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Issue Brief

Connecting Climate, Water, Equity, and Public Health in the United States

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Shannon M. McNeeley, Morgan Shimabuku, Rebecca Anderson, and Jessica Dery

1. Overview and Purpose

Climate change is intensifying threats to public health by disrupting water and sanitation systems. Hazards such as extreme heat, drought, wildfires, flooding, and sea level rise are increasingly compromising access to clean water and safe sanitation across the United States. Frontline communities — those impacted first and worst — bear the greatest burden (Pacific Institute and DigDeep 2024). These disruptions elevate risks of waterborne disease, mental health challenges, economic hardship, and social inequities, and can lead to displacement and loss of cultural identity. This is particularly true in Indigenous and rural communities, where water access is closely tied to traditional and cultural practices (Dizack et al. 2025).

Water, sanitation, and hygiene (WASH) are foundational to public health. Climate-related failures in these systems, as demonstrated by events like Hurricane Katrina, Hurricane Helene, and California's 2012–2015 drought, have resulted in outbreaks of disease, mental health stress, and long-term infrastructure challenges (McNeeley et al. 2024; Pacific Institute and DigDeep 2024; Congressional Research Service 2006; Barreau et al. 2017). Addressing these interlinked risks is essential to protect health and enhance resilience in overburdened and underresourced communities.

This brief examines the pathways through which climate change affects public health via its impacts on water and sanitation. It highlights disproportionate burdens on populations facing systemic barriers and identifies key areas for research, policy development, and community-led solutions. Specifically, it addresses three questions:

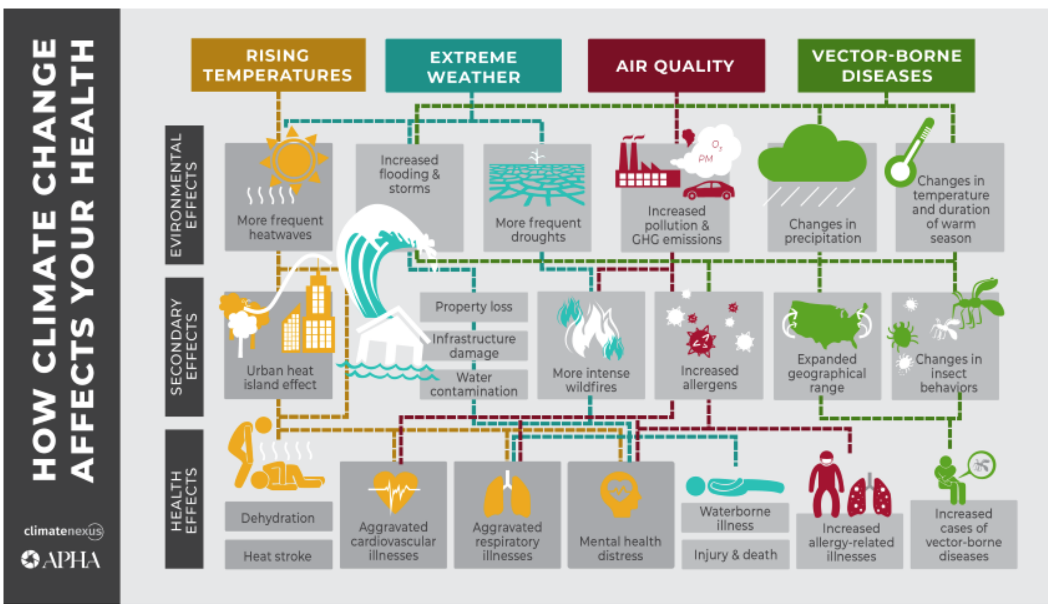
- How does climate change affect public health by disrupting water and sanitation systems and access?
- What topics require further exploration to inform equitable, climate-resilient responses that protect public health?
- What policy approaches can integrate climate adaptation, water access, and public health equity at local, state, and federal levels?

2. Climate Change Impacts on Water, Sanitation, and Public Health

Climate-related changes in weather patterns are already affecting the health of Americans, with vulnerable populations bearing disproportionate risks (Ebi and Hess 2020; Ebi et al. 2018). Consequently, incorporating climate change indicators into public health frameworks is gaining momentum, particularly with an emphasis on adapting these indicators to local contexts (Doubleday et al. 2020; Houghton and English 2014). However, stronger integration is needed to understand how climate-related health impacts intersect with disruptions to water and sanitation access. Because climate change disruptions to water and sanitation systems are inherently cross-sectoral, siloed approaches are insufficient, complicating preparedness and public health response efforts (Grigg 2018; Taylor et al. 2024; Pacific Institute and DigDeep 2024). For example, events like wildfires that degrade water quality or floods that overwhelm sanitation systems often affect infrastructure, the environment, and public health simultaneously.

Furthermore, the combined effect of multiple hazards, such as extreme heat during drought, can amplify public health risks and strain response systems. These cascading impacts underscore the critical interdependence of water, sanitation, and health systems, and the need for integrated, cross-sectoral resilience planning and governance (Grigg 2018). Figure 1 illustrates some of the pathways through which climate change impacts public health, many of which are water-related (American Public Health Association, n.d.).

Figure 1. Pathways Through Which Climate Change Impacts Public Health



Source: American Public Health Association n.d.

2.1 Extreme Temperatures

Extreme temperatures severely strain water systems and public health; in fact, extreme heat takes more lives annually than any other climate hazard (Howard et al. 2024; US Environmental Protection Agency (US EPA) 2024; National Weather Service and NOAA 2025). Extreme heat reduces water availability through evaporation and increased demand, concentrates pollutants, and accelerates the growth of toxins, which heightens health risks, especially for communities with limited access to clean water (USGCRP 2016; Every et al. 2021; Z. F. Levy et al. 2021; National Council on Aging 2024). Populations with greater exposure, such as outdoor workers, older adults, and unhoused individuals, experience increased health risks. Racial disparities are stark: Black Americans are 40% more likely to live in areas with the highest projected heat-related deaths, and Hispanic/Latino individuals are 43% more likely to live in areas with the greatest projected labor losses due to extreme heat (US EPA 2021b). These risks are further magnified where extreme heat degrades water quality or disrupts sanitation systems, increasing exposure to waterborne contaminants and limiting access to the safe water needed to prevent heat-related illness.

Higher temperatures also elevate exposure to harmful algal blooms and associated toxins, as well as risks from other waterborne pathogens and toxins such as cyanobacteria, enteric bacteria, protozoan parasites, and viruses through recreational and drinking water, and food. These exposures can lead to illnesses like gastrointestinal and neurological disorders, liver and kidney damage, and septicemia (USGCRP 2016; Paerl and Huisman 2009; Wang et al. 2022; Zamyadi et al. 2012).

Extreme cold also poses threats to water systems and public health. For example, Winter Storm Uri in 2021 caused widespread power outages and water system failures across Texas, cutting off essential services (Calabretta et al. 2022; Igini 2022). In remote cold regions, such as rural Alaska Native communities, extreme cold intensifies the challenges of maintaining in-home water and sanitation systems. Where homes lack piped water or rely on systems vulnerable to freezing, residents experience higher rates of respiratory and skin infections, demonstrating how water and sanitation service disruptions directly affect health (Hennessy et al. 2008).

2.2 Drought

Droughts, especially when coupled with extreme heat, contribute to mental health issues, waterborne diseases, and contamination of private wells and community water systems (US Centers for Disease Control and Prevention (US CDC) 2018; Vos et al. 2021). During a severe drought in California, households reported increased stress and worsening of chronic health conditions (Barreau et al. 2017). Limited water availability can lead to hygiene-related illnesses, also known as water-washed diseases, which occur due to a lack of water for sanitation and hygiene (The Open University 2016), and increase the transmission of diseases like West Nile virus (USGCRP 2016; Energy and Environmental Affairs 2022).

Drought can concentrate naturally occurring contaminants such as arsenic in groundwater by lowering water tables and altering geochemical conditions. Lombard and co-authors (2021) estimated that drought conditions could increase the number of people exposed to elevated arsenic levels from private domestic wells from approximately 2.7 million to 4.1 million in the conterminous United States. Chronic exposure to arsenic in drinking water is a well-established risk factor for cancer and other adverse health effects (Mendez et al. 2017; Stoiber et al. 2019). Allaire and Acquah (2022) found that systems serving predominantly Black Americans were more likely to have arsenic violations, while systems serving predominantly Latino communities were more likely to rely on nitrate-contaminated groundwater. Some studies show racial disparities in access to municipal water systems, such as Black communities in Wake County being less likely to be connected to community water supplies (MacDonald Gibson et al. 2014). Private domestic wells receive less regulatory oversight than public systems, and socially vulnerable populations face greater barriers to testing and treatment, resulting in lower well-stewardship rates (Flanagan et al. 2016; George et al. 2023). As such, drought-related declines in groundwater quality and reliability are more likely to translate into sustained and disproportionate exposure to contaminants and create barriers to safe drinking water access, with direct implications for public health (Wamsley et al. 2024; Hayes et al. 2025; Williams et al. 2024; George et al. 2023; Greene and Ferguson 2024).

In addition to health risks, drought-related water shortages and treatment challenges can increase utility costs, placing financial strain on households and small water systems with limited resources (Barreau et al. 2017; US Water Alliance 2020). These rising costs may force difficult trade-offs between water, food, health care, or other necessities, particularly in low-income communities (Barreau et al. 2017; DigDeep 2022; US Water Alliance 2020).

2.3 Wildfires

Wildfires can severely contaminate water systems by depositing ash and sediment into source waters and by mobilizing volatile organic compounds (VOCs), such as benzene, within drinking water distribution systems. These impacts often trigger boil-water or "do not drink" advisories and posing long-term health risks (Bladon et al. 2014; Proctor et al. 2020). For example, following the 2002 Hayman Fire in Colorado, Denver Water undertook a $30 million dredging project to remove debris from the water supply (Meyer 2006). Similarly, VOC contamination after the Tubbs (2017) and Camp (2018) fires in Northern California resulted in "do not drink" advisories that persisted for months (Proctor et al. 2020). Furthermore, after a wildfire, concentrations of dissolved organic carbon (DOC) often rise in downstream water supplies. Elevated DOC can reduce the effectiveness of water treatment processes and increase the formation of potentially carcinogenic disinfection byproducts. This strains community water systems and increases the risk of cancer in people who consume the water (Bladon et al. 2014). Home filtration systems are not designed to remove the high levels of wildfire-related contaminants that can occur following major fire events (Water Quality Association, n.d.), further limiting access to safe drinking water. In addition to these physical health impacts, prolonged water quality disruptions, such as extended "do not drink" advisories, can contribute to adverse mental health outcomes, including heightened anxiety and stress among affected community members (McCarty et al. 2016).

Photo by EyeEm Mobile GmbH via iStock.

Wildfires that destroy entire neighborhoods or towns, such as the 2018 Camp Fire in Paradise, California, and the major fires in Los Angeles County in January 2025, can eliminate or severely damage the water and sanitation infrastructure that communities depend on for basic needs. The destruction of homes, service lines, and distribution systems can lead to a widespread loss of potable water and functional wastewater services, as heat damage and pressure fluctuations compromise system integrity and allow contaminants to move through the network (Bladon et al. 2014; Proctor et al. 2020). Consequently, when returning residents find water unavailable, unsafe, or restricted to nonpotable uses, they often must rely on bottled water, portable toilets, or temporary sanitation units, as documented after recent wildfire-related drinking water contamination events (Proctor et al. 2020; Water Quality Association, n.d.). Communities with fewer financial resources and those with existing health conditions experience the greatest obstacles to maintaining safe water and sanitation access during prolonged outages (Nagpal et al. 2024; Heil 2022). By compromising water quality, service lines, and wastewater systems, severe wildfires leave communities facing extended periods of unsafe or unreliable water and sanitation access, with serious implications for public health and long-term resilience.

2.4 Flooding and Extreme Storms

Floods can introduce chemical contaminants into water supplies, overwhelm septic systems, and spread pathogens (Pacific Institute and DigDeep 2024). For example, the US EPA estimated that Hurricane Katrina disrupted approximately 1,200 drinking water systems and more than 200 wastewater treatment plants, leaving over a million people without access for days to weeks (Congressional Research Service 2006; US EPA 2006a, 2006b, 2006c). This prolonged loss of safe drinking water and sanitation disproportionately affected low-income and displaced residents, increasing the risks of infectious disease, dehydration, and mental health stress in already overburdened communities (Johns Hopkins Bloomberg School of Public Health 2005; Johnson and Rainey 2007).

Similarly, Superstorm Sandy's coastal flooding in 2012 disabled centralized power and water infrastructure in New York City, forcing the evacuation of hospitals and nursing homes. This placed medically dependent and elderly populations at acute risk and exposed vulnerabilities in centralized health and utility systems (City of New York 2024; Levinson 2014). In 2017, Hurricane Harvey caused catastrophic flooding in the Houston region that overwhelmed centralized stormwater, wastewater, and health care systems, resulting in sewage overflows, petrochemical releases, drinking water advisories, hospital disruptions, and elevated public health risks in flood-prone, low-income communities (US EPA 2017; Stuckey 2017; Jones Sanborn 2018; Flores et al. 2021; Smiley et al. 2022; Berberian et al. 2024).

Flooding can also saturate soils around septic systems, causing effluent to back up into homes and expose residents to raw sewage (Calabretta et al. 2022). This contamination risk extends to nearby wells, as demonstrated in Texas *colonias*, where heavy rains in 2018 led to higher bacterial concentrations in private wells near flooded septic systems or cesspools (Rowles III et al. 2020).

Furthermore, floodwaters carry fecal bacteria, viruses, petroleum hydrocarbons, and pesticides, increasing the risks of gastrointestinal illness, skin infections, and other potential long-term health impacts (US EPA 2005; Alderman et al. 2012; Conrad and Harwood 2022). For instance, infections from *Vibrio vulnificus*, a highly virulent marine bacterium that enters the body through open wounds exposed to warm, brackish floodwaters, have increased in Florida following hurricanes (Florida Department of Health, n.d.).

Photo by FEMA/John Shea.

2.5 Sea Level Rise

Sea level rise exacerbates coastal flooding, saltwater intrusion into surface water and aquifers, and elevates groundwater levels in coastal communities. Unlike episodic flooding, saltwater intrusion driven by sea level rise poses an ongoing threat to drinking water security by degrading coastal freshwater aquifers and surface waters (Zamrsky et al. 2024). Together, chronic salinization and sea level rise-driven flooding disrupt drinking water and sanitation systems, including centralized infrastructure and household-scale wells and septic systems, increasing contamination risks or forcing systems offline (Cushing et al. 2025). When treatment capacity is exceeded or systems fail, residents may be exposed to salinity, inadequately treated sewage, and waterborne pathogens, even beyond flooded areas (Wade 2022; Hummel et al. 2018; Cushing et al. 2025). Damage to coastal wastewater infrastructure can disrupt service for more people than direct flooding alone, amplifying public health risks across a community (Hummel et al. 2018; Cushing et al. 2025). These risks disproportionately affect socially marginalized coastal communities, where households with lower incomes, renters, and communities of color are more likely to live near wastewater, industrial, and other hazardous facilities vulnerable to sea level rise-driven flooding (Cushing et al. 2025).

Elevated groundwater levels caused by sea level rise can also compromise coastal septic systems by reducing the separation between drain fields and groundwater (Vorhees et al. 2022). This can diminish treatment capacity and increase the release of inadequately treated effluent (Calabretta et al. 2022). Unlike acute flooding impacts, these failures can create chronic contamination of groundwater and nearby drinking water sources that persist long after floodwaters recede (Vorhees et al. 2022; Calabretta et al. 2022). In the United States, such septic system failures are already contributing to groundwater contamination, particularly in low-income coastal communities where monitoring, alternative water supplies, and remediation options are limited (Handwerger et al. 2021; Calabretta et al. 2022). These conditions increase sustained exposure to pathogens and chemical contaminants, elevating risks of gastrointestinal illness, skin infections, and other waterborne diseases, especially among populations with limited access to health care and safe water alternatives (Humphrey et al. 2011; US EPA 2025b).

3. Cross-Cutting Issues

While Section 2 describes health impacts associated with specific climate hazards, several critical public health challenges linked to water and sanitation systems cut across all hazard types. These impacts emerge through shared pathways such as water insecurity, infrastructure disruption, economic strain, and prolonged uncertainty (Grigg 2018). This section synthesizes three cross-cutting issues – mental health, economic impacts, and emerging contaminants - to highlight how climate change compounds public health risks beyond discrete hazard events.

3.1 Mental Health and Psychosocial Impacts

Climate-related water insecurity and loss of essential services contribute to a wide range of mental health challenges, including anxiety, depression, and post-traumatic stress disorder (Kimutai et al. 2023). Power outages during extreme climate events can trigger cascading failures across water systems, cutting off access to safe drinking water and sanitation, creating conditions that elevate public health risks, and further intensifying psychological distress (Kimutai et al. 2023; Melaku et al. 2023; Do et al. 2025).

Displacement from floods, droughts, and wildfires disrupts daily life, severs social networks, and causes traumatic stress, all of which negatively affect mental well-being and recovery (US CDC 2024; Lee et al. 2020; Barreau et al. 2017). As described in Section 2.3, wildfires can contaminate drinking water systems, leading to prolonged boil-water or do-not-drink advisories. This creates uncertainty about water safety, a documented driver of chronic stress and anxiety (US EPA 2021a; Water Quality Association, n.d.; Kimutai et al. 2023).

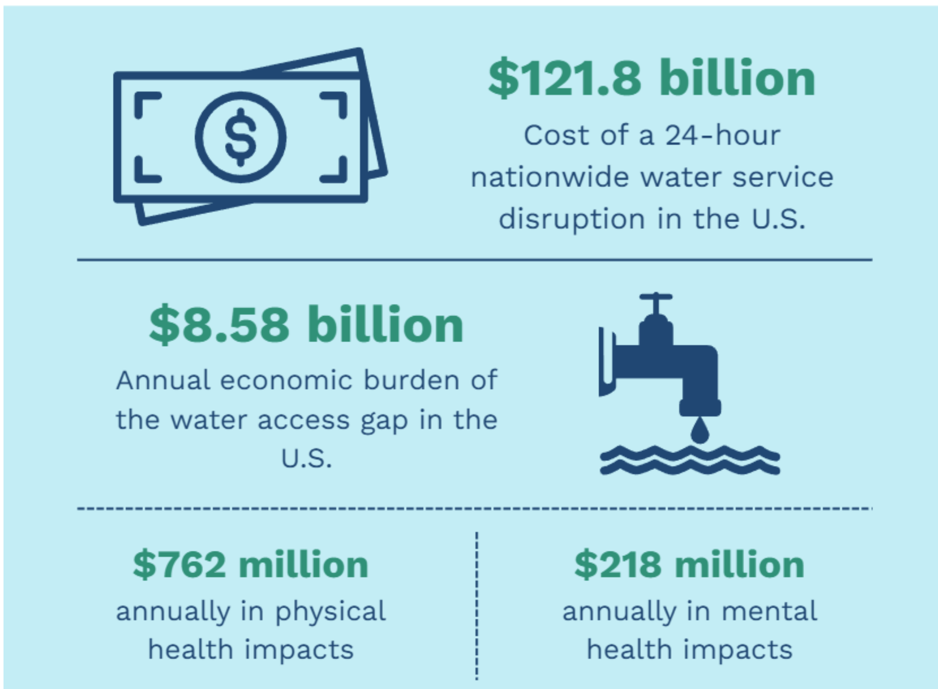
These impacts are especially severe for Indigenous, rural, and low-income communities, where repeated exposure to climate hazards and systemic barriers to mental health services compound risk and reduce adaptive capacity. Furthermore, the loss of culturally significant lands and water sources can break intergenerational ties and erode cultural identity, deepening psychological distress (Aung et al. 2025; Sodiq et al. 2025; Morganstein 2024). Addressing these challenges requires culturally informed, community-based approaches that support resilience and recovery (Loppie and Wien 2022; Dyk et al. 2018).

3.2 Economic and Workforce Impacts

Economic and workforce impacts from climate-driven water disruptions are not only financial challenges; they are key public health issues. Reduced income, job instability, and unsafe working conditions directly shape people's ability to maintain health, access care, and avoid heat- and water-related illness. Water disruptions caused by climate hazards have cascading economic consequences. Interruptions in water supply and sanitation systems reduce productivity in water-dependent sectors, such as agriculture, construction, and manufacturing (Environmental Defense Fund 2023; Marston et al. 2020; Smart Water Magazine 2025). These disruptions can halt operations, damage equipment, and increase downtime, leading to significant financial losses (US Water Alliance 2020). The Value of Water Campaign (2025) and DigDeep (2022) quantified the economic costs of ongoing water insecurity and new disruptions in the United States to illustrate the importance of reliable water service (see Figure 2). They estimated that a hypothetical 24-hour nationwide disruption of water service in the US could cost a total of $121.8 billion in economic output (Value of Water Campaign 2025). Beyond temporary disruptions, long-standing inequities in access to water and sanitation – known as the water access gap – create an estimated annual economic burden of $8.58 billion in the

US, including $762 million tied to physical health impacts and $218 million from mental health consequences (DigDeep 2022).

Figure 2. Economic Impacts of Water and Sanitation Access Challenges in the United States

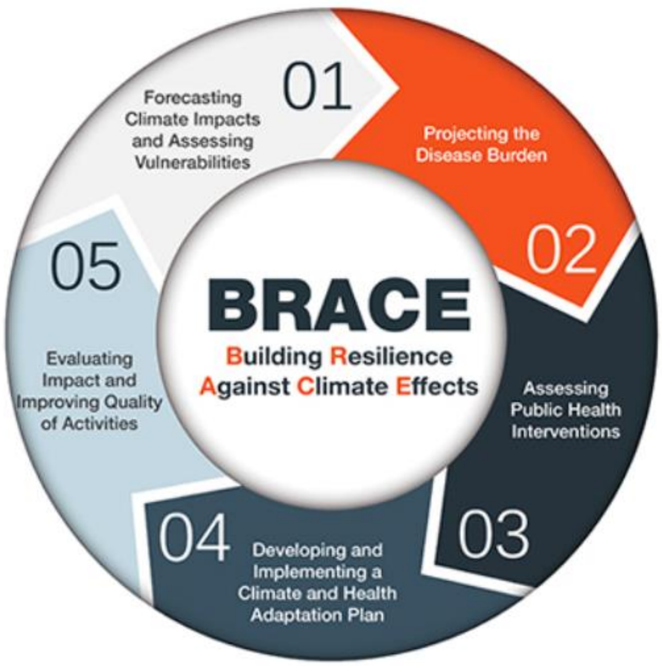


Source: Adapted from Value of Water Campaign 2025 and DigDeep 2022

Additionally, infrastructure damage from floods, droughts, or wildfires drives up repair costs and strains municipal budgets, burdening local economies (Pacific Institute and DigDeep 2024). Healthcare expenditures also rise due to an increased incidence of waterborne diseases, heat-related illnesses, and mental health conditions linked to water insecurity (B. S. Levy and Roelofs 2019; Barreau et al. 2017). Small businesses and rural economies are particularly vulnerable because they often lack the resources to absorb these shocks or invest in climate-resilient infrastructure.

Workforce impacts are equally significant. Extreme heat and unreliable water access threaten worker safety and productivity, especially in outdoor and labor-intensive industries such as farming, landscaping, and construction. Hispanic and Latino workers are disproportionately affected due to their high representation in weather-exposed jobs, compounding existing social and economic inequities (US EPA 2021b). Prolonged disruptions can also lead to job insecurity and wage losses, further exacerbating financial strain for low-income households. To prevent heat stress and dehydration, employers will need to adapt by implementing hydration protocols, cooling stations, and emergency response plans (B. S. Levy and Roelofs 2019). The US CDC developed the Building Resilience Against Climate Effects (BRACE) framework (see Figure 3) to assist public health agencies in anticipating likely climate change impacts in specific geographies, enabling the sector and other stakeholders to prepare and mitigate impacts (US CDC 2025). These dynamics surrounding climate change, health impacts, and access to water and sanitation underscore the need for integrated policies and governance that protect workers, stabilize local economies, and build resilience against climate-driven water challenges. Ultimately, protecting economic resilience and safeguarding worker health are essential components of preventing climate-related illness and reducing long-term public health burdens.

Figure 3. United States Centers for Disease Control and Prevention Building Resilience Against Climate Effects Framework



Source: US CDC 2025.

3.3 Emerging Contaminants

Emerging contaminants are substances or microorganisms, whether naturally occurring or manufactured, that are increasingly detected in the environment and may pose newly identified or re-emerging risks to human health or ecosystems (US EPA 2025a). Climate change is increasingly linked to the contamination of groundwater and surface water by emerging contaminants such as per- and polyfluoroalkyl substances (PFAS) and microplastics. Floods and stormwater runoff transport these pollutants, while wildfires and drought release or concentrate contaminants into drinking water sources (Proctor et al. 2020; Pennino et al. 2022; da Fonseca and Gaylarde 2025; Oliveri Conti et al. 2024; Parvez et al. 2024). These pollutants are now more frequently detected in floodwaters and drinking water systems, raising concerns about their potentially serious but poorly understood health effects (Cserbik et al. 2023; Gander 2022; Daly et al. 2018). Intensifying storms and flooding events driven by climate change are believed to increase the deposition of these contaminants in low-lying urban areas and floodplains, where they can persist in the environment and bioaccumulate, posing long-term risks to human health (Gander 2022).

Despite the known risks of contamination during flood events, private wells remain unregulated under federal drinking water standards like the Safe Drinking Water Act, and most states do not require regular testing (Flanagan and Zheng 2018). Studies show that well stewardship practices, including testing, are minimal (Colley et al. 2019), and when contamination is detected, the cost of filtration systems or bottled water can be prohibitive for low-income households (Sohns 2023). As a result, individuals relying on private wells face greater exposure to waterborne contaminants compared to those using regulated municipal systems (MacDonald Gibson and Pieper 2017; Allaire and Acquah 2022). This burden falls disproportionately on low-income, marginalized, and minority communities, who are more likely to lack access to water services and depend on private wells, further increasing their vulnerability to pollution (Sohns 2023).

4. Examples of Existing Prevention and Response Strategies

While few approaches explicitly integrate climate adaptation, water and sanitation, and public health, existing efforts across sectors demonstrate how targeted investments, community-led approaches, and climate-informed planning can reduce health risks associated with water insecurity. The examples below illustrate three key strategies: decentralized service delivery in climate-vulnerable communities, integration of climate and health into planning processes, and preventive investments that protect water quality and continuity of service.

Even though most remain limited in scope or scale, several existing approaches demonstrate how targeted, place-based investments can reduce public health risks associated with climate-driven water insecurity. For instance, in climate-vulnerable communities where centralized infrastructure is infeasible or unreliable, decentralized water and sanitation approaches have reduced exposure to health risks associated with water insecurity. In coastal Alaska, the Alaska Native Tribal Health Consortium piloted mobile water and sanitation technologies in Kivalina, an Inupiat community facing sea level rise and extreme storms (Alaska Native Tribal Health Consortium 2017, 2020). Designed with community input to reduce exposure to human waste, these systems led to residents reporting fewer illnesses and clinic visits. This aligns with evidence that Alaska Native households without in-home water services experience higher rates of respiratory and skin infections (Hennessy et al. 2008). Similarly, the Navajo Nation has implemented decentralized water hauling and solar-powered treatment systems to address chronic water insecurity exacerbated by drought and climate change (DigDeep, n.d.). These systems provide safe drinking water to households that previously relied on contaminated wells or distant sources. Research indicates that improved water access and quality can reduce gastrointestinal illness risk among Navajo Nation households (Grytdal et al. 2018). Together, these examples illustrate how decentralized and community-informed water service delivery can reduce health risks in climate-vulnerable communities where centralized infrastructure is infeasible or unreliable.

Beyond service delivery, other approaches focus on integrating climate, water, and health considerations into planning and decision-making processes. In the public health sector, Michigan State University and the Michigan Department of Health and Human Services developed a *Climate and Health Adaptation Planning Guide*. They used Marquette County as a case study to engage rural residents in identifying climate-related health risks such as waterborne disease and mental stress (see Figure 4). Flooding and water quality emerged as top concerns across many sectors, shaping local adaptation strategies (Michigan State University School of Planning, Design, and Construction et al. 2020).

Figure 4. Marquette Area Climate and Health Adaptation Project Community Visioning Workshop

Photo by Michigan State University School of Planning, Design, and Construction et al. 2020.

Funding programs also play a key role in safeguarding water quality. For instance, Delaware's Division of Public Health offers free water testing kits to private well owners, facilitating early detection of flood-related contamination and reducing associated health risks (Delaware Division of Public Health and Delaware Health and Social Services 2023). Similarly, New York City's Department of Environmental Protection incorporates climate projections into its water and wastewater infrastructure planning through its Climate Resiliency Design Guidelines. These guidelines mandate flood-resistant designs for pump stations and wastewater treatment plants, which minimizes contamination risks and reduces service disruptions during extreme storms. Maintaining operational water and wastewater systems during climate-driven hazards is critical for public health; service failures can expose communities to untreated sewage, contaminated drinking water, and waterborne pathogens, increasing the risk of gastrointestinal illness, skin infections, and other diseases. This proactive approach, by ensuring continuous access to safe water and sanitation, protects community health, reduces strain on healthcare systems, and serves as a model for urban climate adaptation strategies (NYC Mayor's Office of Climate and Environmental Justice 2022). These preventive and anticipatory efforts highlight the importance of upstream investments and planning in protecting water quality and maintaining essential services during climate-related disruptions, thereby reducing downstream public health risks.

Despite these efforts, gaps remain. While many water security frameworks include public health, they often overlook its direct and indirect impacts (Paudel et al. 2021). A review of existing literature on water insecurity and public health interventions by Schimpf and Cude (2020) found that most interventions are limited in scope and primarily focused on surveillance. Furthermore, few water insecurity policies in the United States promote public health and health equity (Schimpf and Cude 2020), and the review did not extend to interventions that incorporate climate considerations. Collectively, these limitations reveal a critical need for holistic, monitored strategies that unite water insecurity, climate change, and public health.

These examples illustrate that protecting public health in the face of climate-driven water challenges requires more than emergency response. Strategies that draw on climate-informed planning, reliable access to safe water and sanitation, and upstream prevention can reduce health risks even when climate impacts are unavoidable. However, because most efforts remain fragmented, under-evaluated, or limited in scale, more integrated and equity-centered approaches are needed.

5. Priority Research Gaps at the Intersection of Climate Change, Water and Sanitation, and Public Health in the United States

While the preceding sections synthesize existing evidence on how climate change affects public health through water and sanitation systems, significant gaps persist in both research and policy. The topics outlined in this section highlight priority questions and understudied linkages where limited data, fragmented governance, or emerging risks impede effective public health action. Identifying these gaps is essential for guiding future research, policy development, and investment. Although a growing body of research addresses elements of these topics, often in isolation, outside the United States, or focused on narrow components of climate, water, or health, this section specifically addresses gaps in research that examines these issues holistically, at the nexus of climate change, water and sanitation equity, and public health in the United States.

Photo by CDC/Robin Spratling on Unsplash.

Clarifying Health Pathways Linking Climate Change, Water, and Sanitation Access: Despite growing evidence connecting climate change, water, and public health, the ways in which water and sanitation systems mediate these impacts remain understudied. Future work is needed to disentangle the direct (e.g., exposure to contaminated water) and indirect (e.g., stress, mental health, economic strain) health consequences of climate-related disruptions to water and sanitation in the United States. Research can also examine how social determinants — such as race, income, geography, and disability — interact to shape water- and climate-related vulnerability and health outcomes.

Understanding Health Implications of Community-Centered Water and Climate Decision Making: Frontline and historically marginalized communities are often underrepresented in water management and climate adaptation planning. When water and climate adaptation decision making lacks equitable representation, it can deepen existing inequities, shift burdens, and create new challenges. Further research on participatory and equitable approaches at the intersection of water, sanitation, climate, and health planning and implementation is needed to understand their influence on health outcomes, especially for those most at risk. Although separate bodies of research examine participatory governance, climate adaptation, and health equity, few studies assess how community-centered decision making at the nexus of climate change, water and sanitation, and public health shapes health outcomes, particularly for frontline communities in the United States.

Investigating Health Impacts of Nature-Based Solutions for Water and Sanitation Resilience: Nature-based approaches, such as wetlands and forest restoration, urban green spaces, and permeable pavements, offer promising ways to improve water quality, reduce flooding, and enhance the climate resilience of water and sanitation systems. These strategies have the potential to reduce public health risks posed by climate disruptions to water and sanitation, in addition to offering numerous other co-benefits. Further research is needed to understand and evaluate the public health outcomes of nature-based water and sanitation strategies.

Monitoring and Evaluation for Climate-resilient WASH and Health Outcomes: Further research is needed to strengthen the monitoring and evaluation of climate-resilient WASH strategies. Future work could develop integrated frameworks that draw on existing public health indicators, such as the environmental public health indicators (EPHIs) used by local, state, and federal health agencies. These frameworks could help connect the performance of climate-resilient WASH to public health and equity outcomes at the local level, and leverage advances in data collection and community-based monitoring.

Expanding Understanding of Cultural and Educational Impacts of Water Insecurity: There is a need for future research to examine how climate-related water disruptions affect cultural continuity, especially in Indigenous and rural communities, and how these disruptions impact children's health and education. Schools facing water shortages or contamination may be forced to close or operate under unsafe conditions, disrupting learning environments and child development. Examining these broader social and cultural dimensions can clarify underexplored pathways through which climate-driven water insecurity shapes public health and equity outcomes.

Evaluating Water Supply and Infrastructure Vulnerabilities with Public Health Implications: Many cities rely on aging water infrastructure and water supplies that are increasingly vulnerable to climate stressors. Water supply disruptions in urban communities can impact thousands, or even millions, leaving them acutely vulnerable to public health risks like dehydration or pathogen transmission due to lack of hygiene. More integrated research is needed to explore how climate risks to water infrastructure and water supply intersect with public health risks, particularly in low-income urban neighborhoods.

Assessing the Role of Legal Frameworks and Climate Funding: Legal and financial systems influence public health outcomes during climate-related disruptions to water and sanitation by shaping service continuity, recovery timelines, and exposure to health risks. Regulatory frameworks establish water quality standards and emergency response requirements, yet many do not explicitly account for climate-driven system failures or equity considerations, contributing to uneven health protections across communities. Similarly, access to climate finance, insurance, and disaster assistance affects whether water and sanitation infrastructure can be repaired or adapted after climate events; delays increase the likelihood of prolonged exposure to contaminated water, inadequate sanitation, and associated physical and mental health impacts. In the United States, evidence remains limited on how these legal and financial structures mediate such pathways and shape differential public health outcomes, particularly for underserved and frontline communities.

6. Policy Recommendations

The following recommendations are informed by the evidence synthesized in this brief, which demonstrates that climate-driven disruptions to water and sanitation systems pose significant and inequitable public health risks. While not every recommendation corresponds to a single study or example discussed above, together they reflect cross-cutting implications of the documented pathways linking climate hazards, water systems, and public health. These recommendations are intended as a starting point for policy development and further evaluation, rather than a comprehensive or fully tested set of interventions.

1. **Strengthen Infrastructure Resilience:** Prioritize investments in climate-resilient water and wastewater infrastructure, particularly in communities facing the greatest climate-related risks, to prevent service failures that can lead to exposure to untreated sewage, contaminated drinking water, and waterborne pathogens.

2. **Integrate Climate and Health in Water Policy**: Incorporate public health risk considerations into water and sanitation policies, planning, and regulatory frameworks to reflect the documented health impacts of climate-driven system disruptions. Aligning climate adaptation, water management, and public health objectives can improve preparedness for service failures, reduce exposure to contaminated water and inadequate sanitation, and support more coordinated responses across water utilities, health agencies, and emergency management systems.

3. **Support Private Well and Septic System Management**: Expand funding and technical assistance for the testing, maintenance, and upgrades of private wells and septic systems, particularly in rural and underserved areas. Strengthening these systems protects public health by lowering the risks of gastrointestinal illness, skin infections, and other waterborne diseases, while ensuring safe sanitation during climate-related disruptions.

4. **Protect Water Access During Disasters**: Ensure the continuity of water service during extreme events, given the documented health risks associated with service shutoffs and contamination during climate hazards.

5. **Advance Environmental Justice**: Embed health equity metrics into water and climate policy frameworks to ensure fair resource distribution and protections. Equitable policies help prevent disproportionate exposure to contaminated water, inadequate sanitation, and climate hazards, reducing the risks of waterborne disease, heat-related illness, and mental health impacts.

6. **Fund Community-Led Solutions**: Support Indigenous and local initiatives that use community knowledge and participatory planning to deliver sustainable water and sanitation systems. These approaches help maintain safe water access during climate disruptions, reducing health risks and building resilience.

7. **Enhance Monitoring and Reporting**: Develop integrated systems to track water quality, health outcomes, and climate impacts, enabling data-driven decision making.

Photo by CDC on Unsplash.

7. Conclusion and Future Directions

Climate change is increasingly disrupting water and sanitation systems, intensifying health risks, and deepening social inequities (Pacific Institute and DigDeep 2024). This issue is particularly urgent given recent reductions and uncertainty in federal funding and programs, which are placing increased pressure on state and local governments to maintain water, sanitation, and public health protections amid escalating climate risks. These impacts are especially severe in communities already facing systemic barriers to safe water access, sanitation, and health care. Hazards such as extreme heat, drought, flooding, wildfires, and sea level rise are compounding water insecurity and straining public health systems.

Responding effectively requires integrated, cross-sectoral frameworks and approaches that align infrastructure investment, public health planning, and community-led adaptation with climate resilience goals. Policy action should prioritize climate-resilient infrastructure, protect water access during disasters, and embed equity into water governance frameworks. Strengthening collaboration among water utilities, health agencies, emergency management, and community organizations is essential to ensure inclusive and coordinated responses.

Future research should prioritize the health outcomes of climate-related water insecurity, the effectiveness of both existing and new WASH technologies, and the economic costs of water disruptions. Further studies should examine legal frameworks and climate finance mechanisms that influence recovery and resilience, as well as equity in governance and decision-making processes. Research into cultural and educational impacts, infrastructure vulnerabilities in urban settings, and the role of technology and real-time data systems will be critical for shaping holistic strategies. Intersectional analyses and documentation of Indigenous and grassroots adaptation approaches will help ensure equitable and evidence-based interventions. Developing integrated monitoring systems to track water-health-climate linkages will support timely decision making and policy innovation.

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