Issue Brief

Water Scarcity

A safe and reliable water supply is crucial for a healthy and prosperous society. Healthy communities need sufficient quantities of high-quality water for their residents year-round. Water supply managers are responsible for ensuring that plans are in place to meet water supply demands and address the threats to water quality. For much of the nation, these plans must address changes in precipitation patterns associated with climate change, which magnify the impacts of drought and water scarcity on water supplies.

A Government Accountability Office survey of state water managers found that officials in 40 states expect water shortages to occur in some parts of their states in the next decade.[1] These results are supported by a 2013 U.S. Geological Survey finding that showed an increase in the rate of groundwater depletion since 2000.[2] National water consumption has been increasing yearly, with total water withdrawals (ground and surface water) dominated by the electric power and agricultural irrigation sectors.

Background

Seventy-one percent of the Earth's surface is covered by water, and the oceans hold 96.5 percent of Earth's salt water.[3] Surface water found in rivers, streams, lakes, and reservoirs accounts for the majority of freshwater resources. Approximately 1.7 percent of Earth's water is groundwater, and it accounts for 30.1 percent of the planet's freshwater supply.[4] In 2005, the United States used 328 billion gallons of surface water and 82.6 billion gallons of groundwater every day.[3] Although surface water is used more to supply drinking water and to irrigate crops, groundwater is a vital natural resource that helps replenish rivers and lakes. Groundwater also provides drinking water for more than 90 percent of the rural United States population, which does not receive water from state water departments and private companies.[5]

The sustainability of surface water and groundwater supplies is threatened whenever consumption exceeds replenishment, and these supplies are dependent on precipitation for replenishment. Changes in precipitation patterns associated with climate change impact water supplies, either because the amount of rain or snow decreases or because rainfall patterns feature more severe storms in which stormwater runoff occurs preferentially to groundwater recharge. Water consumption greatly increases during periods of decreased precipitation and increased heat, as consumers want to maintain lawns and plantings and farmers need more water for crops and livestock. In coastal areas, sea level rise threatens surface water and groundwater supplies due to saltwater intrusion into low-lying reservoirs or aquifers. Climate change preparedness requires resource managers to assess the multiple threats that water scarcity poses to their states and citizens and ensure that adequate water is available in light of these challenges. Water scarcity affects every continent and approximately 700 million people in 43 countries suffer from water scarcity. By 2030, it is projected that half of the world's population will be living in water scarce areas.[6]

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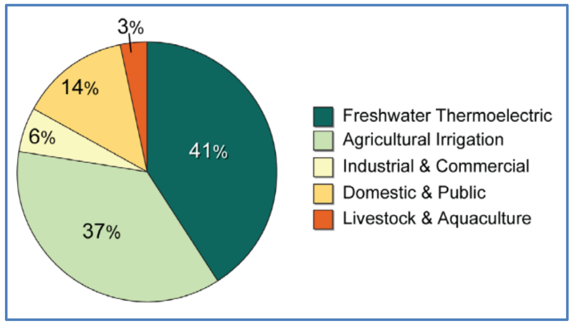
U.S. water consumption has doubled in the past 60 years to keep pace with the growing population. Groundwater and surface water use in the United States are dominated by the agriculture and energy production sectors.[7] As industrial and energy base activities expanded after World War II, water use continued to rise until more efficient practices and environmental awareness became widespread in the early 1980s. Many routine domestic, industrial, or agricultural activities can undermine the quality and quantity of freshwater resources, either because of contamination from pollutants or because water demand exceeds recharge, especially in areas with dwindling supply as a result of droughts.

Freshwater Withdrawals by Sector[7]



Climate Change

Climate change continues to alter the global hydrological or water cycle, which involves a delicate balance between evaporation, condensation, and precipitation. Water quality and quantity are also being impacted by climate change. Changes in precipitation, sea level rise, and increases in runoff and flooding can lead to salt-water intrusion, increased sediments, and nutrients and pollutants entering water supplies and making them unsafe. In addition, extreme weather events and flooding can damage the infrastructure used to treat, transport, and deliver water.[8] In the United States, climate change is threatening water resource management and supply across geographic regions and economic sectors. Droughts are expected to intensify due to longer periods of dry weather and extreme heat. The Southwest, Great Plains, and Southeast regions are particularly vulnerable due to short-term and long-term droughts. The overall extent and time scale of droughts range from seasons to years or even decades.[7] Shrinking water supplies will require state and territorial water managers to adopt strategies to meet the needs of growing communities, sensitive ecosystems, farmers, ranchers, energy producers, and manufacturers.[8]

Health Impacts

The global impacts of water scarcity on human health are profoundly demonstrated in countries where water-borne diseases such as diarrheal illnesses are a major cause of illness and death. Approximately one in nine people lack access to safe water, and unsafe water is estimated to cause more than 840,000 deaths per year worldwide.[9] Without an adequate supply of freshwater for human use, the double burden of decreased water quality and degraded sanitation facilities increases the risk of water-related illnesses. In arid regions, decreases in soil moisture results in increases in airborne dust levels, which contributes to suspended particulate matter and poor air quality that impacts respiratory disease.[10] Dry conditions promote wildfires, and water scarcity limits emergency response services' capacity to respond to them.

Water scarcity can also indirectly impact health by disrupting food systems and energy production. Without sufficient affordable, high quality water, farmers either stop irrigating crops or seek alternative water supplies, which may be of substantially lower quality and lead to a higher risk of bacterial contamination.[11] Irrigating with water contaminated with bacteria has been associated with foodborne illness associated with E. Coli, salmonella, Shigella, cryptosporidium, giardia, Toxoplasma, norovirus, and hepatitis A virus. Discontinuing irrigation can lead to crop failure, herd die-off, and a decline in the food supply, and poses threats to economic and social systems. Economic hardships among food producers has been linked to mental illness: one study found an increase in suicide rates among Australian farmers over a seven-year drought period.[10]

Water scarcity puts energy production at risk, as well as the vulnerable populations that rely heavily on it, such as patients with chronic disease who rely on electrical equipment to survive.[10] Water scarcity can also put non-agricultural communities at risk, as was demonstrated when a catastrophic chemical release contaminated the Charlestown, West Virginia water supply in January 2014.[12] Charlestown could not shut down its water supply, so the area water systems continued to provide contaminated water to households in order to maintain the basic sewage and fire suppression systems required for a community's health and safety.

Environmental Impacts

Water scarcity impacts to groundwater sources are especially critical in large regions of the Southwest, Great Plains, Midwest, Florida, and other coastal areas, where groundwater is the primary water supply. When groundwater is excessively pumped, the storage capacity of an aquifer can be permanently reduced, drying soils in a process known as aquifer-system compaction.[13] This effectively reduces ground support and has resulted in soil collapse, or land subsidence, in 45 states.[14] Groundwater pumping can also lead to saltwater intrusion, where saline groundwater found deep below the earth's surface rises and contaminates the fresh groundwater layer.[15] In coastal areas, salt-water intrusion threatens both groundwater and surface water systems.

Extreme weather events associated with climate change can impact surface water supplies, either from water scarcity associated with drought, or from water quality problems associated with severe storms. Severe storms are associated with greater stormwater runoff and associated contaminants such as heavy metals, industrial chemicals, and sediments into waterways. Inadequate source water protection from stormwater and other non-point sources of water contamination threaten surface water drinking water systems. High levels of nutrients in stormwater pollute drinking water sources and increase the probability of harmful algal blooms, creating additional stress on freshwater sources during droughts.

Economic Consequences

Improved water management has direct consequences for economic development. Populations with sufficient freshwater supplies for consumption and sanitation experience improved health and reduced healthcare costs and benefit from a strong workforce.[16] Economies can also benefit by indirectly trading water through water intensive goods. This is also known as "virtual water," and benefits regions with the most abundant water supplies, which trade virtual water largely in the form of agricultural goods.[17] Conversely, in areas with aging water infrastructure or limited or unreliable access to freshwater, higher water costs are routinely transferred to households and businesses[18].

Case Study: California's Freshwater Withdrawals

As the nation's produce basket, California is the largest agricultural exporter, producing almost two thirds of the country's fruits and nuts and generating more than $18 billion in annual revenue. Since 1980, the state has continued to increase its agricultural input despite a slow decline in water resources. More efficient irrigation methods accounted for some of this increase, but a number of these gains have been lost by practices such as growing water intensive crops like alfalfa during the summer. Under drought conditions, loss of agricultural production contributes to huge economic losses for the state, which is already experiencing significant job losses and expecting to lose $810 million in crop revenue this year.[19] The state's energy sector is also being impacted by water shortages, and in 2012 it experienced a one-third reduction in its hydroelectric-power generation relative to 2011.[19]

Monitoring

Making informed decisions to maintain a safe and reliable water supply requires data on both health outcomes and environmental conditions. Environmental monitoring is critical to understanding the effects of climate change on freshwater sources. Aquifers are particularly vulnerable to changes in the frequency and intensity of high rainfall periods, the seasonal timing of recharge events, and the strength of surface water interaction and basin geology. According to the 2014 National Climate Assessment report, aquifers are not generally monitored in ways that allow researchers to clearly identify climatic influences despite their critical importance as a water supply source. For example, many monitoring sites are focused in areas where aquifers are dominated by groundwater pumping, making it difficult to distinguish between climate effects from other activities, and highlighting the need for a national framework for groundwater monitoring.[7]

Policy and Management

Federal mandates provided by the Safe Drinking Water Act and the Clean Water Act authorize EPA to establish regulations for safe drinking water and for monitoring and controlling activities that contaminate the nation's potable and non-potable water sources. EPA relies on states to administer the regulatory requirements of both Acts.[10] Because these laws do not address issues of water scarcity or issues related to water resources shared across state boundaries, issues related to water scarcity present difficult policy challenges. Maintaining healthy communities can require public health agency participation in decisions about water policy.

States are divided between policy options that encourage either supply enhancement or demand management. Supply enhancement strategies span water reuse, desalination, and pollution control, while demand management may include economic policies to increase water use efficiency or reallocating water use towards higher value sectors. Water management is more effective when state agencies coordinate water policies. Conflicts are common due to each state's unique needs and priorities: For example, agricultural and energy policies may conflict and compete for limited water resources with respect to planting corn for ethanol. Public health officials can leverage the importance healthy communities when advocating for water conservation.

Balancing freshwater supply and demand across all users and industries requires that water management plans include consideration of climate readiness. Climate readiness can be integrated into water infrastructure through projects aimed at modernizing the nation's aging water and wastewater infrastructure.[20] Systems that are overwhelmed during high precipitation and runoff events create significant challenges for resource managers and planners. EPA developed the Climate Ready Water Utilities initiative to give resource managers tools and resources to help them better prepare for climate change impacts. According to EPA's 2011 Drinking Water Infrastructure Needs Survey and Assessment, the United States will require a $384.2 billion investment by 2030 to ensure that its public water systems are capable of continuing to provide safe drinking water to their customers.[21]

Examples of innovative structural and non-structural strategies to improve access to water in the United States include:[20]

- Encouraging water conservation at all scales of use and developing water conservation programs that use pricing incentives and rebates to curb use (e.g. residential rebates for qualifying high-efficiency clothes washers and toilets).
- Artificial aquifer recharge: enhancing natural groundwater supplies using man-made conveyances such as infiltration basins or injection wells.
- Reducing community water and wastewater systems' reliance on the central electricity grid by investing in more energy efficient water purification and supply systems and on-site or local renewable power sources.
- Green infrastructure projects that involve green roofs, rain gardens, roadside plantings, porous pavement, and rainwater harvesting.
- Monitoring and reporting epidemiological assessments of the risk of water scarcity. Typical data collected for water safety include water levels in aquifers or surface water sources (or snow pack levels in states that rely on mountain sources), concentration of reportable impurities (particularly downstream of known point and nonpoint source polluters), morbidity and mortality rates from food- and water-borne diseases, and the state of drought and environmental indicators of watershed safety, particularly for vulnerable populations
- Improving coordination among hydrologists, atmospheric scientists, and governmental water management officials to more effectively translate science to practice.

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