
The Impact of Water Scarcity on Public Health and National Security

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Water scarcity, the lack of sufficient freshwater resources to meet the demands of a region, poses a significant challenge for both public health and national security, seasonally affecting as many as four billion people worldwide (He et al., 2021). It is projected that water scarcity will significantly increase in the next two decades, with cities and urban centers seeing the greatest impacts (Greve et al., 2018; He et al., 2021). There are a wide range of health consequences related to water scarcity, including rates of disease, malnutrition, and social instability (Freeman et al., 2019). Inadequate supplies of clean water can hinder sanitation efforts in communities, in turn increasing risk of disease and infection (Tortajada & Biswas, 2018). When clean water is not accessible, rates of waterborne diseases increase, including cholera, dysentery, and typhoid (Forstinus et al., 2016). When rivers and lakes are polluted with human waste, water scarcity can result in declining agricultural productivity and insufficient water for irrigation (Tortajada & Biswas, 2018). These agricultural effects, in turn, reduce overall food availability and increase rates of malnutrition (Patlán-Hernández et al., 2022). At the societal level, increases in water scarcity result in increased costs of energy and other goods, amplify economic downturns, and create the potential for civil unrest (Dolan et al., 2021).

From a psychological standpoint, water scarcity has been shown to affect levels of stress, anxiety, depression, and overall negative emotionality (Seretlo-Rangata et al., 2025). For example, a mixed-method study in Uganda showed that water insecurity predicted significantly higher levels of depression, with this effect being more pronounced for men than women (Mushavi et al., 2020). Another study in Iran showed that individuals in areas experiencing water scarcity endorsed significantly higher levels of psychopathology and were less likely to engage in rational coping strategies (Khodarhimi et al., 2014). Experiences of shame and deprivation further can serve as community-level barriers to institutional trust, often preventing public health interventions to alleviate water scarcity from being implemented effectively (Goldin, 2010).

Globalization, the non-linear diffusion of cultures, information, and technology across national borders through interconnected networks of transportation, trade, and communication, has exacerbated water scarcity and its consequent impact on public health (Wang & Zimmerman, 2016). As population density increases in large cities worldwide, industrialization and urbanization have led to overextraction of water resources (Koop van Leeuwen, 2017). The data needs of increasingly globalized and connected cities further exacerbate the direct and indirect needs for water, such as cooling data centers used for artificial intelligence and stabilizing power grids to keep up

with energy demand (Karimi et al., 2022). These same trends toward urbanization, digital technology, and industrialization contribute to pollution of rivers and lakes, reducing the availability of clean water available throughout large watersheds (Chen et al., 2017; Ren et al., 2014). For example, plastic waste continues to contaminate fresh water supplies, in turn resulting in the contamination of food sources (Global Economic Forum, 2025). Rainfall pattern changes and pervasive droughts have resulted in the expansion of mosquito habitat and malaria zones, precipitating increases in rates of disease such as the Zika virus (Busby, 2017). Conversely, globalization has allowed for the sharing of water conservation techniques and technologies, including wastewater recycling, efficient agricultural management of water, and desalination (Gude, 2017). The benefits of these advances notwithstanding, wealthier nations are better equipped to implement such strategies than lower-income nations (Emile et al., 2022).

Previous assessment by the World Economic Forum (2018) indicates that global climate change and its sequelae, including water scarcity, comprise five of the top ten most impactful global risks, as well as three of the most likely risks. Water scarcity may be the most serious outcome of global climate change, as it has direct impact on U.S. national security through the disruption of stability in strategic regions and related economic effects (Mazarr et al., 2016). For example, the 2011 drought in Somalia killed approximately 250,000 people, exacerbated by al-Shabab interference with international aid groups (Busby, 2017). Drought—and ensuing poor harvests—in Russia and other countries was a core driver behind the Arab Spring movement, as the sharp increase in the price of food resulted in protests and regime change (Busby, 2017). A significant number of regional conflicts have resulted from water scarcity and disputes related to water rights, including in the Nile, Indus, and Jordan River valleys (Wirtz, 2013). These regional disputes have the potential to escalate into global conflicts, as evidenced by India disrupting water access to Pakistan in retaliation for military action (Busby, 2017). As a precursor to the Syrian Civil War, water mismanagement and its effects on the economy drove urban migration, in turn igniting conflict between migrant and native ethnic groups (Busby, 2017). Similar migration patterns, including both forced and voluntary movements of groups across sovereign borders, have driven large-scale urbanization, in turn driving an increase in energy costs (McQuaid et al., 2017).

The Role of Health Inequity

As water scarcity increases, the noted health impacts are likely to be exacerbated by social problems such as health inequity (Harhay, 2011). When water scarcity problems

impact higher-income areas, alternative solutions such as bottled water or point-of-consumption filtration can be readily implemented (He et al., 2021). However, these solutions rely on existing infrastructure that may not be available in marginalized communities (Padowski et al., 2016). Indeed, vulnerable populations and marginalized communities already are disproportionately impacted by water scarcity (Sanchez et al., 2023). Among the poorest 10% of households in the United States, costs for obtaining basic water and sewer may exceed 8% of monthly budgets (Teodoro & Saywitz, 2020). Globally, low-income populations and rural areas often have the least access to clean water infrastructure, leaving them more vulnerable to water scarcity if freshwater aquifers or wells are contaminated or exhausted (Emile et al., 2022; Sanchez et al., 2023). In developing nations, social inequality also can be exacerbated by water scarcity (Emile et al., 2022). For example, a disproportionate burden for obtaining water often is placed on women and children, who must forego educational and occupational opportunities due to daily water gathering tasks (e.g., Chakrabarti, 2025; Otufale & Coster, 2012). From a health equity perspective, water scarcity increases rates of physical and cognitive disabilities, with a differential impact on areas that also face food insecurity (Chakrabarti, 2025). Thus, addressing water scarcity simultaneously through equitable processes and policies while considering existing health disparities may be crucial in mitigating projected trends and impact.

A secondary effect as globalization increases water scarcity is population displacement, which can include migration across regional and international borders (Warziniack, 2013). When communities face prolonged droughts or upstream actions deplete water sources, populations may be forced to relocate in order to improve living conditions (Stoler et al., 2021). This displacement also can be caused by armed conflict related to water scarcity, such as recent conflicts in Syria aggravated by multi-year drought (Kreamer, 2012). Furthermore, these displacement effects disproportionately impact marginalized groups and vulnerable communities, as these groups do not have the means to obtain alternate sources of water (Adeyeye et al., 2020). These migrant populations can face significant health effects related to water scarcity, including dehydration, malnutrition, and increased transmission of diseases (Forstinus et al., 2016; Warziniack, 2013). Water scarcity concerns may not solely impact the country from which migrants are fleeing, but can strain the water and sanitation infrastructure of the areas into which these displaced populations migrate (Stoler et al., 2021).

Addressing Water Scarcity

There is no single solution to the emerging problem of water scarcity and its impact on public health and national security. Addressing the increasing risk of water scarcity throughout the world will require the combined efforts of stakeholders at the community, state, national, and international levels (He et al., 2021). Indeed, addressing the effects of water scarcity inherently draws on globalization,

as collective action by the global community is necessary to resolve these conflicts (Wirtz, 2013).

Responsible Leaders

Leaders at many levels are responsible for mitigating water scarcity, including at the local, state, and national levels (see Stoutenborough & Vedlitz, 2014). These include local municipality leaders who are responsible for wastewater removal and delivery of water to homes and businesses, state-level departments overseeing natural resources and environmental protection, and federal entities such as the Environmental Protection Agency and the U.S. Geological Survey. Federal oversight extends to building reservoirs and dams on public land and managing watershed areas (such as rivers) that cross state boundaries, as well as water exchange treaties with other countries (Huffman, 2008). In addition, non-governmental organizations and corporations may play key roles in implementing strategies to mitigate water scarcity, such as promoting water reclamation projects in developing nations and partnering with federal programs to build water infrastructure (e.g., Debaere & Kapral, 2021; Emile et al., 2022). Indeed, partnerships across all of these levels of public and private management may be needed to effectively address water scarcity and its public health impact.

Individuals and Local Communities

At a local level, food consumption patterns can directly relate to a community's overall water consumption. Decreasing consumption of beef, increasing the consumption of fruits and vegetables (especially low-water-intensity vegetables), decreasing sugar consumption, and utilizing low-water-intensity grains can significantly improve the water utilization of a geographic area (Vanham et al., 2018). Local communities can incentivize lifestyle changes to reduce water use through the use of targeted conservation campaigns, which can be more effective than water price increases in changing consumer behavior (Katz et al., 2016). The use of moisture-retaining additives to soil in public parks and sport fields can reduce water consumption in these areas by over 30% (Tsai et al., 2011). Local water demand also can be decreased through mandatory restrictions and increasing water prices, although these approaches primarily reduce elastic, outdoor water demand (such as watering lawns) rather indoor water demand (such as showering and laundry), which is inelastic (Olmstead & Stavins, 2009).

States and Regions

At the state and regional level, greater investment in water conservation technology and infrastructure is a necessary step to increase the supply of available water (Koop et al., 2019). For coastal areas, desalination—the conversion of salt water to fresh water using membrane transfer or changes in matter states—has shown to be an effective method to increase water supplies, but relies heavily on renewable energy sources to be cost effective (Esmailion et al., 2021). Similar technologies can be used for wastewater recycling, especially when reused water is

provided for non-potable purposes such as irrigation, industrial cooling, firefighting, and sanitation (Garcia & Pargament, 2015). Although the building of reservoirs has been heavily utilized in the past to address water shortages and mitigate droughts, the overall effectiveness of reservoirs in reducing water scarcity has been more equivocal, with downstream communities often seeing negative effects on the economy and the environment (Di Baldassarre et al., 2018). Rainwater harvesting through stormwater control and surface runoff can similarly increase the overall supply of water available, but require various levels of infrastructure development to be scalable (Zhang et al., 2020). State or provincial legislatures and regional water management districts must prioritize investment in these types of infrastructure projects in order to ensure long-term availability of water supplies.

National and International

As climate change exacerbates droughts, disrupts precipitation patterns, and reduces freshwater availability, federal policies and initiatives are essential to ensure sustainable water management and long-term resilience of water systems (Huffman, 2008). The primary roles of the federal government in addressing water scarcity are legislation and regulation. For example, the Clean Water Act provided a nationwide framework for protecting water sources from pollution and contamination, and the Safe Drinking Water Act established standards for contaminants in drinking water (Rotman et al., 2021). Federal agencies such as the Environmental Protection Agency enforce water quality standards and oversee conservation efforts (Sanchez et al., 2023). Other agencies such as the National Oceanic and Atmospheric Administration provide data on hydrology and climate patterns that informs policy makers on current trends in water scarcity (Kogan et al., 2019). These capabilities come together at the federal level to implement strategies for mitigating water scarcity. Federal-state partnerships have shown success in increasing sustainable groundwater utilization, particularly in arid regions that may not have direct access to large bodies of water (Pérez et al., 2019).

International trade may be crucial in addressing water scarcity, since relationships between countries have been shown to address water scarcity both through water transfer and through promoting international food trade (Weiss & Slobodian, 2014). In particular, mediation by the federal government in international water disputes can avert armed conflict that can result from water scarcity and the perceived need to control critical water resources (De Angelis et al., 2017). Strategies for alleviating water scarcity also may differ depending on regional and economic differences between countries. Whereas increasing international food trade reduced water scarcity in countries like Ethiopia and Uganda, increasing international food trade increased water scarcity in countries like India and Pakistan (Gu & Qin, 2024). This highlights the need for tailored solutions to water scarcity problems that take into account the local ecosystem, availability of runoff versus other freshwater sources, and the root causes of water scarcity in specific regions (Sanchez et al., 2023).

Conclusion

Water scarcity poses a significant public health challenge for billions of affected individuals worldwide, with attendant effects on disease, malnutrition, and social instability (He et al., 2021; Forstinus et al., 2016). Addressing water scarcity requires a multi-level approach involving local, state, national, and international stakeholders (Koop et al., 2019). Tailored solutions that consider regional and economic differences are essential to mitigate water scarcity and its public health impacts effectively, particularly for marginalized groups who already face health equity challenges (Emile et al., 2022). Only through this kind of collaboration can sustainable and equitable access to clean water be ensured.

Author note. The views expressed herein are the private views of the author and do not necessarily reflect the official policy or position of the United States Government or the Department of Defense. Correspondence regarding this article should be directed to the author at tim-hoytpsych@gmail.com.

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