with an annual recharge of about 1,300 million cubic meters. But withdrawals are estimated to be around 2,500 million cubic meters per year. It is now estimated that, at current the rate, it could only take [twenty years](#) to deplete Yemen's groundwater resources.

As in the rest of the Middle East, Yemen's water crisis has its roots in sustainability failures dating back to the post-independence era—1962 for North Yemen and 1967 for South Yemen, although the south did not politically stabilize until the 1970s. Between the 1970s and the late 1990s, the state promoted unrestricted use of groundwater and subsidized energy in its [pursuit](#) of agricultural development and food security. This resulted in Yemen being [pumped dry](#)—a sad departure from its rich tradition of managing water through carefully designed terraces and infrastructure for floodwater-based spate irrigation. Instead, water misuse has led to agricultural abandonment and increased rural to urban migration, [inflaming political and social tensions](#) in the country's fertile highlands.

With the availability of subsidized water pumping technologies, farmers were able to use more water. The amount of irrigated land [ballooned](#) by 1,800 percent between 1970 and 2004—from 37,000 hectares to 680,000—with two-thirds of this area depending on groundwater. But the real reason for overabstraction is the state's failure to govern groundwater through regulation, monitoring, and enforcement. For many decades, drilling groundwater wells did not require a license. Wells still do not cost money to use or even have water meters. Even after the water regulations of the early 2000s, influential tribesmen and powerful officials were often involved in so-called [water wildcatting](#) through illegal drilling.

The expanded cultivation of the cash crop *qāt* can be seen as a direct consequence of the shortsighted groundwater promotion policies of the 1970s and 1980s. *Qāt*—a mild narcotic now used daily by a [majority of the adult population](#)—has grown to dominate irrigated agriculture in Yemen, accounting for about 30 percent of all [groundwater withdrawals](#). This [water-intensive crop](#) (which can be grown 3–4 times a year as opposed to coffee, which is less profitable because it only grows once) is linked to groundwater depletion, particularly in the northern regions, where *qāt* cultivation is responsible 40 percent of [water abstraction](#) from the Sana'a Basin. *Qāt* presents a complex ecological, economic, and social problem that affects households' expenditures, decreases work productivity, and contributes to the loss of

traditional export crops, such as coffee. It is difficult to solve this problem in the absence of economic opportunity—particularly for youth—but governing [water consumption](#) for qāt is a necessary step toward combatting this unhealthy phenomenon.

The legacy of mismanaging groundwater resources has also created inequalities between irrigation farmers and traditional rain-fed farmers. Irrigation farming requires up-front investments. This has favored wealthier farmers, who also got state subsidies for purchasing pumping and drilling equipment and benefited from unregulated access to groundwater. Though farming using rainfall or runoff harvesting has [decreased significantly](#)—from about 1,285,000 hectares of farmland in 1970 to 507,000 hectares in 2018—it still accounts for 50 percent of the cultivated area in Yemen. The millions of Yemenis who depend on this type of agriculture are more vulnerable than irrigation farmers to climatic effects. Climate change is expected to exacerbate the threats facing the agricultural sector, changing the sowing seasons for rain-fed farming and [decreasing yields for irrigated crops](#) such as wheat and sorghum. At the same time, the state has provided little assistance to help rainfall farmers keep or expand their traditional [water-harvesting infrastructure](#).

A Water Crisis in the Middle of a War

Dire warnings about Yemen’s water crisis point to two things: wasteful water use practices and the rapidly increasing population. Yemen has one of the world’s highest [population growth rates](#) (around 3.34 percent between 2012 and 2021). Its current population of about 32 million could reach [55 million](#) by 2050. But the war that started in 2015 has also affected water resources. Combatants have targeted water infrastructure, and the population is grappling with decreased access to safe sources of water, the rise of water-borne diseases, and deteriorating food security. And the repercussions could last through reconstruction; it may be many years before the state is capable of delivering adequate services. Yemen has a long history of [state fragility](#) and protracted conflicts, and the current scale of devastation is arguably the greatest it has ever suffered.

Since the start of the current conflict, only around 60 percent of the population has had access to [safe drinking water](#) and just 20 percent to safe sanitation. The war has damaged [water infrastructure](#)—both through air strikes and on-ground fighting—and the water supply sector has deteriorated, leading to cascading impacts on other sectors including health and food security. The ongoing cholera outbreak that was triggered in 2017 by collapsing water, sanitation, and health services has been one of the world’s worst health crises. During the conflict, the [food sector](#) has also suffered due to the country’s devalued currency and the lack of employment. During the COVID-19 pandemic, a large proportion of the Yemeni population became food insecure. Economic hardship caused by the conflict—for example, the [deteriorating financial system](#)—has further exacerbated food insecurity.

With increased water scarcity and the deterioration of state capacities, more local water and land conflicts can be expected. Before the current war, the government estimated that 4,000 people **died annually** fighting over land and water rights—more than from any internal political conflict at that time. Water-related conflicts are now exceeding the capacities of **traditional and tribal lawmaking**, through which most local disputes were previously settled. Groundwater aquifers, which have expanded tribal and geographic boundaries, now require formal monitoring and regulatory frameworks. With the weakness of state institutions and the growing demand for water use, competition among groundwater users will only increase.

An unnoticed but significant development for groundwater depletion that has happened during the war is the growing use of solar energy in agriculture. In the absence of fuel and electricity, the use of **solar power** has been a coping mechanism for the Yemeni population. Due to the lack of viable alternatives, the expansion of solar energy in Yemen—particularly in the war-torn northern regions—has been impressive. Although some reports have estimated that **photovoltaic systems** reach 50 percent of households in rural areas and 75 percent in urban ones, it will be difficult to know the real scale of the Yemeni solar revolution before the war ends. For the water sector, the availability of **solar pumps in agriculture** has been associated with groundwater depletion across the world—cheap power means people can pump water around the clock. In Yemen, **wealthier farmers** are embracing solar energy for water pumping and irrigation—often to grow qāt—in the absence of any rules and restrictions.

A Bygone Period of Reform

In the late 1990s and early 2000s, there was a wave of optimism about the water issue in Yemen. With the support of donors—particularly the German and Dutch governments, as well as the World Bank—Yemen committed to **sustainably managing its water resources**. The subsequent reforms created national institutions for water management (including groundwater aquifer management), consolidated water policymaking, and decentralized the water suppliers.

The concept of integrated water resources management (IWRM) is key to understanding the ideas that motivated these reforms. At a 1992 conference in Dublin, Ireland, a global group of experts reached a consensus on water management. The so-called **Dublin principles** acknowledged the economic value of water and proposed that it should be managed holistically using integrated environmental policies and public participation. The resulting paradigm of IWRM was adopted by expert networks and the donor community, who saw it as a way to reform the water sectors of many developing countries. IWRM-based reforms have produced **mixed results** across the world—particularly due to rushed implementation and a one-size-fits-all approach—but they underscored the need for water sustainability by acknowledging that water, as a finite resource, requires protection and careful management. IWRM has now been incorporated into the UN’s **Sustainable Development Goal 6.5.1**, prescribing its implementation for all countries and “at all levels.”

In Yemen and many other developing countries, IWRM-based water reforms led to the creation of new water institutions based on the idea of consolidated water policymaking. Integrated water management implies that all aspects of water use should be managed together, at the national or regional levels, and at the level of different water ecosystems (for example, river basins or groundwater aquifers). By the early 2000s, Yemen—with the help of donors—created the Water and Environment Ministry responsible for water policymaking and issued a [national water sector strategy and investment program](#) with ambitious expenditures of about \$1.5 billion between 2005 and 2009. In 2002, the country established its first [national water law](#) (later amended in 2006), which tackled critical issues such as water rights and the licensing of water wells to prevent overpumping. The National Water Resources Authority (NWRA) was created to study and plan groundwater aquifers, as well as to implement the licensing and metering systems for groundwater wells.

These water reforms also created a new generation of water practitioners, who were educated abroad in [special university programs](#) based on the ideas of IWRM and sustainable development. Until the early 2000s, most water-related tasks were assigned to officials in the Agriculture and Irrigation Ministry—who tended to favor water development over sustainable water management. The new water institutions received important capacity-building aid, including training, systems for performance monitoring, and water management equipment. The water supply and sanitation sector received [the second-largest share of aid flows in Yemen](#), increasing from about \$36 million in 2002 to \$53 million in 2009. Additional water-related research institutions were created, such as the Water and Environment Center at Sana'a University initially funded by the Dutch government.

Another key pillar of reform was strengthening investments in the urban water sector. Such investments have a higher social return rate—in comparison to agriculture—since municipal water contributes more to economic output as well as health and education outcomes. Municipal water can also be more effectively treated and reused. The urban water sector received almost half of the envisioned investments in the national strategy. Prior to the reforms, Yemen's urban water supply was delivered through one national supplier. Many of the national supplier's branches in major urban areas were transformed into financially and administratively independent local water corporations (although they remained public utilities), which received technical support from donors—especially from Germany. These decentralization reforms [proved controversial](#), due to their fast pace and the choice of decentralized utilities. Some of the decentralized utilities were unprepared; others were created to appease politically unstable governorates. However, decentralization was widely perceived to be necessary due to the resulting [benefits of improved services](#). Thanks to these reforms, some independent water utilities were able to continue functioning during the conflict.

The Way Forward: Build Back and Update

Yemen's efforts to reform its water management were interrupted by political turmoil in the aftermath of the 2011 revolution and have effectively ground to a halt since the start of the 2015 war. The new state water institutions were weak from the start compared to the powerful agricultural institutions and interest groups who largely opposed, or boycotted, the reforms. Even the most optimistic experts did not expect the reforms to entirely solve the water crisis. But they represented a hopeful start. When the Yemeni state begins reconstruction efforts after the war ends, it will be important to both build on these reforms and learn from the past. This can be done in three ways.

First, water institutions need to be strengthened, both through technical support and law enforcement. For example, the NWRA, established as part of the water reforms, is a key organization for managing groundwater resources in Yemen. The national water law gave it the necessary leverage to monitor and regulate water abstractions by managing drilling permits and abstraction conditions. But the NWRA achieved little beyond quantifying the country's groundwater resources. Today, due to a weakened central state and several de facto territorial governments, enforcement of the water law is arguably even worse than before. Fierce political will is needed to stop illegal water drilling, whether by strengthening the NWRA and its branches or by creating stronger regional environmental regulators. Uncontrolled drilling has been a major calamity, and the state has seemed complicit—or at least helpless—[admitting](#) that 99 percent of extracted water is unlicensed.

The NWRA's mandate goes even further. It has the authority to establish and support aquifer committees that can develop detailed plans to rehabilitate and protect each groundwater basin. Although this idea of [basin-level water management](#) is a core premise of the IWRM reforms, there is much work to be done to implement it in Yemen.

Second, the water issue is central to the future of Yemeni society, and a broad debate over a participatory reform agenda is long overdue. Past reforms have created nascent institutions and actors, with an emphasis on strengthening them in the face of entrenched and powerful agricultural interests. These interests are intertwined with the agribusiness sector, apparently corrupt state officials, and tribal elites. The past reform agenda did not effectively address societal debates, mediation between the interests of different water users, or reform of the agricultural water sector itself.

Future reform efforts can confront the poor environmental and food security performance of the agricultural sector—including the use of [incentives](#) to combat the qāt economy. This sector has failed to improve food security in Yemen. In the [food emergency](#) that followed the start of the war in Ukraine, seven million Yemenis were suffering from catastrophic or emergency levels of hunger by the end of 2022. For decades, agribusiness and state elites have favored food imports rather than [investments in sustainable local agriculture](#)—contributing to the agriculture sector's failure to meet Yemen's food needs.

Third, an emphasis on community-level support for resilience and supply security is necessary. The current conflict has shown how communities are embracing [self-sufficiency](#). In the absence of national water and electricity supplies, communities have relied on traditional systems for water harvesting or used solar technologies and improvised infrastructure to integrate energy, water, and food production. If planned well, these community-led adaptations can increase resilience to both protracted conflicts and external aggravators like climate change. Such adaptations represent the building blocks for more [decentralized and integrated supply systems](#) based on locally available resources.

Conclusion: Costly but Necessary Choices

With the war coming to an end, Yemen has a chance to finally tackle the issue of sustainable water management and invest more political will and money in its water sector. The necessary reforms should address the underlying causes of the water crisis with the aim of stopping or slowing groundwater depletion by the agricultural sector. But time is of the essence due to the increased overuse of resources, as well as the mounting evidence of climate change's effects. Yemen needs a strong internal consensus and international support to design a broader water reform agenda while experimenting with solutions at the local level. Recommitting to reform will require public leadership and support from the international community. It may be some time before a water reform agenda takes root at the national level. But there are important short-term investment choices to be made in order to secure the municipal supply.

Although the impacts of climate change on [rainfall](#) in Yemen are not consistent, Yemen has more precipitation (about 200 millimeters per year) than other countries in the arid Arabian Peninsula. Therefore, infrastructure for collecting and reusing storm water (such as micro-dams or drainage systems) can be a part of the solution for aquifer recharge or some urban water uses. Infrastructure support to protect and expand [indigenous water-harvesting systems](#)—particularly in rural areas—is also necessary. At the same time, every drop of municipal water needs to be valued and reused by expanding the municipal wastewater collection and reuse systems. In the Middle East, many countries are increasingly investing in a [circular water economy](#) through water recycling. For example, Jordan is transporting treated wastewater to farms (by mixing it with freshwater in rivers and canals) in order to decrease the freshwater demands of agriculture.

In the costly pursuit of new water sources, the Yemeni state will have to contend with the inadequacy of its regional planning. Major cities such as Sana'a and Taiz will soon have chronic water problems, but they continue to [expand rapidly](#)—since 1950, the population of Sana'a has grown from 50,000 to more than 3 million. Some observers argue that the costs of providing additional water supplies through options such as recycling and transfer (such as from other basins or from coastal desalination plants) might be unaffordable for Yemen. With desalination plants being considered for low-lying areas close to the coast—like the [solar desalination plant](#) in Seiyun—the Yemeni state should consider putting a greater emphasis on the regional development of its coastal areas, including increasing the distribution of population in these regions.



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Notes

- 1 The author was one of the organizers of the You Stink movement until September 2015.
- 2 Population figures come from a 1940 British census. Gaza was 1,100 square kilometers at the time.
- 3 According to the Meteonorm database consulted by authors. See: <https://meteonorm.meteotest.ch/en/meteonorm-features>.
- 4 Theodor Herzl, *Altneuland = Old-New Land* (Haifa, Israel: Haifa Publishing Company, 1960), 241.
- 5 Author interview with Dr. Shaddad Attali, then head of the Palestinian Water Authority, April 2010, West Bank.



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